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REPORT

on

**BLAST AT BRANDY CITY HYDRAULIC MINE,
BRANDY CITY, SIERRA CO., CALIFORNIA.**

DECEMBER 23, 1916.

by

G. Chester Brown, E. M.,

Deputy Mine Inspector, Calif. Ind. Acc. Comm.

Written January 13, 1916.

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REPORT ON BLAST IN WHICH FOUR MEN MET DEATH FROM GAS AT
THE BRANDY CITY HYDRAULIC MINE, BRANDY CITY, SIERRA COUNTY, CALIFORNIA.

By

G. Chester Brown.

THIS accident occurred on December 23, 1915 at 3:45 P.M., at the Brandy City Hydraulic Mine, due to gases generated by detonating a charge of 11 tons of powder, although all the men overcome by these fumes were in the hydraulic pit at that time; i.e. on the surface.

Four men died before the doctor arrived on the scene of the disaster; the other four have fully recovered. The following were asphyxiated:

E. E. Godfrey.....American
John Hayes....."
Joe Tioni.....Italian
T. H. Gudger.....American

(See interview with Dr. Lord in appendix and description of the accident by Supt. Geo. F. Taylor.)

GENERAL INFORMATION.

The mine is located in Sierra County, California, about 32 miles west of Nevada City, and 10 miles north of the town of Camptonville at an elevation of 3800 feet. A telephone line connects the mine with these towns.

Method of transporting freight and passengers:- Auto trucks are used in the summer to carry passengers and freight from Nevada City to Camptonville, and then by horse drawn vehicles to the mine, a distance of 15 miles. In winter, horse drawn vehicles to Camptonville are used from which place, for a distance of ten miles, pack animals are employed; the trail is narrow and steep.

Kind of mine, No. men employed, Production:- Property is operated as a placer mine, hydraulic methods being used. Fifteen men are employed throughout the year. The annual production varies from \$35,000 to \$55,000 in gold.

OWNERS AND OPERATORS.

This property was first worked in the early fifties, and several short tunnels run on the bed rock to tap the pay channel. Mine idle from 1890 to 1907. Operations have been pursued continuously since that time. Property is owned by the Brandy City Mining Company:- J. Frowenfeld, Pres., C. Allenberg, Sec. and Mgr., Geo. F. Taylor, Supt., office of company at 323 Kearny Street, San Francisco; address of mine is Comptonville, Sierra County, California. This company owns 1000 acres of land, but only have about 160 acres of gravel remaining which will pay to work. The banks have an average height of 200 feet. The bedrock consists of diorite and slate.

The method of mining consists in running tunnels and drifts on the bedrock under the bank, the same being loaded with explosives, (gravel and rock used for stemming), and the charge then detonated to loosen up the gravel, which is then forced into sluice boxes by means of "giants."

STORY OF DISASTER.

Mine in operation at time of the disaster, eight men being in the pit when the charge was detonated. Weather was cold; temperature 38 degrees above zero; atmosphere heavy.

The Disaster:- Charge detonated by Mr. Taylor, Supt. of the mine, who occupied a position near the blacksmith shop, with two other employees (Godfrey and Grant). The other employees (Sadler, Hayes and

Tioni, who were asphyxiated), were stationed about 250 feet west of the open cut while E. E. Godfrey and Addison were in line with the end of the open cut and about 300 feet south of the blacksmith shop; E. E. Godfrey also was asphyxiated. As soon as the charge had been fired those men west of the open cut and those south of the blacksmith shop advanced toward the open cut to ascertain the result of the charge and had advanced only a few feet when they were overcome by the gas. W. S. Godfrey, Taylor and Grant remained in their respective positions, and were protected to some extent by an old dump some 8 feet in height and 30 feet long. (For details see report of Geo. F. Taylor, Supt.)

The cause of the disaster appears to be due to the positions taken by the men at the time of shooting and to the fact that all advanced toward the open cut as soon as the charge had exploded, except those near the blacksmith shop.

The cause of the accident has not been determined as yet. The superintendent has not made an inspection of the tunnel, as some gas still remains in the same.

Prof. Edward O'Neill, Department of Chemistry, University of California, visited the mine on December 30, 1915 for the U. S. Fidelity and Guaranty Company, (insurance carriers), and investigated the accident for this corporation.

CORONER'S INQUEST AND VERDICT.

Dr. Lord states that a coroner's inquest was held at the mine and that the verdict was as follows:- That the deceased came to their death by asphyxiation by gases from powder."

SUMMARY OF EVENTS.

For details read report of the Superintendent of the mine and the story of the disaster.

LESSON TO BE LEARNED IN PREVENTING REPETITION.

Apparently the accident could have been avoided by having all the men out of the hydraulic pit before detonating. Up to the time of this disaster, the maximum charge fired was 7 tons; the men have always assumed the positions as shown in sketch and have not suffered from powder, gas, or smoke.

The hydraulic pit has a depth below the original ground surface of at least 200 feet.

APPENDIX

Dr. F. J. Lord of Comptenville, Sierra County, states as follows:-

"That he arrived at the mine at seven o'clock in the evening, or some three hours after the accident, being the first doctor on the job. Other doctors from Nevada City came some two hours later. That four of the men, Sadler, Hayes, Tioni and E. E. Godfrey were dead when he reached the mine. That the other four men were unconscious and frothing at the mouth with blood coming from the lungs. That after giving them artificial respiration they were revived several hours after the accident. That death was due to asphyxiation from poisonous gases given off by the powder. That he signed the death certificates."

Mr. Geo. F. Taylor, Supt. Brandy City Hydraulic Mine, states:-

"That the charge was fired at about 3:45 P.M., that after firing, all the men, with the exception of those with him, ran forward toward the blast to ascertain the result of the shot and were overcome by the gas; that this gas was colorless and odorless; that two men and himself were behind an old dump and that gas was not so strong there, so they recovered from the gas. That heretofore only from 5 to 7 tons of powder have been exploded at one time; this last charge was the largest ever set off."

Brandy City Mining Co.

Brandy City, Sierra Co., California.
January 5, 1916.

Industrial Accident Commission,
Underwood Building,
San Francisco, Cal.

Gentlemen:-

Following is a description of the accident that occurred at the Brandy City Mine on Dec. 23, 1915, and which resulted in the death of John Hayes, E. E. Godfrey, Joe Tioni and Thos. H. Sadler, and through which W. S. Godfrey, W. G. Grant, J. T. Addison and Geo. F. Taylor were temporarily overcome by gas.

We had been engaged for nearly three weeks in the loading of a powder drift, and finished at 3:30 P.M., Dec. 23, 1915.

The total length of the drift was 420 feet, and consisted of an old drift 240 feet long known as the Reddington drift, which was run some 22 years ago, and a small powder drift 180 feet long which was run from the end of the Reddington Drift and just completed by me. Referring to the map shown herewith, the Canyon Creek Tunnel is an old tunnel used for hydraulicking some twenty-five years ago. It is 2200 feet in length and connects the present hydraulic pit with the Canyon Creek drainage, and entering the pit by means of a cut about 30 feet deep. The Reddington drift was run from the top of an upraise which communicates with the Canyon Creek Tunnel. This upraise is 60 feet in length on a slope of 45 degrees. A small drift A-C was run from this powder drift to the surface to facilitate the work of loading the drift. It was first necessary to close up a portion of the Reddington drift next to the upraise. So 52 feet of this drift was tamped solid with dirt and rocks. Then the drift was loaded with ten tons of Hercules railroad powder (5%) and one ton of Hercules forty per cent gelatine powder, distributed in eight charges, as shown on the plat. Charge No. 1 contained 55 cases of 50 pounds each of R.R. powder and 275 pounds of 40 per cent powder. Charges 2, 3, and 4 contained a similar amount. Nos. 5 and 6 contained 50 cases R.R. powder and 250 pounds of 40% powder each, while Nos. 7 and 8 contained 40 cases of R.R. powder and 200 pounds of 40% powder each.

All of the intervening spaces between the charges were tamped full of gravel and boulders, and the drift A-C was also tamped. All of the powder charges were connected by wire and electric fuses, so that all could be fired simultaneously by electricity. Current was supplied by means of a dymo located in the shop. At 3:45 everything was in readiness, and the men who had just completed the work of loading had retired to a safe distance from the blast. A switch had been installed in the open air and behind a rock pile about 100 feet west of the shop, from which point the result of the blast could be observed and at the same time the observer would be protected from any flying rocks, by the rock pile.

W. S. Godfrey and W. O. Grant were standing at my side at this point when I made the contact that fired the blast. Almost instantly we heard a loud roar and smoke and gas issued from the Canyon Creek tunnel at the point marked F, and almost immediately we detected the presence of the gas and began to run. We were all overcome by the gas before we had run 100 feet and fell in the positions indicated on the plat. Sadler, Hayes and Tioni were perhaps 100 feet further to the east than the points indicated on the map when the blast was fired, and immediately walked toward the shop. They were met by the spreading gases and fell at the points indicated. E. E. Godfrey and J. T. Addison were overcome at the points marked on the map.

Nine other men witnessed the firing, most of them at a safe distance, but three of them were prostrated by the gas but managed to crawl to positions of safety. As soon as possible after the shot these men began the work of rescue.

E. E. Godfrey and John Hayes were dead when the rescuers were first able to enter the pit. Tioni and Sadler died two or three hours later and before any medical assistance could arrive. W. S. Godfrey, W. O. Grant, J. T. Addison and Geo. F. Taylor were resuscitated some twelve hours later.

The disaster was no doubt caused by the blowing out of Charge No. 1, though as yet we have not been able to enter the tunnel and make any examination.

All funeral and other expenses have been met by the U. S. Fidelity and Guaranty Company, but the amounts paid out have not been reported to me, hence I am not able to answer the questions pertaining to this matter. This report has been delayed beyond the time permitted by your department, but as it devolved upon the undersigned to make the report and as he was one of the victims of the disaster, the report could not be prepared earlier.

Respectfully,

(signed) Geo. F. Taylor.

Supt. Brandy City Mining Co.

EDMOND O'NEILL

UNIVERSITY OF CALIFORNIA,

BERKELEY, CALIFORNIA.

Department of Chemistry.

January 3, 1916.

The United States Fidelity and Guaranty Co.,
First National Bank Bldg.,
San Francisco, Cal.

Gentlemen:

At the request of your Messrs. Smith and Bell, I have made an investigation of the cause of the accident at Brandy City, Sierra County, California, on December 23, 1915, resulting in eight casualties, four of which proved fatal.

The Brandy City Mining Company operates a hydraulic mine at Brandy City. It is one of the oldest mining enterprises in the vicinity and is operated in the usual way, viz., by sluicing a gravel, with powerful streams of water directed from an adjustable nozzle, the water issuing from the nozzle under a great pressure. This powerful stream of water wears down the bank and washes it away. The fine particles of gravel and clay, together with the gold, are carried along with the stream of water and are conducted into a long sluice, provided with obstructions called riffles. The heavier gold settles, and the lighter particles of clay and sand are carried on, and finally impounded in a catchment basin.

It is essential for this process that the bank be loosened, to enable the stream of water to tear up and disintegrate the mass of gravel and clay. This loosening is accomplished by blasting. A long gallery is run in behind the face of the bank, filled with powder, and exploded. This shatters the face of the bank, enabling the water stream to thoroughly disintegrate it, as previously explained. Sometimes these blasts are very large. In this particular case 22,000 lbs., 11 tons, were used. The accompanying sketch will give a clear idea of the disposition of this large amount of powder and incidentally will show the cause of the accident.

The sketch is not drawn to scale, as time did not permit of an accurate survey of the locality, but the figures are approximately correct.

At A, a tunnel was driven in for a distance of 126 ft. and a 3 x 4 powder gallery run at right angles to this tunnel, one wing having a length of 180 ft., the other 126 ft. At B was an old tunnel 10 x 12, run over 20 years ago. Connected at C was an equally old drift 5 x 6, rising 80 ft. on a slope of 45 degrees. This drift was shut off from the powder gallery by a tamping of 52 ft. of rock and gravel.

The powder was distributed in the gallery in 8 fractions separated by 40 ft. spaces, the spaces being filled up solid with sand and gravel. In the sketch the powder is shown in black and filled spaces are shaded.

Each of the eight powder charges consisted of 50 cases of Hercules railroad powder, and 5 cases of Hercules 40% gelatine. The cases hold 50 lbs. each, the entire charge therefore weighing 22,000 lbs. or 11 tons. Two caps are placed in each charge and the whole exploded by an electric detonator. The blast was successful and the bank was well shattered.

Immediately after the explosion a cloud of smoke was observed issuing from the mouth of the old tunnel B. All the men in the vicinity were struck down by the gas. Those nearest to the mouth of the tunnel became unconscious. Those somewhat farther away were similarly stricken but were able to make efforts to escape. Some men on the road over a thousand feet away were affected but nevertheless hastened to the rescue of the others.

The space in front of the mine is the form of a huge pit or amphitheatre. This space was filled with the poisonous gases and all who ventured in were attacked by these fumes.

The symptoms were, to a large degree, similar; a feeling of faintness followed by a period of unconsciousness when any large amount of gas had been inhaled. During this time of anesthesia, the victims struggled violently, laughed and talked incoherently. Two of the men who were nearest to the mouth of the tunnel, must have died very quickly. They were able to crawl but a few feet from where they fell and when taken from the digging were apparently dead. In two other cases which resulted fatally the victims lingered for several hours without regaining consciousness. In the four other serious cases the men on regaining consciousness after a lapse of several hours, were violently ill for a considerable period. The symptoms were vomiting, intestinal pains, irritation of the throat and mucous membrane, pain in the back, lassitude and muscular weakness. When the patients were seen, a week after the accident, two had apparently recovered and were at work, but two were still unable to take exercise, the muscular weakness still continuing. In the case of the Superintendent the conjunctiva of the eyes were still violently inflamed, the appetite had not returned and recovery was far from complete.

After reviewing the facts of the catastrophe, it is desirable to seek an explanation. It is not difficult. The powder charge was in a gallery about 400 feet long. It was separated by 53 feet of tamping from the old drift of 220 feet opening into the old 10 x 12 tunnel 700 feet from its mouth. It was like a cannon or more like an old fashioned blunderbuss 1300 feet long with a 3 x 4 foot bore for the powder charge and a 900 foot barrel beyond the load enlarged to a 10 x 12 foot opening. The charge of powder in this huge blunderbuss was eleven tons. The intention was to load the bore of this cannon so tightly that it would blow up. But the wad was not firm enough. It was but 53 feet thick. The thinnest part of this imaginary cannon over 90 feet thick made of tough, toughly cemented clay and gravel. The other parts of the barrel were hundreds or thousands of feet thick. True, the 90 foot wall was shattered but the relatively small and loosely packed 53 feet of tamping was blown out and the gaseous products of a part, if not all, of the eleven tons of powder were shot out of the mouth of the old tunnel, dealing death and disaster to all in its path. The destructiveness of the gas was aided by the pit like or amphitheater character of the diggings. The high walls confined the gas and impeded its diffusion and elimination.

The composition of the gas that produced the effect naturally cannot be determined now. Powder of the character used in this blast produces Nitrogen carbon monoxide

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many gases depending on a variety of circumstances. Nitrogen, carbon monoxide, carbon dioxide, nitrous oxide and other oxides of nitrogen, various hydrocarbons, cyanogen and other gases might have been present. From the nature of the symptoms of the men I should judge that the oxides of nitrogen, carbon monoxide and possibly cyanogen were the chief agents in the toxic effect. All of these gases are poisonous and singly or in combination can produce death.

It is probably that the lives of the victims could have been saved if inhalation of oxygen, best with the aid of a pulmometer, had been given immediately. The mine was not supplied with any such devices and the remoteness of the locality made it impossible to obtain them in time. When they did arrive, it was too late.

If advice is in order, I would suggest that your policies covering blasting and similar operations should require that some of the modern life saving appliances should be available and that some employes should be familiar with their use. Second, that when blasts of this magnitude are to be fired, that some official or expert inspection should be required. Third, that a more exact knowledge of the nature of the occupations or processes be acquired by your Company before writing the insurance. I understand that your agents were not aware that hydraulic mining required blasting. The term hydraulic mining suggests mining merely by the aid of water, yet, as a matter of fact, blasting is necessary and is as much of a necessity as water. The magnitude of the blasts and the consequent amount of explosive used at one time is far greater than in ordinary mining with consequent increase in risk. This extra risk should be paid for, which I understand was not done in this case.

In conclusion, I wish to bear testimony to the efficiency of Mr. Paul Bell, in whose company I made the inspection. The skill and celerity with which he handled this complicated affair was very pronounced. He left a good impression and furthered the interests and reputation of the Company to a marked degree.

If there are any other questions you desire to discuss in connection with this matter, I shall be glad to correspond further.

I am

Very truly,

(signed) Edmond O'Neill.

January 21, 1916

APPENDIX TO REPORT ON BLAST AT
BRANDY CITY HYDRAULIC MINE.

It appears from the evidence submitted in the foregoing report that too little stemming was used in this blast, and it is probable that much of the powder burned, thus producing larger quantities of poisonous gases than would have been the case had the charge been properly detonated. This, together with the fact that the men approached the vicinity of the blast too soon, doubtless accounted for the fatal consequences. It appears that the two principal lessons taught by this occurrence are:

1. In future in firing blasts of this size more attention should be paid to the quantity and quality of stemming used, and
2. Great caution should be exercised in approaching the blasted ground after the charge has been fired.

Edwin Higgins

Chief Mine Inspector.

EH-EC

COMMENTS ON BLAST OF DECEMBER 23, 1915, AT THE BRANDY CITY
HYDRAULIC MINE, CALIFORNIA, WHICH RESULTED IN THE
ASPHYXIATION OF FOUR MEN.

From the reports forwarded by Mr. Higgins, it is my opinion that four things contributed to the cause of the fatalities, as follow:

1. That a large proportion of charge No. 1, and perhaps other charges, burned;
2. That the dirt and rock stemming which isolated the powder tunnel from the Canyon Creek Tunnel was not adequate;
3. That the men were unusually close to the mouth of the Canyon Creek Tunnel, designated "F" on the blue print, and that this was the place where a very large percentage of the poisonous gases escaped to the atmosphere; and
4. That the meteorological conditions were favorable for holding the gases close to the ground.

My comments on the above, in order, are as follow:

1. As a high explosive, Hercules 5 per cent Railroad Powder (belonging to the general class known as 5 per cent granulated nitroglycerin powder) has this peculiar characteristic, in that its proper detonation requires the use of a booster, i.e., a particular brisant high explosive. This booster is to be exploded

by means of the ordinary No. 6 - or stronger - detonators or electric detonators. For such a booster, manufacturers recommend 40 per cent straight nitroglycerin dynamite or straight nitroglycerin dynamites of a higher grade, and nothing else. It is very important to note that such a booster was not used in this blast but that Hercules 40 per cent strength gelatin powder was used. It is my opinion that the booster which they used could not be relied upon to detonate the Hercules Railroad Powder with certainty. Another reason tending to show that the powder burned was that the stemming blew out, and I believe that this blowout would not have been so pronounced had the entire quantity of explosive detonated.

It is not even certain that the gelatin dynamite detonated because the report does not show the age of this explosive; it does not state that the electric detonators were placed in the gelatin dynamite, although I presume that this was done; and it does not indicate the grade of electric detonators.

Gelatin dynamites and 5 per cent granulated nitroglycerin powders produce much larger quantities of poisonous gases when burned than when detonated.

2. The stemming which isolated the charge No. 1 from the Canyon Creek Tunnel was 52 feet in length and consisted of loose dirt and rock, whereas all other lines of resistance were of solid material and not less than 90 feet in length. This shows the weakness of the stemming, and particularly so when assuming that some

or most of the charge burned.

3. Inspection of the blue print shows the nearness of the various men to opening "F" of the Canyon Creek Tunnel which conducted the poisonous and other gases from the powder tunnel very readily after the stemming was blown out. Mr. Edmond O'Neill's illustration showing the likeness of this arrangement to a blunderbus is most apt.

4. I was impressed with the similarity of this accident to one which occurred on September 25, 1886 in the Crarae quarry, Loch Fyne, Scotland, and found in a report of H. M. Inspector of Explosives, No. LXXIV of 1886, an abstract of which is found on page 16 of Bulletin 80 accompanied by a photograph.

In the Crarae quarry 10-1/2 tons of blasting gun powder was used, the open portion of the quarry was in the form of an amphitheater, the day was "dull and no wind, the air saturated with moisture", whereas at the Brandy City Hydraulic mine 11 tons of 5 per cent granulated nitroglycerin powder was used, the excavated space was in the form of an amphitheater, the weather was cold and the atmosphere heavy.

If all the charges had completely detonated, there would have been enough poisonous gases produced to have caused the fatalities, but such quantities would have been much greater if a part or all of the charges burned.

My recommendations are as follow:

1. That the officials of the Brandy ~~Creek~~^{City} Hydraulic mine be advised of the necessity of detonating Hercules 5 per cent Railroad powder with a high grade straight nitroglycerin dynamite (40 per cent

or higher).

2. That their attention be called to the inadequacy of the stemming used to isolate charge No. 1 from the Canyon Creek tunnel.

3. That when a blast is fired, all employees should be stationed outside of the poisonous gas danger zone, and remain there for several hours after large blasts are fired. It would be advisable to not approach the place of a large blast until the day after a shot.

S.O. Howell

2/10/66

4-417

GAB MS

February 11, 1916.

Mr. Wolflin:

I have read with much interest the attached report of the accident at the Brandy City Hydraulic mine, California. Messrs. Brown, O'Neill, Taylor and Howell have commented fully on the gases and made recommendations for the future. I was particularly interested in the constituents of the gaseous mixture that caused the trouble. Undoubtedly oxides of nitrogen had a great deal to do with the men's distress. The irritation of the throat, mucous membranes, and intestinal pains show that. CO may also have been contributory in producing lassitude, muscular weakness, and other symptoms, but undoubtedly the oxides of nitrogen were the main cause.

Very truly yours,

Burnell

SAC 2

January 27, 1916.

My dear Mr. Higgins:

Your letter enclosing copy of the Brandy City explosion was received. The report certainly makes interesting reading. It has been referred to Mr. Burrell, Mr. Howell, Mr. Enzian, and others around the plant for comment, after which it will be forwarded to the Chief Mining Engineer.

Your letter in regard to permissible fuse and caps has been referred to the mining committee for discussion and comment. I shall be glad to report to you later what action is taken. Personally, I am strongly in favor of the plan which you have suggested, if it can be carried out.

With kindest regards and best wishes, I remain,

Sincerely yours,

IN ANSWERING REFER TO NO. _____

DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

407 Underwood Bldg., San Francisco

Bureau of Mines
Pittsburgh, Pa.
JAN 26 1916
Received

January 21, 1916

My dear Mr. Wolflin:

Report on blast at the Brandy City Hydraulic Mine, Cal.

I enclose herewith three copies of a report made by Mr. G.C. Brown, deputy mine inspector, on the blast at the Brandy City Hydraulic Mine in which four men met death. I wish to call special attention to the report of Dr. Edmond O'Neill, professor of chemistry, University of California, which appears at the end of the report. You will note that he makes some very interesting statements as to the nature of the gases formed.

From all the evidence it appears to me that, on account of insufficient stemming much of the charge burned, rather than exploded, producing large quantities of carbon monoxide and nitrous gases.

In making this report Mr. Brown followed as closely as possible the outline suggested by me for Bureau of Mines reports on metal mine disasters.

Very truly yours,

EH-EC
Encl.

H. C. Havens

I have written a short addendum to the report
GN

BRANDY CITY HYDRAULIC MINE
Sketch Showing Location of Explosive
Charge and Positions Assumed by men
At Time Of Firing

