



# Report

**March 24, 1922**

**Sopris #2 Mine**

R E P O R T

ON

EXPLOSION AT SOPRIS #2 MINE, SOPRIS, COLORADO,

MARCH 24, 1922.

BY D. HARRINGTON.

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GENERAL STATEMENT

At about 3:40 P.M. March 24, 1922, there occurred an explosion in the Sopris #2 Mine of the Colorado Fuel and Iron Company, near Trinidad, Colorado, and 17 lives were lost. The day shift of about 125 miners and 50 day men were supposed to come off at 3:30 P.M., and all but eight of the day shift had reached the surface, some of them only a fraction of a minute before the accident, one or two men being slightly injured near the manway portal, and four bodies were found near the air shaft only a few hundred feet from the mouth of the mine. By using the system of checking men into and out of the mine, it was soon established that 18 men were missing, one of these appearing later on as he had failed to go into the mine after having taken his check.

The main fan off-set from the top of the shaft about 50 feet and provided with explosion doors immediately over the shaft, continued to run during and after the explosion, though the explosion doors were blown off and the coke-breeze concrete walls of the fan approach were partially wrecked. The damage to the fan approach was quickly repaired by boards and brattice, and within 40 minutes of the occurrence of the explosion the fan was again pulling air from the mine.

General manager Stout, who happened to be in the vicinity, division superintendent Thomas, mine superintendent Deldossa, company mine inspector McAlister, and others, together with state mine inspector Dalrymple, who was at Aguilar about 20 miles away when the disaster happened, and deputy state inspectors Lawrie and Machin, as well as numerous others aided in the recovery work which was prosecuted with much rapidity, utilizing the air currents by bratticing ahead, much of this being necessary as practically all the stoppings, overcasts and undercasts in the mine near the Main slopes were blown out. Although Mr. George Parker, in charge of mine rescue equipment and rescue work for the Colorado Fuel & Iron Company, was present with the C. F. & I. Co. Rescue Car and numerous men trained in apparatus work, and all assisted in the work, the oxygen apparatus were not used. The entire 17 bodies were recovered within 30 hours of the time of the explosion.

#### LOCATION

Sopris is one of the oldest coal mining camps in Colorado, and is located about seven miles southwest of Trinidad on the C. & S. and C. & W. railroads. It is also reached by the electric interurban from Trinidad. The Piedmont Mine is about one mile distant, and the Cokedale Mine is in a nearby canon about two miles to the northwest. The Sopris Mine is about 215 miles south of Denver.

### OWNERSHIP, OFFICIALS AND TONNAGE.

The Mine is owned and operated by the Colorado Fuel and Iron Company, of which Mr. J. F. Welborn, Denver, is president; Mr. E. H. Weitzel, Pueblo, general manager; Mr. D. A. Stout, Pueblo, manager of fuel department; Mr. J. P. Thomas, Trinidad, district superintendent; and Mr. John Deldossa, Sopris, mine superintendent. Mr. Deldossa has charge of both No. 1 and No. 2 mines at Sopris, the combined tonnage of the two properties in 1920 being 358,239, of which No. 2 mine produced about two-thirds, Sopris being one of the largest producing camps of the Colorado Fuel & Iron Company.

### GEOLOGY

The coal in Sopris #2 mine is in the Laramie formation in lower portion of the known coal measures of the Trinidad region, and not very far above the Trinidad sandstone. It is about 150 feet below the seam worked in #1 mine, and is said to be in essentially the same stratigraphic position as the Starkville Mine. The coal is bituminous and of good coking quality; is bright black, hard and rather brittle, and has fairly well defined "faces" which are about 70° inclination to the roof and floor. The immediate roof is a consolidated fine-grained shale, practically a sandstone, and resembles gray lime. There is a small gaseous seam of coal a few feet above the regular seam, yet the rock roof remains in place remarkably well and notwithstanding the blowing out of considerable numbers of timbers and props by the explosion,

there were comparatively few serious rock falls. The floor is of consolidated shale, somewhat hard, practically a sandstone, and about three feet below the coal seam worked in #2 mine is another small seam which also gives off considerable gas. Numerous rolls and faults and some dykes are found, faulting being responsible for driving of rock tunnels and interruption of systematic plan of laying out workings, as well as the source of large quantities of explosive gas. Coal thickness varies from three to seven feet. The dip of the coal seam varies in connection with faults, but is in general very light (probably less than 2 per cent) and the mine workings are comparatively level.

#### QUALITY OF COAL.

The coal has numerous bands of impurities and is so dirty as to require crushing and washing before coking. Formerly it was coked in beehive ovens at Sopris but at present is sent to Pueblo and coked in by-product ovens at that point. Below is analysis of a sample of coal from the face of the 3rd East entry by J. J. Forbes in May, 1919.

Air-dry loss.. 1.4	Coal (Air dried)	Coal (As recd.)	Coal (Moisture free)	Coal (Moisture & ash free)
<b>(Proximate analysis)</b>				
Moisture .....	.70	2.10		
Volatile matter ....	28.70	28.30	28.91	35.30
Fixed carbon .....	52.62	51.87	52.98	64.70
Ash .....	17.98	17.73	18.11	
	100.00	100.00	100.00	100.00
<b>(Ultimate analysis)</b>				
Hydrogen .....	4.66	4.75	4.62	5.64
Carbon .....	70.32	69.33	70.82	86.49
Nitrogen .....	1.27	1.25	1.28	1.56
Oxygen .....	5.03	6.21	4.42	5.39
Sulphur .....	.74	.73	.75	.92
Ash .....	17.98	17.73	18.11	
	100.00	100.00	100.00	100.00
<b>Calorific value determined,</b>				
Calories .....	6962	6864	7012	8563
British thermal units	12532	12355	12622	15413
<b>Calorific value cal- culated from ultimate analysis,</b>				
Calories .....		6986		
British thermal units		12575		

Date, June 9, 1919.

(Signed) W.A.Selvig,  
Asst. Chemist.



It will be noted that practically 20 per cent of the coal as mined is inert matter (moisture plus ash), nevertheless it has the comparatively high heating value of 12356 B.T.U.

While some advancing entry faces are moist or wet, comparatively few roof drippers are found, and holes drilled for blasting are usually dry; moreover, the roadways are in general free of water, though occasionally pools are found near faulted regions and water kept down by pumping. Rooms, in general, are dry.

#### LAY-OUT OF MINE WORKINGS.

The mine is operated on the room and pillar system, the main slope from the surface being about 15 per cent for a distance of about 700 feet to the coal, then on a light grade about 1-1/2 to 2 per cent to the dip. There is a substantial pillar between main slope and its air course with a heavy protecting pillar between rooms and the main slope and main air course. Level entries, with about 50-foot pillars between, are turned off the main slope to the right and to the left at intervals of about 500 to 700 feet and from these levels rooms are turned, room length being about 250 feet up to 400 feet. Entries are 8 to 12 feet wide except where coal is low and floor brushed and "gob" stored on the rib, in which case the original entry width is 16 to 18 feet, and after "gobbing" is completed about 8 to 10 feet. Room width is about 22 to 24 feet with room pillars about the same.

In the region of the 8th West faulting has intervened and rooms 14 and 15 off the 7th West were utilized as entries to attack the 8th West region driving entries both east and west; the region of the 8th West to the east or "left", encountered faults necessitating driving rooms off rooms to extract the coal, and on the other hand, the 8th West entries going west encountered low coal necessitating the use of "gob" entries and also room brushing.

In the driving of the main slope (which actually has a very light grade, except the first 700 feet from the mine portal), the faults encountered in the 8th West were also encountered and a rock tunnel was driven for a distance of a few hundred feet, the lower end of the rock tunnel being about 500 feet from the location of the slope faces at the time of the explosion.

In order to increase the total quantity of air for the mine, it was decided somewhat over a year ago to drive a third or left slope, and this third slope was being driven at several places in the lower part of the mine with intent ultimately to extend it back to a point opposite the air shaft, giving a three-entry system for the slopes practically thruout.

## OPERATING METHODS.

### Mining and Shooting:

The coal in the first north region was undermined by pick miners, while the rest of the mine was undercut by electrically driven short-wall machines, most of the undercutting being done on the night shift, the machine men going on shift at 2:30 P.M. while the day shift went off at 3:30 P.M. The three slopes were driven on the day shift by four men who had a contract cutting and loading using electrically driven short-wall machines to do the cutting, this machine being the only one operated during the full day shift at the time of the explosion.

All holes are drilled by miners (about two holes to an entry face, and three or four to a room face), using breast auger, the miner supplying the one to two, or three sticks of Monobel #4 permissible explosive per hole, and also providing the adobe dummies. The miner carries the explosive into the mine in a fiber container holding about eight sticks. Also where brushing is done (generally in the floor to a width of about seven feet in entries and five feet in rooms), Monobel #4 is used (about one to three sticks in the one hole drilled). All shots are fired by shotfirers who enter the mine at 11:00 P.M. (after all others are out of the mine) and shoot by electric battery. No shots are supposed to be fired during either day or afternoon shafts, or between them, and no exception to this rule was made as far as can be ascertained.

### Haulage:

Gathering in rooms is done by mules, and on main levels there are 500 volt D.C. trolley locomotives. About 700 feet from mouth of the main slope is the main parting from which a surface hoist pulls the coal by rope up the approximately 700 feet of 15 to 20 per cent grade. Heavy steel rails are laid on haulage roads where mechanical hauling is done, and lighter steel rails are laid on mule hauls in entries and rooms. Haulage tracks are generally dirt ballasted. Some of the cars are of steel and some of wood with iron bands; all have end doors, hence have leakage of slack along roads and have capacity of about 3000 pounds of coal.

### Electrical Equipment:

The mine is equipped with both 440 volt A.C. and 500 volt D.C. current, power wires going down the air shaft and the return air course to the 1st North and to the 7th West, thence into 7th and 8th West; one line also goes down the main west slope air course to the face. The 500 volt D.C. is used on electric locomotives in the 1st North, Main slope from 7th West to main parting 700 feet from mouth of slope, and in the 7th West also for one pump. The 440 volt A.C. is used for electric cutting machines and three small pumps in the 7th and 8th West, and in the Main slopes. The mine was not thought to be sufficiently gaseous to require power wires kept on intakes, but after the explosion wires are to be removed from returns.

There were four electric cutting machines manufactured by the Sullivan Machinery Company, all being in use about three years and described as CE-7, 440 volt A.C., 42 amperes, 60 cycles, 30 H.P., and said to be flame-proof, originally carrying Bureau of Mines permissibility plate, the latter not being found on the machines in the mine after the explosion. The machine in the 8th West air course was #5969, the one in the Main slope #5970, and the one in room 3 off room 8, 8th left, #5968, the machine in the 7th West not being seen because of water. The power wires serving the machines were well insulated triplex cables, each of the three parts being about #6 copper wire or strand. At points available to places in which the machines were to be used, the three wires of the insulated cables were separated for a few feet and bared for a few inches to provide for connection with the machine cables to give power to the machines. Ordinary flexible machine cables were used on the machine reel. The connectors on the machine cable to be attached to the mine power wires were home-made and of #6 copper wire, bent to form prongs; contacts were made by pushing this prong over the bared places on the power lines.

Ventilation:

The main fan is steam-driven, belt-connected, substantially housed with fan location offset about 50 feet from top of air shaft, and fan well protected by suitable explosion doors which were blown out by the explosion and the fan left uninjured. Ordinarily, the fan pulled 70,000 to 80,000 cubic feet of air per minute from the mine, with water gage of 2.6 to 3.1 inches and on the day after the explosion the water gage was 5.0 inches.

Air samples taken by J. J. Forbes on May 19, 1919, were as follows:

	3rd East Entry Return from East Side of Mine.	4th West Return from Entire Mine.
Quantity (Cu.Ft.per min.)	7680	74,400
Wet Bulb Temperature	61	61
Dry Bulb "	63	62
Relative Humidity	89½	94½
CO <sub>2</sub>	0.13	0.09
O <sub>2</sub>	20.57	20.56
CO	0.00	0.00
CH <sub>4</sub>	0.56	0.44
N <sub>2</sub>	78.74	78.91

From the above it will be noted that the main return had 0.44 per cent methane for 74,400 cubic feet of air per minute, this agreeing fairly closely to the 500,000 cubic feet of methane per 24 hours said to be removed from the mine before the explosion by the 75,000 cubic feet of air being handled.

Underground workers used only permissible electric cap lamps of the Wico make and were prohibited from carrying matches, smoking material, etc., though from evidence at the coroner's inquest search for the latter was not made very systematically. Flame safety lamps were used only by officials, such as shotfirers, fire bosses, foremen, etc., and these lamps were of magnetically locked type as required by an order of the state coal mine inspector, applying to all coal mines of Colorado. Below is data as to air quantities splits, etc., as given at the coroner's inquest from report by deputy state coal mine inspector Lawrie of his last inspection of Sopris #2 mine, January 30, 31 and February 1, 1922.

Location	No. Men	Area (sq.ft.)	Velocity (Lineal ft. per min.)	Quantity (Cu.Ft. per min.)
Main slope intake	--	68	800	54,400
Manway intake	--	--	--	21,000
Main return	--	48	1600	76,800
7th West entry	12	42	200	8,400
8th West entry	40	45	60	2,700
5th East entry	21	40	140	5,600
4th East entry	31	50	160	8,000
3rd East entry	11	40	100	4,000
4th North entry	25	40	300	12,000
Main slope faces	4	60	140	8,400

(Fan Revolutions 200 - Water gage 3 inches)

Overcasts were constructed of brick or concrete, or both, and main entry stoppings generally of coke breeze-concrete of about 8-inch thickness. Doors were of wood, generally with door jamb of 8 by 8 or 10 by 10 timber, set in concrete frame. Line brattices were used to some extent to carry air from last crosscut to the working face; and room crosscuts driven approximately 60 feet apart.

Methane issued from roof, coal and floor and in region of the main slope could be heard bubbling through the water at points several hundred feet from the working face. Holes drilled in the coal in face of the West main slope before the explosion forced out methane at sufficient velocity on April 4, 1922, to turn an anemometer, and on that date while making the mine examination, one of the state inspectors secured a 3/8-inch gas cap on a Koehler safety lamp at a point about 100 feet from the face of the West main slope in a separate split of 8,400 cubic feet of air per minute, supposed to be ventilating only the three advancing slope faces, though the air may have been contaminated by leakage as permanent stoppings had not been placed after the explosion. Drill hole in the face of the 8th West air course drilled before the explosion, gave off methane at considerable velocity on April 4, 1922, and as ventilation had not been completely restored, a heavy gas cap was readily obtained in this entry face. At the coroner's inquest it was brought out that room 10 off the 8th West (left) entry was one of the most gaseous places in the mine and, in general, it was brought out that gas accumulations could be



expected in almost any part of the mine upon interruption of ventilation, and probably dangerous accumulation at face of main slope upon interruption of ventilation for as short a period as quarter of an hour.

Safety Practices:

This mine, known to be gaseous and to have an easily ignited and explosive dust, had adopted numerous safeguards against possible explosion. Since 1911, it has been equipped with a system of humidifying intake air, and it is said that rarely, if ever, did air of the mine workings have relative humidity less than 90 per cent. (This humidification system is described in Appendix #1). Roadways were sprinkled by water car and in places by hose. No open lights of any kind were used, all underground workers having Wico electric/<sup>cap</sup>lamps and only the mine officials used flame safety lamps, and these were magnetic locked.

A well equipped and housed fan was provided and the mine divided into splits with substantial concrete or brick overcasts, stoppings, etc. While electricity was used underground, trolley wires and pumps were generally located on intake air courses, though main power wires were on the return. The electric cutting machines were of flame-proof type and all coal was undercut by machine or by pick; shooting was done by battery by shotfirers after all but the shotfirers were out of the mine, and nothing but permissible explosive (Monobel #4) was used, and the amount of explosive per hole held within the permissible limit and holes tamped with clay.

In addition to having a foreman and assistant foreman for the day shift, there was a night boss and there were three fire bosses and three shotfirers, all of whom were expected to take part in detecting and removing dangerous conditions, such as accumulations of gas and dust. There was also a company mine inspector who made periodical examinations with especial respect to dust and ventilating conditions, and at intervals samples of air together with air quantity were taken at each ventilation split and at the fan, and the air analyzed as to methane content by the company's chemist. A system was in operation checking all employees into and out of the mine, and all persons were supposed to be searched before going into the mine for matches, smoking tobacco, etc.

In addition, the company had numerous men trained in the use of oxygen breathing apparatus, had a readily available mine rescue car thoroughly equipped with oxygen apparatus, stretchers, etc., and various kinds of emergency equipment, such as telephones, telephone wire, power wire, etc.; and while the oxygen apparatus was not used, much of the emergency equipment on the car proved of material aid in effecting the prompt removal of the bodies after the disaster.

## THE MINE INVESTIGATION AFTER THE EXPLOSION

### General Statement:

As before stated, the fan was uninjured by the explosion and it required but about 40 minutes to repair the fan approach to a sufficient extent to start pulling fumes out of the mine. Before the time the fan approach was repaired there was a reversal of air, the air shaft becoming downcast instead of upcast and forcing explosive gases out of the manway and Main slope. By utilizing the ordinary air currents, together with emergency equipment such as telephones, telephone wire, brattice cloth, etc., which were quickly available, many of the bodies were recovered within three hours of the explosion though at least six overcasts and more than fifteen doors and sixty main concrete stoppings had been blown out.

### Main Slope and Main Return Air Course:

While there was sufficient force at the mouth of the Main slope to partly dislodge about 30 feet of the roof of the concrete approach, still there was little destruction along the slopes until the 4th West was reached, though some props were dislodged, and just outbye the 4th West two doors on the return air course deflecting the return air to the air shaft were blown outbye and two bodies found near these doors; two bodies having previously been found in the manway, one about 260 feet and the other 320 feet from the manway portal.

