

PRELIMINARY REPORT OF GAS EXPLOSION OF MAY 29, 1931,
IN THE RICHARDS COLLIERY, SUSQUEHANNA COLLIERIES COMPANY,
NEAR MT. CARMEL, NORTHUMBERLAND COUNTY, PENNSYLVANIA

By

S. P. Howell,
Explosives Engineer

DEPARTMENT OF COMMERCE
BUREAU OF MINES

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Introduction:

This explosion was of a body of gas at and near the face of No. 38 breast, 174 feet above the monkey heading which apparently accumulated because of a derangement of the ventilation. The means by which this gas was ignited has not been definitely established by the writer, but with the evidence now available it seems probable a blown-out shot of high explosive - probably the permissible branded explosive Red HCLF - ; or by the electric current used for firing the shot; or by incandescent smoking material - cigarettes, lighted match.

The explosion occurred about 12:20 p.m., Friday, May 29, 1931, on the day shift.

Ventilation:

Near the place of origin of the explosion there are four active breasts working, 38 to 41 inclusive. Because of a faulted section there are no breasts between Nos. 35 and 38. The air enters the gangway to No. 43 chute, hence to the monkey heading, and then toward the face of No. 38 breast, it being directed or coursed through the last open heading between the breasts and is directed toward the face of each breast by means of wooden brattice with canvas brattice near the face. From breast 38 the air returns to the monkey heading, passes through headings to No. 35 breast, from 35 breast through the top headings to 33 breast, then through a hole to the gangway at the

level above. It was near the portal of this hole into this gangway of the shaft level that the coal had sloughed off, from the pillar above that gangway, restricting the return air. The firebosses' marks at this hole on the top round were dated, that is, the more recent ones, 5-2, 5-13, 5-29, and 5-30. The fireboss had visited this place the morning of May 29, and there was no impediment to the ventilation there then.

The miners from 39 breast were returning by the way of 41 chute after eating their lunch on the gangway at the time of the explosion, and neither were injured, but it is rumored that they exchanged information with the miners of No. 38 breast, both of whom were killed, just before the lunch hour to the effect that there was gas in both places.

The Location of the Section:

Breasts and chutes, numbered 38 to 41 inclusive, are off of the east gangway off the No. 12 slope off the shaft level in the No. 4 (Little Back) seam on the North Dip. Coal averages about four feet thick, has a pitch varying from 20 to 28 degrees, and all of these working places are considered gassy.

General Information:

The only electricity entering or used in this section is that which is provided by the Schaffler system 10 hole capacity, and the Hercules Midget 5 hole capacity blasting units. Atlas No. 6 electric blasting caps with six foot copper legs are used, and these legs are shunted. In coal the permissible explosive Red HCLF in $1\frac{1}{2}$ by 8 inch cartridges is used, and in rock at the face of the gangway

60 per cent gelatin dynamite in $1\frac{1}{2}$ by 8 inch cartridges is used. Individual miners use the permissible Wheat electric mine lamp while the pair of miners in each breast have one permissible Kohler flame safety lamp magnetically locked. Supervisory officials all carry the same kind of flame safety lamp.

Occasionally a miner who is under suspicion or a miner selected at random is thoroughly searched for matches and smoking material, and it is reported that on the morning of May 29, 1931, a search disclosed matches in the possession of a miner and he was disciplined by being discharged.

Flame safety lamp No. 8 found on the steps of the manway of No. 38 breast, 15 feet from the face, indicated by visual inspection that it was in first-class condition.

Safety lamp No. 74 which was found near the face of No. 40 breast showed by visual inspection that it was in first-class condition. The management are willing to have these two lamps sent to Pittsburgh for lamp box test, but this apparently is entirely superfluous.

One miner working in 40 breast was drilling a hole in the east rib, the collar of this hole being about 8 feet from the face. This hole was in about 8 inches. This position of the man was almost directly opposite the second heading through pillar $39\frac{1}{2}$. He was killed by being thrown violently against the rib. He was not burned. The other miner in the breast was somewhat lower in the breast and was near the sheet-iron slide. At the time of the explosion he threw himself on this slide, and slid about a hundred and forty feet down

it to the gangway. He was not seriously injured.

One miner from No. 38 breast was found on the left (east) rib of No. 39 breast with most of his clothing blown off, and severe wounds from violence. His clothing bore evidence of burns. He was evidently killed instantly. It seems probable that this miner was perhaps standing in the top heading in pillar 38 $\frac{1}{2}$, and received the full force of the explosion from No. 38 breast.

The other miner from 38 breast was found along the right (west) rib of No. 39 breast just outby the corner of this rib with the top heading. His clothing bore evidence of burns but he did not show evidence of much violence.

The miners in 41 breast were uninjured and it is reported that neither they nor the miner who survived from No. 40 breast saw any flame.

Two shot-firing units were found along the left (east) rib of No. 39 breast, one of them—the Schaffler system—was badly indented on the outside as though it had been projected violently, possibly from the top pillar heading in 38 $\frac{1}{2}$ pillar.

After the explosion there was discovered in this heading two 25 pound cases of Red HC L.F. permissible explosive, and neither the cartridges nor the boxes showed evidence of extreme violence. There was likewise some electric blasting caps lying loose between the boxes after the explosion. There was no evidence of a carton near by. On the low side of this heading strands of hair were found as though a man had been violently skidded along this lower side of the heading.

The force of the explosion entered the gangway through No. 38 chute with great violence and fatally injured two men who were loading a car at that chute, a driver and a loader.

On the gangway about fifteen feet outby No. 38 chute four men were eating lunch. They were not seriously injured. They were the three gangway miners and a loader.

It is not yet established as to who owned the Schaffler system battery but if it were owned and used by the miners in 38 breast, it could not have been projected where it was found unless it was suspended, or held, somewhere in the top heading through 38 $\frac{1}{2}$ pillar. On the other hand I am assured that if the miners had fired a shot at the face of No. 38 breast that their safety lamp would not have been found so near the face of that breast.

At the face of No. 38 breast near the center of the breast was a 15 inch socket (bootleg) of a hole which had obviously been drilled in such a way that it had no chance to break the coal properly, and was obviously liable to blow out.

Fatalities:

There were five fatalities, the two miners from No. 38 breast who were found in No. 39 breast, one miner in No. 40 breast, and a driver and a loader on the gangway.

Rescue Work:

The driver was killed instantly on the gangway; the loader was very severely injured and died in about twelve hours at the hospital. His was the only hospital case. Three bodies in the breasts were

recovered by 6 o'clock Friday evening, May 29, in advance of fully re-stored ventilation by four men wearing McCaa Self-Contained Mine-Rescue Breathing Apparatus.

Foreman Miner Jesse Henson assisted in the investigation which was made on June 4, 1931.

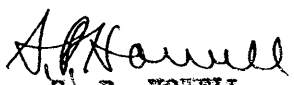
Air Samples Taken:

The following mine air samples were taken: No. 718 at the face of No. 41 breast; No. 575 at the face of No. 40 breast; No. 717 at the face of No. 40 breast (it is possible that this sample is a "dud" because the bottle did not sizz when the tip was broken); No. 573 at the face of a blind heading off No. 39 breast (this was the only place where the safety lamp showed any evidence of gas. The flame of the lamp went out); No. 574 at the face of No. 39 breast; and No. 576 at the face of No. 38 breast.

Members of the Inspection Party Made June 4, 1931:

A trip into the explosion area was made by the following representatives of the Susquehanna Collieries Company: Mr. R. C. Penman, mine foreman, Richards Colliery; Mr. George E. Cleaver, general inside foreman, Richards and other collieries; Mr. C. H. Brehm, supervisor of safety and compensation, Wilkes-Barre, Pa.; and Mr. C. E. Billman, inside foreman at the Cameron Colliery but temporarily assigned to the Richards Colliery, and the following representatives of the U. S. Bureau of Mines: Mr. Jesse Henson, foreman miner, and Mr. S. P. Howell, explosives engineer.

Respectfully submitted,


S. P. HOWELL,
Explosives Engineer.

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DEPARTMENT OF COMMERCE
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C O N T E N T S

	<u>Page</u>
Introduction	1
Location	2
Production and Employees	2
The Mine	3
The Coal Bed	3
Method of Mining	3
Ventilation and Gases.	4
Haulage	9
Lighting.	9
Machinery Underground.10
Explosives, Blasting Accessories and Blasting Practice10
Storage and Transportation of Explosives12
First-Aid, Mine-Rescue, and Safety Organization.15
Conditions Immediately Prior to the Accident15
Rescue and Recovery Operations17
Mine Conditions After the Explosion. . . .v.19
Summary of Evidence as to the Cause and Origin of the Explosion22
Probable Cause of the Explosion	24
Recommendations	24
Acknowledgment	25
Appendix A - Map of a portion of Richards Colliery	
B - List of fatally injured	
C - Individual gas analysis report sheets	

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INTRODUCTION

This was a gas explosion in 38 breast, east north dip gangway, No. 4 vein, No. 12 slope, shaft workings, Richards Colliery, Shamokin Division, Susquehanna Collieries Company, near Mt. Carmel, Northumberland County, Pa., which occurred about 12:20 p.m. on May 29, 1931.

There were fourteen men in the section at the time of the explosion, four of whom were killed outright, one succumbed about twelve hours after the explosion from the effects of violence, and nine were uninjured.

None of the uninjured men were imprisoned, or their lives placed in serious jeopardy by the explosion.

The fatally injured are listed in Appendix B.

The accident was caused by accumulation of a body of gas probably caused by a fall or slipping off of a mass of coal which in turn partially closed an air hole outby 38 breast. The ignition of this gas was probably simultaneous with a blown-out (or windy) shot of a permissible branded explosive used in a non-permissible manner. The ignition may have resulted from the flame of the explosive or from the arc or spark from the current from a Schaffler system 10-hole capacity, shot-firing unit. It is remotely possible that the ignition may have been caused by incandescent smoking material, though no direct

evidence was adduced to substantiate this.

The effect of the explosion was localized in 38, 39, and 40 breasts and on the gangway at and near 38 and 39 chutes.

This explosion was investigated by the writer and Mr. Jesse Henson, foreman miner, U. S. Bureau of Mines, in company with officials of the Susquehanna Collieries Company on June 4, 1931, and subsequently by the writer.

LOCATION

The Richards Colliery is near Mt. Carmel, Mt. Carmel Township, Northumberland County, in the West Mahanoy district of the Western Middle Anthracite Coal Field of Pennsylvania, and is served by railroad connection with the Pennsylvania Railroad.

The Richards Colliery is operated by the Susquehanna Collieries Company, P. O. Box 427, Wilkes-Barre, Pa.

The principal officers of the Susquehanna Collieries Company with whom the writer made contact are: Mr. C. A. Gibbons, general manager, Wilkes-Barre, Pa.; and Mr. William Watkins Williams, district superintendent, Shamokin Division, Shamokin, Pa.

PRODUCTION AND EMPLOYEES

In 1930 the entire colliery produced about 600,000 short tons of coal, worked 285 days, and employed 1096 men. The average daily production in May, 1931, was 2172 short tons.

This section of the colliery - east gangway, No. 4 vein, No. 12 slope, shaft workings - produces an average of about 70 tons per shift (2,000 pounds) of which about 85 per cent is coal.

In this section there are about 17 employees including super-

visory officials.

THE MINE

The production of the Richards Colliery comes from three separate units - the Richards slope, the Richards shaft, and the water level tunnel.

The section in which the explosion occurred is reached by a 900-foot shaft, a short gangway or tunnel, a 20°, 290-foot slope, and the east gangway in some 2000 feet.

This east gangway is in the No. 4 (Little Buck) vein, north dip.

The section from breast 38 to 41 is considered very gassy, and no power-driven equipment is used for mining here.

THE COAL BED

The coal in the No. 4 vein is anthracite, averages four feet thick, and dips northerly, in the section involved, from 20 to 29°. One inch from the bottom there is a band averaging about three inches thick. The roof is a black sandstone which requires timbering. It is several feet thick. The floor is a hard, black sandstone, having a smooth surface.

METHOD OF MINING

The breast and pillar method of mining is used and the chutes are normally placed on 50-foot centers but because of local irregularities in the vein in the section affected by the explosion, this placement of the chutes and other dimensions did not conform closely. The gangways are twelve feet wide; the monkey headings and other headings six feet wide; the breasts twenty-four feet wide, and

the breast pillars twenty-six feet thick. About 40 per cent of the coal is extracted in advance work, of which all is recovered.

The coal is mined at the face by blasting and hand pick work. Pillars are not now being extracted in this section. No mechanical loaders or conveyors are used, but because of the pitch and the use of sheet iron slides, the coal slides or is easily pushed to the gangway.

There are systematic timbering rules which bear evidence of enforcement. There are three lines of props in the breast, spaced 6 feet apart, and the posts in each line of props are spaced 6 feet. Cap pieces one to two inches thick, two feet long, are generally used on the props in the breasts. Monkey headings and other headings are generally posted on the high side, the posts being spaced about six feet apart.

VENTILATION AND GASES

The section of the mine in which the explosion occurred is rated as gassy; is known to produce considerable gas; and care was taken to see that the air was conducted to the face of all breasts.

The ventilation was conducted in the manner shown in Appendix A of the map of this section of the mine, and was in the east gangway to the face of the gangway through 43 chute, back the monkey heading, to the face of breasts No. 41, 40, 39, and 38, back to the open heading to breast 36, then through the top heading and the monkey heading from breast 36 to breast 35, to the face of breast 35 through the top headings to the top of breasts 34 and 33, then through an air hole

into the east north dip gangway in the No. 4 vein, shaft level, at which point it split and returned to the surface through numerous inactive and other workings.

Special attention is directed to the vent where this air hole enters the east dip gangway, shaft level, for it is here that the loose coal from a pillar above this point, broke off and slid into this air hole, and blocked, at least partially, the return air at this point, thereby substantially reducing the ventilation of the affected area, and permitting the accumulation of a body of explosive gas. Since this point was visited early on May 29, by the fire boss and was reported clear, it may be concluded that this fall and slide of coal occurred sometime before noon of May 29, though this is not certain.

This area was ventilated by an 8-foot Connellsville force fan, while the west split of the exhaust from this east gangway was equipped with a Jeffries exhaust fan. The Connellsville fan is electrically driven. There was said to be no reserve motive power for this fan. It is located outside and the volume of the air in the main intake aggregated 80,000 cubic feet per minute. The air entering the east gangway No. 12 slope was from one of ten main splits. The air returning to the east gangway of the shaft level from the affected area measured 3,350 cubic feet per minute on May 19, 1931. The fan is inclosed in a steel housing with the motor in a near by brick building. The fan is equipped with explosion doors and the air may be reversed by door adjustment. The fans are run continuously and not slowed down. The water gauge on the Connellsville fan is plus 1.2

inches, and on the Jeffries fan minus 1.6 inches.

The fire bosses employed make pre-shift inspections and forenoon inspections. Fourteen men are employed in this section. Stoppings are made of wood reinforced with cleats and wood patching, that is, calked. Stoppings in chutes and monkey headings are provided with slide doors. There are no overcasts. Old workings are ventilated. All of the shaft section is considered as gassy.

On May 18, 1931, gas was discovered in 38 breast and was removed by repairing a faulty stopping, being the stopping in the pillar 34 $\frac{1}{2}$ second heading above the monkey heading, as shown in Appendix A. It is considered that gas may be suddenly liberated and a vigorous attempt is made to keep the mine free from standing gas. A quiet bleed-er was known to exist at the face of 40 breast.

Fire bosses' report of inspection and testing is recorded in the fire bosses' report book.

For gas detection the permissible magnetically-locked Kohler flame safety lamp is used, there being one for each working place in which two certified miners are employed, fire boss, section foreman and mine foreman. Miners, and others, use the permissible Wheat electric cap lamp. Mixed lights are not used in this section.

The only source of electricity in this section would be from the battery of the electric cap lamp and from the generator or magneto type of shot-firing units which are described elsewhere.

Table 1 - Tabulation of analyses of mine air samples in places off East, North Dip, Gangway; No. 4 Vein; No. 12 Slope; Shaft Workings; Richards Colliery, Shamokin Division, Susquehanna Collieries Company, Northumberland County, Pennsylvania

Lab. No.:	Date:	Hour:	Location	Pitch, degrees:	Analyses					Remarks
					CO ₂ :	O ₂ :	CO:	CH ₄ :	N ₂ :	
54429	4	a.m.	Face of 41 breast.	20	0.13	20.75	0.00	0.40	78.72	Flame safety lamp did not indicate inflammable gas.
54428 ^a	4	a.m.			.15	20.71	.00	.65	78.49	
54426 ^a	4	a.m.	Face of 40 breast.	20	.12	20.77	.00	.55	78.56	do.
54424	4	a.m.	Face of 11-foot, blind heading from east rib of 39 breast, 16 feet below face of breast.	5	.25	15.80	.00	21.00	62.15	Flame safety lamp indicated inflammable gas. Then extinguished.
54425	4	a.m.	Face of 39 breast.	22	.27	19.92	.00	3.59	76.22	Flame safety lamp did not indicate inflammable gas.
54427	4	a.m.	Face of 38 breast.	22	.15	20.58	.00	.89	78.39	do.

^a Duplicates - 54428 taken first.

Note: Samples taken in the order tabulated between 9 a.m. and midday.

Since ventilation had not entirely been restored to normal by June 4, for men were finishing the building of and calking some of the wooden brattice, no air velocity readings were taken. Samples were taken at the face of breasts 41, 40, 39, 38, and at the face of the blind heading just below breast 39, as indicated in Appendix A, tabulated in Table No. 1, and shown by individual report sheets in Appendix C.

It will be noted that the sample taken at the face of the 11-foot deep blind heading from the east rib of 39 breast, 16 feet below the face of that breast, showed 21.8 per cent of methane, 15.8 per cent of oxygen, no carbon monoxide and 0.25 per cent of carbon dioxide. The safety lamp was extinguished when slowly raised at the face of this blind heading. It should be said that the face of the heading was pointed somewhat toward the rise; and had not been squared up, and its cross-sectional area at the face was therefore very much reduced.

The sample taken at the face in the 39 breast (54425) showed 3.59 per cent of methane, 19.92 per cent of oxygen, and 0.27 per cent of carbon dioxide. The brattice at this face was some 15 feet east of the point of taking the sample; the sample was taken at the top and foremost point of the face; and the brattice was six feet from the face. Because of this, this sample was not in a moving air current. Moreover, the testing and sampling at the face of the blind heading certainly moved some gas out into 39 breast after the test at the face of 39 breast with the safety lamp and before the gas sample was taken.

The other samples varied from 0.40 to 0.89 percentage of methane in the samples increasing progressively from that taken at the face of 41 breast to that taken at the face of 38 breast, that is, in the direction of the ventilation. These percentages indicate that unless the ventilation is at all times kept up to a high standard, dangerous percentages of methane will surely accumulate, and that a high degree of inspection and supervision must be maintained in order to meet this hazard in this dangerously gassy section.

HAULAGE

The track gauge is 48 inches; the rails 40 pounds per yard. Animal haulage is used on the gangway, rope haulage on the 290-foot slope. The slope is 20° grade.

The cars are of the steel and wood end-gate type and sprags are used. On the slope there is a back switch heading, derrails are not used. There is no trolley wire on the gangway.

The men walk from the foot of the shaft to their working places.

There are no safety hooks on the cars.

Haulage is on intake air.

LIGHTING

For general illumination miners and officials use permissible sheet electric cap lamps. Permissible magnetically locked Kohler flame safety lamps are used for testing by miners and officials. Each pair of certified miners have one such lamp. Mixed lights are not used. Neither flood lights nor incandescent lights are used in this section.

MACHINERY UNDERGROUND

The only power-driven machinery in the section is the non-permissible electric plunger pump located at the foot of No. 12 slope. It works against a head of at least 125 feet and is guarded.

EXPLOSIVES, BLASTING ACCESSORIES, AND BLASTING PRACTICE

In blasting coal the permissible branded explosive Red HC, L.F. is used. For blasting rock Atlas 60 per cent strength gelatin dynamite and duPont Gelex A (60 per cent strength), are used. For starting batteries Atlas 40 per cent strength extra dynamite (ammonia dynamite) is used.

All shots are fired electrically, and where single shots are used, as in coal, the Atlas No. 6 electric detonators having six feet copper legs, shunted, are used.

The driver delivers the explosives to the miner's chute and raps on battery for the miner to take the explosive up. The miner procures his explosive in original twenty-five pound cases and the breast miners store their explosives in a near by heading, usually on the low side of the floor but in gangways the explosives are stored in gangway boxes.

Electric blasting caps are procured by the miner from the supply room and are taken underground in original cartons, there being fifty units in each carton. Explosives and electric blasting caps are not hauled or stored in the same vehicle or container.

The maximum charge of the permissible branded explosive Red HC, L.F. permitted is 4, $1\frac{1}{2}$ by 8 inch cartridges which is slightly more than two pounds. The average charge is three cartridges which is

slightly more than $1\frac{1}{2}$ pounds (one $1\frac{1}{2}$ by 8 inch cartridge of the permissible branded explosive Red HC, L.F. weights 240 grams).

The holes are about six feet deep. An average of eight holes to a breast which is 24 feet wide, in the No. 4 vein is used. Mixed charges are not allowed and as observed explosives are in good condition as stored underground for use.

Bags of anthracite are used for stemming, and are tamped with a wooden tamping bar.

Certified miners load the cartridges which are not slit or broken during charging, and tamp and fire any time during the shift. An effort is made to get the miner to charge his explosive without breaking the wrapper, that is, not attempt to get a high charging density.

The usual routine is for the miner to test for gas before retreating to fire his shot, to remove the shunt on the legs of the electric blasting caps immediately before connecting to the shot-firing line, and to fire one shot at a time. An effort is made to get the miner to so direct the hole that the charge of explosive will have a chance to break the coal without blowing out or producing a windy shot. This is particularly necessary in the breaking-in shot, where there is but one free face.

The miners in 38 breast used a 10-hole Schaffler blasting unit while the miners in 39 breast use a 5-hole capacity Hercules Midget.

The firing line is two separate lines of No. 20 gauge annunciator wire.

The rules of the mine regarding misfires are to wait fifteen minutes, then investigation by the miner, and to remove by drilling a hole eighteen inches away. It is stated that very few misfires occur.

Dependant shots are not fired simultaneously but sometimes two independent shots in the same face such as two relievers or two rib holes are fired simultaneously. It was stated that occasionally slightly windy shots occurred.

A socket such as the 15-inch socket observed in the face of 38 breast is not unusual.

An official who had been at this mine three months stated that no accidents from blasting had occurred in 1931 to the date of the accident here reported.

STORAGE AND TRANSPORTATION OF EXPLOSIVES

Magazines at the Richards Shaft are on a cleared area. The magazines stand 150 feet apart. The explosives magazine is 450 feet from the hoist house and at least 700 feet from a public road - the Natalie highway - and is screened from the highway by substantial trees. The detonator storage magazine is 150 feet from the explosives magazine. These magazines are not barricaded.

The probable maximum quantity of explosive stored in the magazine at one time is 7,000 pounds, and the most vulnerable near by place is the hoist house. If this magazine should explode while men are being transported on the cage, it is apt to be very disastrous. The American Table of Distances shows that inhabited dwellings should be at least 1610 feet from a magazine containing as much as 7000 pounds of explosive. This indicates very definitely that the hoist house

especially should be protected from the effects of an explosion of this magazine, no matter how remote such an occurrence may be considered. It should be barricaded and the quantity of explosives stored in it kept to not more than 800 pounds, thus conforming to the American Table of Distances for inhabited buildings.

These two storage magazines, however, are well designed, well constructed, and maintained in first-class condition. They are dry, well ventilated, lined with wood, no exposed metal on the inside (a minor infraction in this regard will be noted later), and bear evidence of very good housekeeping. Nothing other than explosives are stored in the explosives magazine, and nothing other than electric blasting caps in that magazine. There is a ten-inch sand filled space between the matched sheeting lumber, and is maintained without leakage of sand.

Explosives and electric blasting caps are brought to the magazines by the manufacturer or his agent in separate motor-propelled vehicles, the explosives are taken from the magazine - about 32 cases daily - loaded on special explosives cars on a near by side track used exclusively for this purpose.

From here the explosive is taken by a trolley locomotive to the shaft, thence on to the cage of the shaft to the shaft bottom; hauled by mules to slope No. 12; by rope haulage to the bottom of this slope, where explosives are transferred to ordinary coal cars in which they are hauled by mule along the gangway, taken out of the cars and placed in the chute by the driver, then left for the miner who comes for the explosive.

Obviously it would be better if the special explosives car itself were taken into the gangway, for the covered cars are needed here as well as elsewhere to protect the explosive.

On the front of the door of the electric blasting cap magazine or detonator magazine was the sign "Explosives - Keep Off" while on the door of the explosives magazine was printed "Danger - High Explosives." At the very top of the gable in front of the explosives magazine was a sign "Explosives - Keep Off". The first two of these signs are not as well placed as they might be for they offer an alluring target and such signs should thus preferably be placed at the entrance to the area and so positioned that a bullet passing through them will not hit either magazine. The sign at the very top of the explosives magazine because of its great height is not considered a menace.

A few of the boxes in the explosives magazine were placed above the ventilating vent in the floor. Some of the boxes were placed against the sides of the magazine. Better ventilation would be given these boxes if they were kept, say, 6 inches from the inside of the magazine. This can easily be accomplished with certainty if false inside walls of vertical strips be placed four to six inches from the wall.

The detonator magazine because it was not very high was piled with boxes of electric blasting caps almost to the roof. In one place a long nail had extended through the roof into the magazine, presenting a hazard for if a box should be forced against the end of this nail it might penetrate the box through a carton and into the capsule of an electric blasting cap. If this was so, it would be

likely to cause all of the electric blasting caps to explode. This protruding nail should be removed or clipped, preferably removed.

Before leaving this subject the writer desires to emphasize the very favorable impression that these magazines made upon him with respect to their design, construction, and maintenance.

FIRST-AID, MINE-RESCUE, AND SAFETY ORGANIZATION

The Susquehanna Collieries Company maintains at the near by Scott Colliery, $1\frac{1}{2}$ miles away, a rescue station equipped with 5 McCaa 2-hour self-contained mine-rescue breathing apparatus, a respirator, and accessory equipment. The Scott Colliery was not visited by the writer.

The company recently placed a supervisor in charge of their accident-prevention and compensation department, and this is very favorably noted by the writer.

CONDITIONS IMMEDIATELY PRIOR TO THE ACCIDENT

The section was working regularly and as usual, and since May 29 was the last working day of the month, it is not unlikely that the miners were bending every effort to get out as much coal on this day as possible. The writer was reliably informed that the two miners in breast 38 and the two miners in breast 39 had exchanged information sometime that morning to the effect that there was gas in each place.

Information is to the effect that the fire boss, Samuel Spheffal, had made the pre-shift inspection of the working places in this section, made the forenoon inspection, and in addition had been, that morning, where the fall was later discovered, and had found it not blocked.

The fourteen men in the immediate section where the explosion

occurred were distributed as follows when the explosion occurred; four men - the three gangway miners and one loader - were on the gangway, not more than twenty feet outby 36 chute, eating their mid-day lunch, or otherwise engaged. The driver - Kish - and a loader - Meleski - were loading coal from the chute into the car on the gangway at 38 chute. It is possible that Kish was adjusting a chute board. The two, 41 breast, miners were in their working place. The two, 40 breast, miners were in their working place, one drilling a hole near the face, on the left side, namely, Paraginski, while the other miner, Kinitchey, was thirty feet from the face, shoveling coal onto the sheet iron slide. The two, 39 breast, miners were returning to their working place, after lunch, on the gangway, and were not far from 40 chute in 40 breast. The two miners in 58 breast were probably in the top heading between 38 and 39 breasts.

The explosion occurred about 12:20 p.m., and it is not clear why the miners from 38 breast had not come to the gangway for their lunch since their lunch buckets were there. This raises the question as to whether or not it may not be possible that they wanted to fire some shots before lunch so that the smoke could clear out while they were eating lunch, or possibly, were anxious to blast additional coal so that lunch was of secondary consideration.

It was reported that no shots were noted as having been fired in 38 breast for sometime previous to the explosion.

A miner in the near by section - west north dip gangway, No. 4 vein, No. 12 slope - was suspected of having smoking materials and was searched and discharged the morning of May 29.

RESCUE AND RECOVERY OPERATIONS

The explosion occurred about 12:20 p.m., Friday, May 29, 1931.

The fall or sloughing off of coal which blocked the ventilation probably caused the accumulation of gas in the section, but it is possible that this fall did not occur until the time of or shortly after the explosion. In any event the afterdamp remained in the section until this fall was removed, some hours later, and it impeded the recovery work greatly. The explosion caused no fire in the section.

The force of the explosion disarranged the ventilation by destroying considerable brattice, and blew out the stoppings in 38 and 39 chutes. Curiously, practically no posts or props were blown out. The coal in 38 chute was released and fell into the gangway.

The four men who were just outby 38 chute spread the alarm and rescue and recovery operations started promptly.

The fatally injured man - Moleski - was first found, given medical attention underground, removed to the Shesokin State Hospital, where he died about 12 hours later.

A check up showed four additional men unaccounted for - three miners and a driver - two 38 breast miners, one 40 breast miner, and the driver (Kish).

The air stopping in 38 chute was found blown out. The two mules hitched to the car at 38 chute were uninjured but found turned eastward.

Kish's body was found after a search back of a leg of a

timber set, not burned, but killed by violence.

Canvas for restoring ventilation was then sent for and inspection of workings started. Proceeding up 38 breast the afterdamp was too strong above the first heading to proceed; retreated to gangway; the force of men started to restore ventilation with canvas beginning at 38 chute.

Proceeded on gangway to 41 chute; up to face of 41 breast; here everything normal except small cap of gas at face. No evidence of afterdamp here; through first breast heading into 40 breast and found evidence of afterdamp, but no gas; retreated to gangway; others joined the party; returned to 40 breast via 41 breast; at first heading into 40 breast; still found afterdamp but got far enough to detect gas; returned to breast heading for consultation and decided to use the McCas 2-hour rescue apparatus which had been previously sent for; four men thus equipped recovered in a short time the body of Leo Paraginski, found just below the face of 40 breast (Appendix A).

The protected rescuers then proceeded into 39 breast and recovered, first, the body of Lewis Bogdon on the east side of 39 breast, above the blind heading, and next the body of Paul Probilla in 39 breast at the lower corner of the top heading to 38 breast, i.e., on the west side of 39 breast. These rescuers then returned to the gangway.

Previously others had been directed to inspect the return at split on east gangway, Shaft level, and reported that they found the airway partially blocked, about half blocked.

All bodies were on the gangway before 6 p.m. and to the

surface before 7 p.m.

The fall at the split was cleaned up the night of May 29, 1931, all men withdrawn to the gangway at 38 chute, and the restoration of ventilation by wooden brattice begun. Thirty-eight breast was clear of gas by 6 a.m., May 31. While thus restoring ventilation plenty of gas (CH_4) was found ahead of the workmen.

The rescuers consisted of officials of the Richards and other collieries of the Susquehanna Company and State Mine Inspectors Quigley and Evans.

Officials of the colliery gave these state mine inspectors credit for invaluable services.

Speedier rescue operations were hindered by the impediment to the ventilation, in addition to the usual heat, afterdamp, gas and dust.

MINE CONDITIONS AFTER THE EXPLOSION

The force of the explosion was directed outward from 38 chute, the evidence being that Bogdon and Probilla were blown out of the heading from 38 toward 39 breast, and one of them - Bogdon - carried across 39 breast. They were killed outright by violence and flame. The blast was also through the top heading from 39 breast to 40 breast, where the blast blew Paraginski, where he was drilling a hole in the east rib of 40 breast, against the rib, killing him outright by violence. The force was likewise out 38 and 39 chutes into the gangway, while at 38 chute it killed Kish outright and fatally injured Moleski, both by violence.

The brattices from the top headings toward the faces of 38,

39, and 40 breasts, were substantially damaged, though this damage was solely to the boards and not to the posts.

As observed, there were no posts in any of the top headings. The writer was credibly informed that there were two or three posts in the top heading between 38 and 39 breast before the explosion. At one place, sixty feet below the face of 40 breast a section of sheet iron slide was moved eastward and doubled over.

Just below where Bogdon's body was found a Schaffler 10-hole blasting unit was found. It had been damaged severely by violence. It was in all probability projected from the top heading. It is the writer's opinion that it could not have been thus projected unless in the hands of Bogdon because of its great weight per unit volume. Near this Schaffler blasting unit was a Hercules Midget blasting unit, not damaged by violence. Inquiry developed that the Hercules Midget was used by the miners in 39 breast while the Schaffler blasting unit was owned and used by the miners in 38 breast.

Before and after the explosion there were two full open 25-pound cases of the permissible branded explosive Red HC, L.F. They were not exploded or burned by the explosion but were shifted toward 39 breast, and one case was undamaged, the other was pulled apart, but the contents were not scattered about. Between the boxes there were a few electric blasting caps loose and not in a carton as found after the explosion.

After the explosion a fall of coal, which restricted the ventilation, was found in the air hole at the top of 33 breast.

The Wheat permissible magnetically-locked electric cap lamps were found all in good condition after the explosion, except that worn by Bogdon, which was badly damaged by violence, and its condition immediately prior to the explosion could not, therefore, be determined with certainty.

The flame safety lamp used by the miners in 36 breast was found on the steps of the manway fifteen feet below the face of the breast in an undamaged condition and with the round wick $1/4$ inch below the top of the burner. It is known to be extremely difficult, if not impossible, for round wick flame safety lamps with suitable fuel in quiet air to burn if the wick is more than $1/8$ of an inch below the top of the burner, and this seems to furnish additional and circumstantial evidence that the wick may have been turned down and burning in inflammable gas.

At the face of 36 breast one hole had been fired - a breaking in hole - so positioned that it had no opportunity to blast the coal properly, and the bottom of the hole was in the form of a socket, 15 inches deep. The material around this fifteen inches of the hole was shattered for one to two inches, indicating that the explosives in this portion of the hole had detonated properly. This shot was at least a windy shot and may be called a blown-out shot. It is recalled that no shots were heard to have been fired in 36 breast prior to the explosion, and it is probable that this shot was fired simultaneous with the explosion. If so, the gas may have been ignited by the shot which probably consisted of four $1\frac{1}{2}$ by 8 inch cartridges of the permissible branded explosive Red EC, L.F. aggregating about two pounds

in weight, or by the current used for firing the charge. The charge was certainly fired with the Schaffler blasting unit of 10-hole capacity. It is known that the current used for firing was ample to ignite the gas should a floating short exist before or as the charge is fired, or should a short circuit be produced by the blast.

There was no direct evidence found after the shot that either of the two miners in 38 breast were smoking at the time of the explosion, neither had they ever been under suspicion as having smoked in the mine.

A bore hole sample of the loose material around the socket of the hole at the face of 38 breast was taken by Mr. Penman under the writer's direction and tests of this sample made in the Explosives Chemical Laboratory of the Bureau of Mines - Mr. J. E. Crawshaw - showed that the explosive used in the hole had certainly detonated and not burned.

SUMMARY OF EVIDENCE AS TO THE CAUSE AND ORIGIN OF THE EXPLOSION

The writer accompanied by Messrs. C. H. Brehm, Supervisor of Safety and Compensation; George E. Cleaver, General Inside Foreman; R. C. Penman, Mine Foreman, Richards Colliery; and C. E. Billman, Inside Foreman of the Susquehanna Collieries Company, and Jesse Henson, Foreman Miner, U. S. Bureau of Mines, investigated the explosion on June 4, 1931. Subsequently the writer interviewed Messrs. Cleaver and Penman.

The following items appear to the writer to need special emphasis:

A. Inflammable gas (CH_4) accumulated in 38 breast and elsewhere, probably due to a fall on the East North Dip Gangway, shaft

level, which blocked, in part, the return from the affected section.

B. The miners in 38 and 39 breasts, not only knew their places were considered gassy, but are reported to have exchanged information the morning of May 29 that each place had gas in it.

C. The 38 breast miners probably fired a windy or blown-out shot immediately before, and almost simultaneous with the gas explosion. Evidence supporting this is (a) that no shot was heard in this breast by survivors prior to the explosion; (b) the 15-inch socket; (c) the projection of the Schaffler shot-firing unit evidently from the top heading between 38 and 39 breasts, and probably in the hands of Bogdon, and (d) the position of the 38 breast miners in, or very near, the top heading, the place of firing, when the explosion occurred. Contradictory evidence is the finding of the Kohler safety lamp fifteen feet below the face of 38 breast on the manway.

D. The shot of a permissible branded explosive in a non-permissible way (a) by firing in a dangerous mixture of firedamp, (b) in excess of $1\frac{1}{2}$ pounds; (c) probably tamped with anthracite stemming and (d) by firing in a hole so positioned or placed that it obviously was liable to blow out.

E. The firing of a shot with a non-permissible shot-firing unit, which produces an electric current ample to ignite firedamp. The writer, by test, has ignited firedamp (8 per cent natural gas and 92 per cent air) with an identical shot-firing unit.

F. There is no direct evidence known to the writer which casts suspicion on the 38 breast miners smoking or striking a match.

The direction of the force and the burns to Bogdon and Probilla

only, and the violence to all victims places the source of the force as an explosion in 38 breast.

The ignition was probably at or near the face of 38 breast, near the shot, though it is possible that the current from the shot-firing unit may have ignited the gas anywhere along the shot-firing line, i.e., from the top heading between 38 and 39 breasts to the shot.

PROBABLE CAUSE OF THE EXPLOSION

The primary cause of the explosion was the accumulation of firedamp in the section, specifically in 38 breast, probably due to deranged ventilation caused by a fall of coal in the gangway above at the top of 33 breast.

The ignition probably occurred simultaneous with the firing of a shot of a permissible branded explosive used in a non-permissible manner, fired with a non-permissible shot-firing unit.

The ignition may have been caused either by the flame of the explosion or by an arc or spark from the current of the shot-firing unit.

It is remotely possible that the ignition was caused by incandescent smoking materials such as a match or cigarette.

RECOMMENDATIONS

The following recommendations are submitted in the expectation that a repetition of this type of disaster will not occur:

1. That all working places be adequately ventilated by a regular coursing of the air and that all air courses be protected against such falls as may impede the ventilation.

2. That supervision and inspection be adequate to insure that no shots be fired in dangerous percentage of firedamp.

3. That shots be so placed that they will not blow out, or produce windy shots, and so that they will have a fair chance to bring the coal.

4. That permissible branded explosives be continued in use and used in a permissible manner.

5. That single shots should all be fired with a permissible single-shot blasting unit.

Unless and until a multiple shot blasting unit is devised which will fire electric blasting caps with a current which will not ignite gas single shots only should be fired in those sections of mines which are classed as gassy.

6. The method of searching for matches and smoking supplies pursued by this company is very commendable and should be continued.

ACKNOWLEDGMENT

The excellent cooperation given the writer of this report by Mr. C. A. Gibbons, general manager; Mr. William Watkins Williams, district superintendent, Shamokin Division; Mr. George E. Cleaver, general inside foreman; Mr. R. E. Penman, mine foreman, Richards Colliery; Mr. C. E. Brehm, supervisor of safety and compensation, Mr. E. G. Erdman, division engineer, and their associates of the Susquehanna Collieries Company is greatly appreciated, and expedited the securing of data on which this report is based.

Respectfully submitted,


S. P. HOWELL,
Explosives Engineer.

APPENDIX A

Map of a portion of Richards Colliery, Shaft
Section, No. 12 slope, No. 4 vein, East
North Dip Gangway.

A P P E N D I X _ B

List of fatally injured.

LIST OF FATALLY INJURED

Type of Injury and Name of the Fatally Injured	Working Place	Job
Killed outright by flame and violence		
Lewis L. Bogdon	38 Breast	Certified Miner
Paul Prohilla	do.	do.
Killed outright by violence		
Paul Kish	Gangway	Driver
Leonard Paraginski	40 Breast	Certified Miner
Fatally injured by violence		
Joseph Moleski	Gangway	Loader

A P P E N D I X C

Individual gas analysis report sheets.

DEPARTMENT OF COMMERCE
BUREAU OF MINES

GAS ANALYSIS REPORT

Bottle No. 878 Laboratory No. 54481
 Sample of Mine air
 Mine Richards Colliery Operator Susquehanna Collieries Co.
 State Pa. County Northumberland Township _____
 Town (distance and direction from, and railroad) Mt. Carmel

Name of coal bed No. 4 (Little Back) Sec. _____, T. _____, R. _____

Location in mine Face of 11-foot deep, blind heading from east rib of No. 39
breast 18 ft. below face of 39 breast. East gangway, No. 12
slope off shaft level, R. Dip

Method of sampling Van. Date sampled 6/4/31 Hour 2:30

Velocity None Area _____ Quantity _____

Barometer: Inside _____ Outside _____

Corrected to sea level: Inside _____ Outside _____

Bulbs: Wet _____ Dry _____ Humidity _____ %

Collector H. F. Merrill & Jesse Bennett Mailed 6/5/31 Received 6/8/31

Laboratory No. <u>54481</u> <u>878</u>	Ethane (C ₂ H ₆) _____
Carbon dioxide (CO ₂) <u>.25</u>	Hydrogen sulphide (H ₂ S) _____
Oxygen (O ₂) <u>15.8</u>	Unsaturated hydrocarbons (C ₂ H ₄ , etc.) _____
Hydrogen (H ₂) _____	Sulphur dioxide (SO ₂) _____
Carbon monoxide (CO) <u>0.00</u>	
Methane (CH ₄) <u>2.8</u>	
Nitrogen (N ₂) <u>62.15</u>	
Total <u>100.00</u>	

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Remarks: _____

Date 6/11/31 (Signed) William P. Frost, Chemist.

DEPARTMENT OF COMMERCE
BUREAU OF MINES

GAS ANALYSIS REPORT

Bottle No. 574 Laboratory No. 54435

Sample of Mine air

Mine Richards Colliery Operator Dunquhanna Collieries Co.

State Pa. County Northumberland Township Ht. Carmel

Town (distance and direction from, and railroad) _____

Name of coal bed No. 4 (Little Buck) Sec. _____, T. _____, R. _____

Location in mine Face of No. 50 breast, east gangway, No. 12 slope, off shaft level; N. dip; 25° Pitch

Method of sampling vac. Date sampled 6/4/31 Hour am

Velocity _____ Area _____ Quantity _____

Barometer: Inside _____ Outside _____

Corrected to sea level: Inside _____ Outside _____

Bulbs: Wet _____ Dry _____ Humidity _____%

Collector S. F. Howell Mailed 6/5/31 Received 6/8/31
Jeane Hanson

Laboratory No. <u>54435</u>	Ethane (C ₂ H ₆) _____
<u>574</u>	Carbon dioxide (CO ₂) <u>.27</u>
Oxygen (O ₂) <u>19.92</u>	Hydrogen sulphide (H ₂ S) _____
Hydrogen (H ₂) _____	Unsaturated hydrocarbons (C ₂ H ₄ , etc.) _____
Carbon monoxide (CO) <u>.00</u>	Sulphur dioxide (SO ₂) _____
Methane (CH ₄) <u>5.50</u>	
Nitrogen (N ₂) <u>76.22</u>	
Total <u>100.00</u>	

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Remarks: _____

Date 6/11/31 (Signed) William P. Yant, Chemist.

DEPARTMENT OF COMMERCE
BUREAU OF MINES

GAS ANALYSIS REPORT

Bottle No. 575 -717 Laboratory No. 54426 -54428

Sample of Mine air

Mine Richards Colliery Operator Susquehanna Collieries Co.

State Pa. County Northumberland Township _____

Town (distance and direction from, and railroad) Mt. Carmel

Name of coal bed No. 4 (Little Buck) Sec. _____, T. _____, R. _____

Location in mine Face of #40 breast, east gangway, No. 12 slope off shaft level,
N. dip, 28° pitch

Method of sampling vac. Date sampled 6/4/31 Hour 6.30

Velocity _____ Area _____ Quantity _____

Barometer: Inside _____ Outside _____

Corrected to sea level: Inside _____ Outside _____

Bulbs: Wet _____ Dry _____ Humidity _____ %

Collector S.P. Howell & James Hanson Mailed 6/5/31 Received 6/8/31

Laboratory No.	<u>54426</u>	<u>54428</u>	
Ethane (C ₂ H ₆)			
Carbon dioxide (CO ₂)	<u>.12</u>	<u>.15</u>	Hydrogen sulphide (H ₂ S)
Oxygen (O ₂)	<u>20.77</u>	<u>20.71</u>	Unsaturated hydrocarbons (C ₂ H ₄ , etc.)
Hydrogen (H ₂)			
Carbon monoxide (CO)	<u>.00</u>	<u>.00</u>	Sulphur dioxide (SO ₂)
Methane (CH ₄)	<u>.55</u>	<u>.55</u>	
Nitrogen (N ₂)	<u>78.56</u>	<u>78.49</u>	
Total	<u>100.00</u>	<u>100.00</u>	

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Remarks: _____

Date 6/11/31 (Signed) William F. Yant, Chemist.

DEPARTMENT OF COMMERCE
BUREAU OF MINES

GAS ANALYSIS REPORT

Bottle No. 576 Laboratory No. 54427

Sample of Normal mine air - air coursed to face

Mine Richards Colliery Operator Susquehanna Collieries Co.

State Pa. County Northumberland Township _____

Town (distance and direction from, and railroad) Mt. Carmel

Name of coal bed No. 4 (Little Buck) Sec. _____, T. _____, R. _____

Location in mine Face of #36 breast, east gangway, No. 13 slope, off shaft level
N. dip Pitch 230.

Method of sampling vac. Date sampled 6/4/31 Hour 8.15

Velocity _____ Area _____ Quantity _____

Barometer: Inside _____ Outside _____

Corrected to sea level: Inside _____ Outside _____

Bulbs: Wet _____ Dry _____ Humidity _____ %

Collector S. P. Howell & Jesse Hanson Mailed 6/5/31 Received 6/8/31

Laboratory No. <u>54427</u>	Ethane (C ₂ H ₆) _____
<u>576</u>	
Carbon dioxide (CO ₂) <u>.15</u>	Hydrogen sulphide (H ₂ S) _____
Oxygen (O ₂) <u>20.52</u>	Unsaturated hydrocarbons (C ₂ H ₄ , etc.) _____
Hydrogen (H ₂) _____	
Carbon monoxide (CO) <u>.00</u>	Sulphur dioxide (SO ₂) _____
Methane (CH ₄) <u>.52</u>	
Nitrogen (N ₂) <u>78.52</u>	
Total <u>100.00</u>	

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Remarks: _____

Date 6/11/31 (Signed) William P. York, Chemist.

DEPARTMENT OF COMMERCE
BUREAU OF MINES

GAS ANALYSIS REPORT

Bottle No. 718 Laboratory No. 54489

Sample of Mine air

Mine Richards Colliery Operator Susquehanna Collieries Co.

State Pa. County Northumberland Township _____

Town (distance and direction from, and railroad) Mt. Carmel

Name of coal bed No. 4 (Little Back) Sec. _____, T. _____, R. _____

Location in mine Face of No. 41 breast, east gangway, No. 13 slope off shaft level;
N. dip 20° pitch

Method of sampling Vac. Date sampled 6/4/21 Hour 2.30

Velocity _____ Area _____ Quantity _____

Barometer: Inside _____ Outside _____

Corrected to sea level: Inside _____ Outside _____

Bulbs: Wet _____ Dry _____ Humidity _____%

Collector S.F. Howell & Jesse Hansen Mailed 6/5/21 Received 6/8/21

Laboratory No. <u>54489</u>	Ethane (C ₂ H ₆) _____
Carbon dioxide (CO ₂) <u>71.8</u>	Hydrogen sulphide (H ₂ S) _____
Oxygen (O ₂) <u>22.75</u>	Unsaturated hydrocarbons (C ₂ H ₄ , etc.) _____
Hydrogen (H ₂) _____	Sulphur dioxide (SO ₂) _____
Carbon monoxide (CO) <u>.00</u>	
Methane (CH ₄) <u>.40</u>	
Nitrogen (N ₂) <u>78.72</u>	
Total <u>100.00</u>	

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Remarks: _____

Date 6/11/21 (Signed) William P. Yeat, Chemist.