

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
Region V

FINAL REPORT OF MAJOR EXPLOSION DISASTER
O'BRIEN MINE
O'BRIEN COAL COMPANY
LOVILIA, MONROE COUNTY, IOWA

March 30, 1953

by

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Coal-Mine Inspector

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Health and Safety Engineer

E. W. Felegy
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INTRODUCTION

A coal-dust explosion in the O'Brien mine about 4 p.m., March 30, 1953 killed two shot firers, the only men in the mine at the time. Their bodies were recovered at 6 p.m. that day. Three of five men who entered the mine about 9 p.m., March 30, reportedly to make an investigation of the explosion, collapsed and died of carbon monoxide poisoning. The other two men escaped to the surface; one was hospitalized but was released from the hospital April 3.

The explosion resulted from two blown-out black blasting powder shots off the solid in No. 4 room, 10 west entry. The force of the explosion spread throughout 9 and 10 west entries, the only active section in the mine, and extended 700 feet in the main entries outby that section.

GENERAL INFORMATION

The O'Brien mine, O'Brien Coal Co., is 3-1/2 miles west of Lovilia, Monroe County, Iowa, and is served by trucks. D. W. O'Brien, 1927 Easton Boulevard, Des Moines, Iowa, is owner and operator of the company. Fifteen men were employed underground, and 4 men were employed on the surface the day of the disaster. Average daily production was 125 tons of coal.

A 300-foot slope and a vertical air shaft 90 feet deep opened the mine in a flat-lying 66-inch bituminous coal bed. The coal bed was not correlated but probably is the Smoky Hollow bed. The roof was shale, usually free from slips and other irregularities, and the floor was fire clay. Analysis of a coal sample collected from the Smoky Hollow bed in the nearby Blackstone mine, now abandoned, was reported in Bureau of Mines Technical Paper 706, Analyses of Iowa Coals, as follows:

| | |
|-----------------|----------------------|
| Moisture | 18.3 percent |
| Volatile matter | 34.5 percent |
| Fixed carbon | 38.4 percent |
| Ash | 8.8 percent |
| | <u>100.0 percent</u> |
| Sulfur | 3.3 percent |
| B.t.u. | 10,400 |

Numerous tests by the Bureau of Mines have shown that dust from coal having a volatile ratio of 0.12 is explosive and that the explosibility increases with increase in the volatile ratio. The volatile ratio of the coal in the O'Brien mine as determined from the analysis given above was 0.47, indicating that the dust from this coal is highly explosive.

According to available records, no fires or explosions resulting in fatalities occurred previously in this or nearby mines. The last Federal inspection was October 9, 1952.

MINING METHODS, CONDITIONS, AND EQUIPMENT

Mining Methods

A room-and-pillar system of mining was employed. Entries were driven in pairs, 12 feet wide on 30-foot centers. Rooms were driven 200 feet deep on 45-foot centers, and crosscuts were 50 to 60 feet apart. Coal was loaded by hand. About 70 percent of the coal was extracted and pillars were not recovered.

A systematic method of timbering was prescribed, but safety posts were not set at the working faces. Timbers knocked out in blasting were reset. Roof in the entries was supported by crossbars and lagging; crossbars generally were set on 4-foot centers throughout the mine.

Explosives

Coal was blasted off the solid by pellet black blasting powder fired by fuse. Occasional opener shots of permissible explosives were fired by cap and fuse. Holes were charged on shift but were fired off shift by shot firers when all other men were out of the mine. Both wooden and copper-tipped steel bars were used to stem the holes with a mixture of fine coal and fire clay. Explosives were stored underground in wooden and cardboard shipping containers and in miners' wooden explosives boxes.

Ventilation and Gases

The mine is classed nongassy. Methane has not been detected by permissible flame safety lamps or other detecting devices in the mine. Analysis of an air sample collected February 3, 1948 at the face of the last crosscut between 1 and 2 west entries; now worked out and abandoned, indicated 0.03 percent methane. Methane was not found in air samples collected in the mine before or after that date. No gas or oil wells were in the vicinity of the mine.

Ventilation was provided by an electrically driven 2- by 4-foot centrifugal fan operated blowing and situated directly over the air shaft. Provisions were not made to reverse the direction of air flow. The fan was not equipped with a pressure-recording gage or water gage, or any device to give warning when the fan slows down or stops. More than 6,000 cubic feet of air a minute was passing through each of the last open entry crosscuts during the last Federal inspection, and 26,000 cubic feet of air a minute was measured at the foot of the slope. Rock stoppings, wooden doors, and brattice-cloth check curtains were used underground to direct air flow.

Preshift and weekly examinations were made for gas and other hazards. Weekly air measurements were made and a record of the measurements was kept by the mine foreman.

Results of analyses of air samples collected during the investigation are shown in table 1.

Dust

The mine was dry and dusty and was not rock dusted. Dust samples were not collected prior to the explosion. Results of analyses of dust samples collected during the investigation are shown in table 2.

Haulage

Single cars were hauled by animals from the face to the main side-track, and six-car trips were hauled to the slope bottom by one 5-ton storage battery locomotive. Single cars were hauled up the slope by a geared hoist powered by an internal-combustion engine on the surface. Crosscuts and room necks served as shelter holes along the haulageways. Man-trips were not provided.

Electricity

Power purchased as 220 volts alternating current was used to operate the fan motor and the mine pumps, and was reduced to 110 volts for lighting on the surface and underground. Power wires underground were insulated and were not in contact with timbers. Electricity was not used in the working areas.

Table 1.--Results of analyses of air samples collected in the O'Brien mine, O'Brien Coal Co., Lovilia, Monroe County, Iowa, March 31 and April 1, 1953

| Bottle No. | Date | Location in mine | Carbon dioxide | Oxygen | Methane | Carbon monoxide | Nitrogen | Cubic feet air per minute |
|------------|------|--------------------------------------|----------------|--------|---------|-----------------|----------|---------------------------|
| D2876 | 3/31 | Return air 50 ft. outby slope bottom | 0.17 | 20.76 | 0.00 | <u>1/</u> | 79.07 | 23,600 |
| E3631 | 3/31 | Face of No. 5 room, 10 west entry | 0.26 | 20.59 | 0.00 | 0.00 | 79.15 | Negligible |
| D8438 | 3/31 | Face of 8 east entry | 0.15 | 20.75 | 0.00 | <u>2/</u> | 79.16 | Negligible |
| D2874 | 3/31 | Return air outby 7 west entry | 0.07 | 20.76 | 0.00 | 0.00 | 79.17 | 6,000 |
| E5887 | 4/1 | Face of 10 west entry | 0.09 | 20.81 | 0.00 | <u>2/</u> | 79.10 | Negligible |
| E5879 | 4/1 | Face of 9 west entry | 0.08 | 20.76 | 0.00 | 0.00 | 79.16 | Negligible |

1/ Trace, less than 0.005

2/ Possible trace, less than 0.0025

Table 2.—Analyses of dust samples collected in the O'Brien mine,
O'Brien Coal Co., Lovilia, Monroe County, Iowa,
April 1-3, 1953

| Can No. | Sample of dust from | Location in mine | Incombustible Content | Coke |
|---------|-------------------------|--|--------------------------|------|
| E358 | Rib, roof, gob, timbers | 9 W. entry between rooms 3 and 4 | 31.3 | None |
| E353 | Floor | do. | 46.5 | Do. |
| J863 | Rib, roof, gob, timbers | 10 W. entry outby room 1 | 36.9 | Do. |
| L637 | Floor | do. | 44.3 | Do. |
| E853 | Rib, roof, gob, timbers | 10 W. entry outby room 4 | 31.6 | Do. |
| V739 | Floor | do. | 39.2 | Do. |
| E316 | Rib, roof, gob, timbers | 10 W. entry inby room 5 | 27.4 | Do. |
| E439 | Floor | do. | 33.3 | Do. |
| F431 | Rib, roof, gob, timbers | Main entry 25 ft. inby 7 E. | 29.1 | Do. |
| K597 | Floor | do. | 32.8 | Do. |
| B828 | Rib, roof, gob, timbers | Main entry 200 ft. inby wrecked door at 7 W. | 44.5 | Do. |
| R209 | Floor | do. | 54.2 | Do. |
| R491 | Rib, roof, gob, timbers | Main entry 130 ft. outby wrecked door at 7 W. | 43.1 | Do. |
| C919 | Floor | do. | 46.9 | Do. |
| C900 | Rib, roof, gob, timbers | Back entry 20 ft. outby 7 E. | 37.7 | Do. |
| R812 | Floor | do. | 35.1 | Do. |
| T452 | Rib, roof, gob, timbers | Back entry midway 6 E. and 7 E. | 44.2 | Do. |
| K754 | Rib, roof, gob, timbers | Back entry midway 4 E. and 5 E. | 63.6 | Do. |

Illumination and Smoking

Electric lights were used on the slope bottom and for a limited distance along the main haulageway. All underground employees used open-flame lights. Smoking was permitted and practiced underground.

Mine Rescue

None of the employees of the O'Brien mine or nearby mines was trained in mine rescue. The only rescue equipment available was that owned by the fire department in Albia, Iowa, 14 miles from the mine; personnel of that department were not familiar with mine rescue procedures and requirements. Water in barrels, fire buckets, and carbon tetrachloride fire extinguishers were available for fire fighting on the surface and underground, but a fire-fighting organization was not maintained at the mine.

Legal Proceedings on Notices

On October 9, 1952, upon completion of a Federal inspection of the O'Brien mine and in accordance with provisions of the Federal Coal Mine Safety Act, a Notice was issued to the operator of the O'Brien mine stating that black blasting powder was used to blast coal in the mine. The notice required that this violation of Section 209(h)(5) of the Federal Coal Mine Safety Act be totally abated by January 16, 1953.

A second Notice issued October 9, 1952 stated that the mine was dry and rock dust had not been applied, and required that this violation of Section 209(e)(3) of the Act be totally abated by April 9, 1953.

A third Notice issued October 9, 1952 stated that preshift examinations of the mine were not made, and required that this violation of Section 209(d)(8) of the Act be totally abated by January 16, 1953.

Copies of the three Notices are shown as appendixes D, E, and F.

Similar Notices concerning the use of black blasting powder and lack of rock dust had been issued October 2, 1952 at the No. 2 mine of the Lovilia Coal Company and October 3, 1952 at the No. 3 mine of the Lovilia Coal Company upon completion of Federal inspections of those mines.

On December 14, 1952, the operator of the O'Brien Coal Company notified the Director of the Bureau of Mines by telegram that he would reduce the number of men employed underground to 14 on January 16, 1953, and requested advice as to whether under these circumstances the mine would be considered subject only to the provisions of Title I of the Federal Coal Mine Safety Act. The Director replied by night letter dated December 15, 1952 and advised in part that if the employment was such after January 16, 1953 that this mine is not covered by the Federal Coal Mine Safety Act, the Bureau of Mines could not require the operator to comply with Sec. 209(h)(5) of the Act pertaining to black blasting powder.

On January 9, 1953, the company requested the Director by telegram for interpretation of the language "fourteen individuals regularly employed underground" as used in Section 201(b) of the Act. The Director replied by air mail letter asking for further information to enable him to answer correctly the telegram of January 9; the Director received no reply to this request.

On January 19, 1953, the Judge of the District Court of the State of Iowa in and for Monroe County granted a restraining order in the case entitled Lovilia Coal Company and D. W. O'Brien, doing business as O'Brien Coal Company, Plaintiffs, vs W. B. Dalrymple and Roy Capps, Defendants, enjoining the defendants from enforcing or attempting to enforce compliance by plaintiffs with the provisions of Section 209(h)(5) of the Federal Coal Mine Safety Act. The temporary injunction was served on Dalrymple the same day and on Capps the following day, and prevented reinspection of the Lovilia Coal Company and O'Brien Coal Company mines. The office of the United States Attorney for the district in Iowa involved cautioned Federal inspectors Dalrymple and Capps not to enter the premises of these mines pending further disposition of the case.

On February 4, 1953, United States Attorneys in Des Moines, Iowa, filed a petition for removal of the case from the State Court to the United States District Court, Southern District of Iowa, Ottumwa Division. The case was docketed as Civil No. 1-36. On February 20, 1953, a motion to dismiss and a brief on the motion to dismiss were filed by United States Attorneys in the United States District Court, and the case was argued orally before the court on March 20, 1953. On March 27, 1953, the Judge of the United States District Court sustained the motion to dismiss and dissolved the restraining order. Copies of this action were forwarded from Des Moines, Iowa, on March 30, 1953 - the day of the explosion - to the Department of Justice, Washington, D. C., and to Region V of the Bureau of Mines. Notice of such action was received by the Bureau of Mines, Duluth office, at 2:00 p.m. March 31, 1953, and was the first official written knowledge the Bureau had that the injunction had been dissolved. However, about noon on March 31 the Chief Counsel, Bureau of Mines, Washington, D. C. called the Asst. U. S. Attorney in Iowa about the Bureau's right in view of the injunction to have Federal inspectors enter the premises of the O'Brien mine to investigate the disaster. During the conversation, the Chief Counsel of the Bureau of Mines was advised that the injunction had been dissolved on March 27, 1953.

STORY OF EXPLOSION AND RECOVERY OPERATIONS

Activities of Bureau of Mines Personnel

Roy Capps, coal-mine inspector, and W. B. Dalrymple, health and safety engineer, Accident Prevention and Health Division, Region V, Bureau of Mines, Duluth, Minnesota, heard about the explosion at 7:30 p.m., March 30, from members of a first-aid class they were teaching at Centerville, Iowa, 31 miles from Lovilia. Dalrymple started for the mine. Capps called the local radio station to verify the news, called the Assistant United States Attorney at Des Moines, Iowa to ascertain if the restraining order (see above this report) permitted Bureau of Mines' personnel to assist in recovery operations and investigation of the explosion at the O'Brien mine, and notified the Duluth office of the Bureau of Mines before leaving Centerville. Dalrymple met T. C. Chapman, Iowa State mine inspector, at Albia, Iowa, between Centerville and Lovilia. Dalrymple was advised by Chapman, who had returned from the mine, that the bodies of the shot firers had been recovered, that no further activities were in progress at the mine, and that the State would conduct an investigation at 10 a.m. the following day. Dalrymple returned to Centerville and telephoned the Duluth office. Capps in the meantime

had started for the mine and learned from miners in Lovilia that the bodies of the shot firers had been recovered, but decided to continue to the mine.

Capps arrived at the mine at 10 p.m., just as 2 of the 5 men who entered the mine at 9 p.m. returned to the surface. He supervised rescue and recovery operations that night, and notified Dalrymple and the Duluth office at 6 a.m. of the latest developments. Dalrymple arrived at the mine at 8:30 a.m., March 31, and supervised recovery operations that day. Rescue work was completed before the arrival of additional Bureau personnel.

James A. O'Connor, health and safety engineer, Accident Prevention and Health Division, Region VIII, Bureau of Mines, Vincennes, Indiana, was notified by the Washington office through the Regional Director, Region VIII to report to the mine, and arrived there at 9 p.m., March 31. H. F. Weaver, Chief, Coal Mine Inspection Branch, Health and Safety Division, Bureau of Mines, Washington, D. C., arrived at the mine at 9:30 p.m., March 31.

E. W. Felegy and R. O. Pynnonen, mining engineers, Accident Prevention and Health Division, Region V, Bureau of Mines, Duluth, Minnesota, arrived at the mine at 12:30 a.m., April 1. Two other men from the Duluth office started for the mine March 31 with the mine rescue truck and equipment but returned to Duluth when they were advised enroute that the equipment was no longer required at the mine. All the above-named Bureau of Mines' personnel participated in the investigation of the explosion.

Mine Conditions Immediately Prior to Explosion

The mine operated the usual single shift the day of the disaster. No unusual conditions were reported by the fire boss or any underground employees, and so far as is known, the fan had been operating continuously from 4 a.m. All men except the shot firers left the mine before 4 p.m.

Story of Explosion

Holes were drilled and charged with pellet black blasting powder on shift in the faces of 13 rooms off 9 and 10 west entries off the main entry and in the face of 7 east entry off the back entry. Two shot firers, one of whom was the mine foreman, remained underground to fire the shots after the end of the shift. Both men were killed in the explosion, and their activities prior to the explosion can only be deduced from observed evidence.

Normal procedure required the shot firers to begin igniting fuses in No. 1 room off 9 west entry and to continue through the six rooms off that entry, cross over into No. 7 room off 10 west entry and work their way back to the main entry, then cross into the back entry to fire the shots in the face of 7 east entry before leaving the mine. That procedure kept them advancing into the air current and apparently was being followed the day of the explosion. All holes except the two in the face of No. 1 room off 10 west entry and three in the face of 7 east entry had been fired when the explosion occurred and killed the shot firers.

The force of the explosion spread throughout the 9 and 10 west entries and rooms and extended 700 feet along the main entries outby that section. Only minor damage resulted in the 9 and 10 west entries. A brattice-cloth check curtain in the main entry between 9 and 10 west entries was destroyed by the explosion, short circuiting the air past those entries. The four gob stoppings between the main and back entries immediately outby 9 west entry were partly or completely blown out into the main entry. A wooden door in the main entry between 7 and 8 west entries was demolished. Ten empty mine cars in the main entry were tumbled about and piled so as to block the entry almost completely. A number of timbers were knocked out at different points in the main and back entries. Roof falls partly blocked the main entry just outby 9 west entry and the back entry near 3 east entry. A roof fall blocked the back entry completely at 6 east entry, and other minor roof falls occurred throughout the affected area.

No definite evidence of the explosion was reported to have been observed on the surface. Three underground employees, X. Lennie, James Love, and Mike Hasso, were waiting on the surface for the shot firers to return. The shot firers usually returned to surface ahead of the main body of smoke from the blasts. The men on the surface observed what they assumed to be smoke from the blast coming up the slope and decided to go down the air shaft to find out why the shot firers had not returned. They entered the air shaft at 4:15 p.m. and found the back entry partly blocked by a roof fall and dislodged timbers near 3 east entry, and completely blocked near 6 east entry. They entered the main entry through a small door near 6 east entry, found additional roof falls and other property damage in the main entry and noticed that the air was contaminated. The men traveled outby on the main entry to a small door near 3 east entry, where they returned to the back entry and left the mine through the air shaft. Lennie called the central telephone operator and told her to summon help because of trouble at the mine.

Recovery Operations

Pliny Samuels and Marion Brawdy, chief and asst. chief of the Albia Fire Department, Dr. F. N. Bay, Monroe County coroner, several members of Iowa Highway Patrol, and numerous miners and other persons arrived at the mine shortly after the telephone requests for assistance were made.

Smoke no longer was visible in the return air coming up the slope, and X. Lennie, James Love, and about 15 others entered the mine through the slope at 5:15 p.m. The party stopped at the first blown-out stopping, about 200 feet outby 9 west entry, and one man advanced a short additional distance until he saw the bodies of the two shot firers lying outby 9 west entry. Four more men helped carry the shot firers back to the point where the main party stopped. Lennie returned to the surface and lowered Dr. Bay and Fire Chiefs Samuels and Brawdy, with a resuscitator, down the slope in a mine car. Men underground were giving artificial respiration to one of the shot firers when Dr. Bay arrived and, after examination, pronounced both men dead. The entire party returned to the surface with the bodies of the victims shortly before 6 p.m. Lennie left the mine about 6:30 p.m.; only a few persons were still at the mine at that time.

Tom Wignall, managing partner, Lovilia Coal Company, and Thomas Little and Gerald Lane, partners and mine foremen, Lovilia Coal Company, arrived at the O'Brien mine shortly after 8 p.m., March 30, and after some discussion decided to enter the mine to see what they might determine about the cause and effect of the explosion. They went down the slope and along the main entry as far as the destroyed door between 7 and 8 west entries, then returned to the surface to obtain a flame safety lamp. D. W. O'Brien, owner and operator of the O'Brien Coal Company, and James Love and A. B. Overturf, motorman and miner respectively at the O'Brien mine, arrived at the mine before Wignall, Little, and Lane reentered. Love previously had helped recover the bodies of the shot firers, and he and Overturf also decided to enter the mine. Wignall and Lane entered the air shaft and Little, Love, and Overturf went down the slope, and the five men met underground.

According to Wignall's testimony at the coroner's inquest, the men were under the impression that flame safety lamps provide adequate warning of all noxious gases encountered in coal mines. The party allegedly split up again, then rejoined at 10 west entry and examined a blown-out shot hole in No. 4 room off that entry. The men had been there "5 or 10 minutes" when Overturf mentioned he "didn't think the air was too good" and suggested leaving the mine. Wignall and Overturf started toward the main entry, but Lane, Little, and Love started toward the face of 10 west entry. Wignall looked back, saw a light below No. 4 room, and returned to find Little lying on the floor. Wignall attempted to help Little, then realized that he too was losing consciousness, and crawled back to the main entry. Lane and Love could not be seen. Overturf helped Wignall reach the locomotive outby the last obstruction in the main entry, and both men rode the motor to the slope bottom and returned up the slope to the surface.

Wignall told Federal Inspector Capps, who had just arrived at the mine, that three men had been overcome by gas and were still in the mine. Capps requested Wignall to check the operation of the fan and to telephone for help and notify the State mine inspector and W. B. Dalrymple at Centerville. Dalrymple was not notified, but other help began to arrive at 10:35 p.m. and Capps attempted to organize recovery operations. Despite his attempts to explain the hazards involved and the safe procedure to be followed, numerous persons continued to go in and out of the slope until Ray Cooley, sheriff of Monroe County, posted a guard at the slope mouth.

A mine map was obtained and at 11:45 p.m. a rescue crew comprised of Capps, 2 miners, and 3 firemen from the Albia Fire Department equipped with 2 Chemox apparatus entered the air shaft and advanced on intake air toward the working section. Temporary brattice-cloth stoppings were erected across the entrances to 4, 5, and 6 east entries, a roof fall at 6 east entry was partly removed and the roof was retimbered, and four stoppings were repaired between the back and main entries inby 5 and 6 east entries. A check curtain in the main entry between 9 and 10 west entries was found to be destroyed when the party reached that point at 2:25 a.m. A test with a Hoolamite carbon monoxide detector indicated 0.3 percent carbon monoxide at a point 20 feet inside the 9 west entry. James Love's body was visible in 9 west entry at the junction with No. 2 room, and two firemen wearing Chemox apparatus carried the victim to fresh air in the main entry at 2:45 a.m. Difficult traveling and fatigue of crew members made it necessary to leave the body at 5 east entry when the rescue crew left the mine.

Experienced help was not available in the few people who were at the mine when the rescue party returned to the surface, and recovery work was suspended until Dalrymple arrived at the mine at 8:30 a.m., March 31.

Dalrymple organized a crew of 10 men and obtained additional repair supplies, stationed guards at the mine entrances, and entered the mine through the air shaft. The crew advanced in fresh air, removed obstructions in the entries, repaired temporary brattice-cloth stoppings erected by the first crew, and erected additional brattices to ventilate rooms and dead ends. T. C. Chapman and William Jervis, Iowa State mine inspectors, joined the party at 11 a.m. Ventilation was reestablished in 9 and 10 west entries by 12 noon. Gerald Lane's body was found in 9 west entry 20 feet outby No. 5 room, and Thomas Little's body was found in 10 west entry at the entrance to No. 6 room. The recovery crew returned to the surface with the three bodies at 1:10 p.m. No further work was done in the mine until the investigation on April 1.

INVESTIGATION OF CAUSE OF EXPLOSION

An investigation of the disaster was conducted April 1, 1953, by representatives of the Bureau of Mines, the Iowa State Department of Mine Inspectors, and an employee of the O'Brien Coal Company. The following persons were in the investigating party:

U. S. Bureau of Mines

| | |
|-------------------|------------------------------------|
| Roy Capps | Coal-Mine Inspector |
| W. B. Dalrymple | Health and Safety Engineer |
| E. W. Felegy | Mining Engineer |
| James A. O'Connor | Health and Safety Engineer |
| R. O. Pynnonen | Mining Engineer |
| H. F. Weaver | Chief, Coal Mine Inspection Branch |

Iowa State Department of Mine Inspectors

| | |
|----------------|-----------|
| T. C. Chapman | Inspector |
| William Jervis | Inspector |

O'Brien Coal Company

| | |
|-----------|-------|
| X. Lennie | Miner |
|-----------|-------|

W. B. Dalrymple and R. O. Pynnonen attended the Monroe County coroner's jury inquest at Albion, Iowa, April 1, 1953. Additional information was obtained April 2 and 3 by Bureau personnel.

Dust and Black Blasting Powder as Factors in the Explosion

The last Federal inspection of the mine was made October 9, 1952. The mine was found to be in violation of Section 209(e)(3) of the Federal Coal Mine Safety Act. A Notice of Findings was issued the same day stating that the mine was dry and rock dust was not applied, and requiring that the violation be totally abated by April 9, 1953 (see pp. 6 and 7 and appendix E).

Recommendations to rock dust the mine according to provisions of the Federal Mine Safety Code were made in five previous inspection reports, the first of which was dated March 15, 1949.

Coal in this mine has a volatile ratio of 0.47, and the coal dust is highly explosive. Dust samples were not collected prior to the day of the disaster, but samples were collected from the roof, ribs, timbers, and bottom at 16 different points in the mine during the investigation. Results of analyses, compiled in table 2, show that the incombustible content of all samples was less than the 65 percent minimum specified in the Federal Coal Mine Safety Act. The incombustible content of the dust was less than 40 percent in 10 samples; only 2 samples contained more than 50 percent incombustible material.

A Notice of Findings also issued October 9, 1952 upon completion of the last Federal inspection of the mine, stated that black blasting powder was used to blast coal in the mine and required that this violation of Section 209(h)(5) of the Federal Coal Mine Safety Act be totally abated by January 16, 1953 (see pp. 6 and 7 and appendix D). In nine previous inspection reports, the first dated March 12, 1947, recommendations were made to discontinue the use of black blasting powder and to use permissible explosives or permissible blasting devices according to provisions of the Federal Mine Safety Code.

Flame

No marked evidence of flame attributable to the explosion was found in 9 and 10 west entries or in the rooms turned off those entries. Paper flags marking the fuses of the unfired shots in No. 1 room off 10 west entry and in 7 east entry were not charred.

Splinters on timbers, and the edges of waxed-paper liners of empty and partly empty explosives containers at many points throughout the entire explosion area were charred, but no completely burned paper was found anywhere. Variation in the degree of charring and the random locations at which the more severe charring occurred made it impossible to trace the course of the flame. All the timbers and many of the discarded containers had been near advancing working faces when those faces were blasted during working periods before the explosion. Flame from black powder shots at those times charred the timbers and containers, and during the investigation it was impossible to determine what part of the charring was attributable to the explosion and what part was attributable to previous blasts.

Definite evidence of flame from the explosion was found in the main entry between 9 and 10 west entries. The fragments of a brattice-cloth check curtain across the main entry at that point were charred severely. The bodies of the shot firers, however, found 45 feet outby the destroyed check curtain, showed no evidence of either flame or violence.

Neither plastic nor crusted coke was found on dust deposits on rib ledges or at any other points in the mine. Coal dust outside the explosion area exhibited the same metallic gray luster observed on dust in the explosion area, indicating that coked particles were not present in the dust in any part

of the mine. The absence of coked particles in the mine dust was verified by results of laboratory analysis of samples collected during the investigation and shown in table 2.

Pellet black blasting powder and a few cartridges of permissible explosives were scattered in the vicinity of several containers at different points, but none of the cartridges were burned or charred and there was no evidence that explosives not confined in shot holes had been detonated.

Forces

Appendix B shows the direction of forces and the approximate area of the mine affected by violence. Forces in 9 and 10 west entries were relatively mild. Only a few timbers were dislodged and the gob stoppings between 9 and 10 west entries were undamaged. Light objects such as empty and partly empty wooden or cardboard explosives containers in 10 west entry were blown outby and inby from No. 4 room. Cars spotted in 10 west entry at the junctions with rooms 4, 3, and 2 before the explosion, were moved outby toward the main entry and one car was derailed. Forces into rooms turned off 10 west entry were not evident except in the outer abandoned portion of No. 1 room, where dislodged props, prevented from falling completely by supporting gob material, were canted toward the room face. Evidence of forces in 9 west entry was limited to movement of light objects toward the main entry.

Shot holes had been charged heavily in all working places. Timbers dislodged by the heavy solid shots had fallen toward the room necks; blasted coal in the shorter rooms was thrown into the room necks and through some room necks into the entries. The strong outward force of the face blasts in rooms off both 9 and 10 west entries obscured any indication of lighter forces from the coal-dust explosion moving into the rooms.

The intensity of the force wave increased suddenly when it reached the main entries. Crossbars at the junction of 9 west and the main entry were dislodged, resulting in a fall of roof at that point. A trip of 10 empty mine cars on the sidetrack immediately outby 9 west entry was hurled outby and wrecked. The cars were not heavily damaged but they were tumbled about and piled so as to block the main entry almost completely.

The forces moved outby in the back entry, and the four gob stoppings between the main and back entries immediately outby 9 west entry were partly or completely blown out into the main entry. Forces continued outby in both main entries, dislodging timbers intermittently, and violently demolishing a wooden door across the main entry at 7 west entry. The 7 and 8 west entries had been abandoned since the last Federal inspection and were not sealed; the momentary resistance of the door appeared to have deflected the forces into the abandoned workings. No timbers were dislodged in the mouths of 7 and 8 west entries but pieces of boards and an empty oil drum were blown 25 to 50 feet into the entries. No evidence of force was observed in the main entry outby the shattered door. Dislodged timbers and a roof fall completely blocked the back entry at 6 east entry. The last signs of violence in the

back entry were dislodged crossbars and a relatively large roof fall near 3 east entry, 170 feet, outby the destroyed door in the main entry between 7 and 8 west entries. Forces in the back entry appeared to have been dissipated in the old workings off 3 and 4 east entries.

Evidence of Activities

The day shift was completed and all men except the shot firers were out of the mine. The investigation disclosed that shots had been fired in the 6 rooms off 9 west entry and in 6 of the 7 rooms off 10 west entry. Two holes in the face of No. 1 room off 10 west entry and three holes in the face of 7 east entry were charged but had not been fired.

Probable Point of Origin

All evidence observed in the investigation indicates that the explosion originated in No. 4 room off 10 west entry. Two blown-out shot holes were found in the solid face of that room, one along the left rib and one along the right rib, and evidence observed in 10 west entry showed that the force of the explosion radiated from the mouth of No. 4 room.

Factors Preventing Spread of Explosion

Analysis of a coal sample collected in the nearby Blackstone mine from the same coal bed mined in the O'Brien mine shows a high ash and moisture content in the coal. The quantity of coal dust observed in the mine passageways was limited, and the coal bed was underlain by a soft fire-clay bottom. The main entry haulageway was wet outby 7 and 8 west entries, and old workings off both the main and back entries permitted expansion of the force of the explosion. All the above-mentioned factors contributed to limiting the spread of the explosion.

Summary of Evidence

Appendix B shows the portion of the mine affected by the explosion, the positions of the slope and the air shaft, the normal course of the ventilating current, the probable point of origin of the explosion, the approximate area traversed by flame, the direction of forces and the approximate area affected by violence, the points at which the victims were found.

Explosion forces radiated outward from the mouth of No. 4 room off 10 west entry, and were relatively mild in 9 and 10 west entries. No evidence of violence was observed in the short distances to the faces of the main entries inby 9 and 10 west entries, but the intensity of the forces increased rapidly in the main entries outby 9 and 10 west entries. Maximum violence occurred outby 9 west entry in the main entry where a trip of 10 empty mine cars was wrecked and piled up in the entry. Explosion forces were dissipated in old workings off the main entries outby 9 and 10 west entries, and the farthestmost limit of violence was 700 feet outby those entries.

Some evidence of flame was observed throughout the area of the mine affected by the explosion, but variation in the degree of charring and the random locations at which the more severe charring occurred made it impossible to trace the course of the flame. Little evidence of flame attributable to the explosion appeared in 9 and 10 west entries and the rooms turned off those entries and little or no evidence of flame appeared in the main entries inby 9 and 10 west entries. Paper flags marking the fuses of unfired shots in No. 1 room off 10 west entry and in 7 east entry were not charred. Maximum flame intensity was observed between 9 and 10 west entries where a brattice-cloth check curtain across the main entry was destroyed and the curtain fragments were severely charred. Plastic or crusted coke was not found anywhere in the mine, and coal dust in the explosion contained no granular coke particles.

Shots had been fired in the 6 rooms off 9 west entry and in 6 of the 7 rooms off 10 west entry. Two shot holes charged with pellet black blasting powder and fuse, but not fired, were found in the face of No. 1 room off 10 west entry, and 3 similarly charged but unfired shots were found in the face of 7 east entry.

The bodies of the shot firers were found in the main entry 45 feet outby the destroyed check curtain across the main entry between 9 and 10 west entries. The shot firers' unopened self rescuers were lying along the rib in the main entry at the junction with 9 west entry. No burns or evidence of violence appeared on the bodies of the shot firers although they were found between the point of maximum flame intensity and the point of maximum violence. Apparently the shot firers were in a place protected from flame and violence when the explosion occurred, but whether they were protected by design or chance is purely conjectural. Their movements after lighting the last shots they fired can not be determined. It is not known whether they took refuge because they expected a shot to blow out in No. 4 room or whether the blown-out shots and the resultant explosion caught them unawares but accidentally in a protected place, whether they started to leave the mine by the back entry intake air course and entered the return air main entry after they found the back entry blocked at 6 east entry, or whether they blindly and by instinct started to leave the mine by their usual route through the return air course and up the slope.

All discharged shots except those in No. 4 room off 10 west entry were effective in moving burden. Two holes in that room blew out.

Appendix C is a large scale sketch of No. 4 room off 10 west entry. One hole was drilled in the solid face along the left rib and one hole was drilled in the solid face along the right rib. Both holes were drilled essentially normal to the face and parallel to the ribs; both the face and ribs were irregular. Opener shots had not been prepared at any point in the face between the two rib holes, and all investigators agreed that the two shots in No. 4 room were what locally are termed "impractical" shots. Both holes were heavily overburdened and probably heavily charged. Widely scattered broken coal and extensive timber dislodgment in other rooms blasted the day of the explosion indicated that all holes were charged heavily. Under the conditions of impossibly heavy burden and heavy explosives charges, it was almost certain that the two holes in No. 4 room would blow out, and in fact they did blow out.

Stubs of blasted holes in No. 4 room and in other working places in the mine were examined closely. Short sections of the bottoms of holes blasted with black powder were identifiable in every instance by characteristic cracks or crevices parallel to the long axis of the hole. Holes shot with higher explosives, probably permissible explosives, the only other type found in the mine, were identified by the shattering effect at the bottom of the hole or by the concave recess remaining when the shattered material was removed.

Four feet of the hole along the left rib in No. 4 room remained intact and the "collar" was coned out to approximately a 12-inch diameter. The hole along the right rib was 5-1/2 feet deep and 1 foot of coal or less had been blown from the "collar" of the hole toward the center of the room. Although little or no burden was moved by the blown-out shots, the hole along the right rib was covered by a quantity of broken coal in the right front corner of the room. It was discovered by Bureau of Mines' investigators only after repeated careful examinations of the room face and ribs. Both holes exhibited the cracks or crevices parallel to the long axis, identified as characteristic of black powder shots.

Analysis of coal samples collected in a nearby mine from the same coal bed mined in the O'Brien mine indicates that the coal in the O'Brien mine has a volatile ratio of 0.47 and that therefore the coal dust is highly explosive.

Heavily charged shots in all rooms off 9 and 10 west entries suspended high concentrations of coal dust in the air throughout the working section before the shots in No. 4 room were ignited. The two blown-out shots in No. 4 room aggravated the dust concentration and greatly increased the air turbulence creating an ideal condition for ignition of the dust cloud by the hot and long enduring flame from the black blasting powder.

High ash and moisture content of the coal, relatively limited dust accumulations in the haulageways, pulverized fire-clay dust from the soft bottom mixed with coal dust in the haulageways, water in the main entry outby 7 and 8 west entries, and pressure release into old workings off both main entries with resultant reduced pressures and temperatures, all contributed to confining the coal-dust explosion to the original dust cloud and preventing propagation of the explosion throughout the rest of the mine.

A test of the atmosphere 20 feet inby the mouth of 9 west entry off the main entry, at 2:25 a.m., March 31, 10-1/2 hours after the explosion occurred, indicated a carbon monoxide concentration of 0.3 percent. The absence of burns or signs of violence on the bodies of the shot firers or on the bodies of the three men who died in the mine about 5-1/2 hours after the explosion indicate that the five fatalities were caused by carbon monoxide poisoning.

The shot firers' unopened self rescuers were found lying along the rib of the main entry at the junction with 9 west entry. It is possible that had they used the self rescuers they might have escaped from the mine.

Statements of 1 of the 2 men who escaped from the mine when 3 other men were overcome by carbon monoxide about 5-1/2 hours after the explosion showed that those men did not know that flame safety lamps cannot be used to detect the presence of dangerous concentrations of carbon monoxide.

Cause of Explosion

The explosion was caused by ignition of a cloud of coal dust by two blown-out pellet black blasting powder shots off the solid in the face of No. 4 room off 10 west entry off the main entry.

RECOMMENDATIONS

Recommendations concerning the safe operation of this mine were made in reports of previous Federal inspections, the last inspection having been made October 9, 1952. Recommendations in this report, therefore, are limited to conditions related to this disaster.

Rock Dust

1. The mine should be rock-dusted to within 40 feet of all faces, including open crosscuts less than 40 feet from the faces. The incombustible content of the combined coal dust, rock dust, and other dust should not be less than 65 percent.

Explosives and Blasting

2. Black blasting powder in any form should not be used underground. Permissible explosives or permissible blasting devices should be used, in a permissible manner.

3. Shooting off the solid should be discontinued. Solid coal should be cut so as to provide at least two free faces before blasting.

Miscellaneous

4. Mine officials and employees in this area should be trained in accident prevention and in mine rescue and recovery operations. The Bureau of Mines training courses include instruction on the occurrence, composition, and detection of mine gases. A central mine rescue station should be maintained to serve the area.

5. The use of open flame lights in this mine should be discontinued; only permissible electric lamps should be used for portable illumination underground.

ACKNOWLEDGMENT

Valuable assistance was rendered in recovery operations by members of the Iowa Highway Patrol, the Albia Fire Department, the Monroe County coroner and sheriff, and mining company employees. Acknowledgment is made to the Iowa State Department of Mine Inspectors, to the mining company, and particularly to K. Lennie, miner at the O'Brien mine, for their cooperation in conducting the investigation.

Respectfully submitted,

/s/ Roy Capps
Roy Capps
Coal-Mine Inspector

/s/ W. B. Dalrymple
W. B. Dalrymple
Health and Safety Engineer

/s/ E. W. Felegy
E. W. Felegy
Mining Engineer

/s/ James A. O'Connor
James A. O'Connor
Health and Safety Engineer

/s/ R. O. Pynnonen
R. O. Pynnonen
Mining Engineer

/s/ H. F. Weaver
H. F. Weaver
Chief, Coal-Mine Inspection Branch

Approved by:

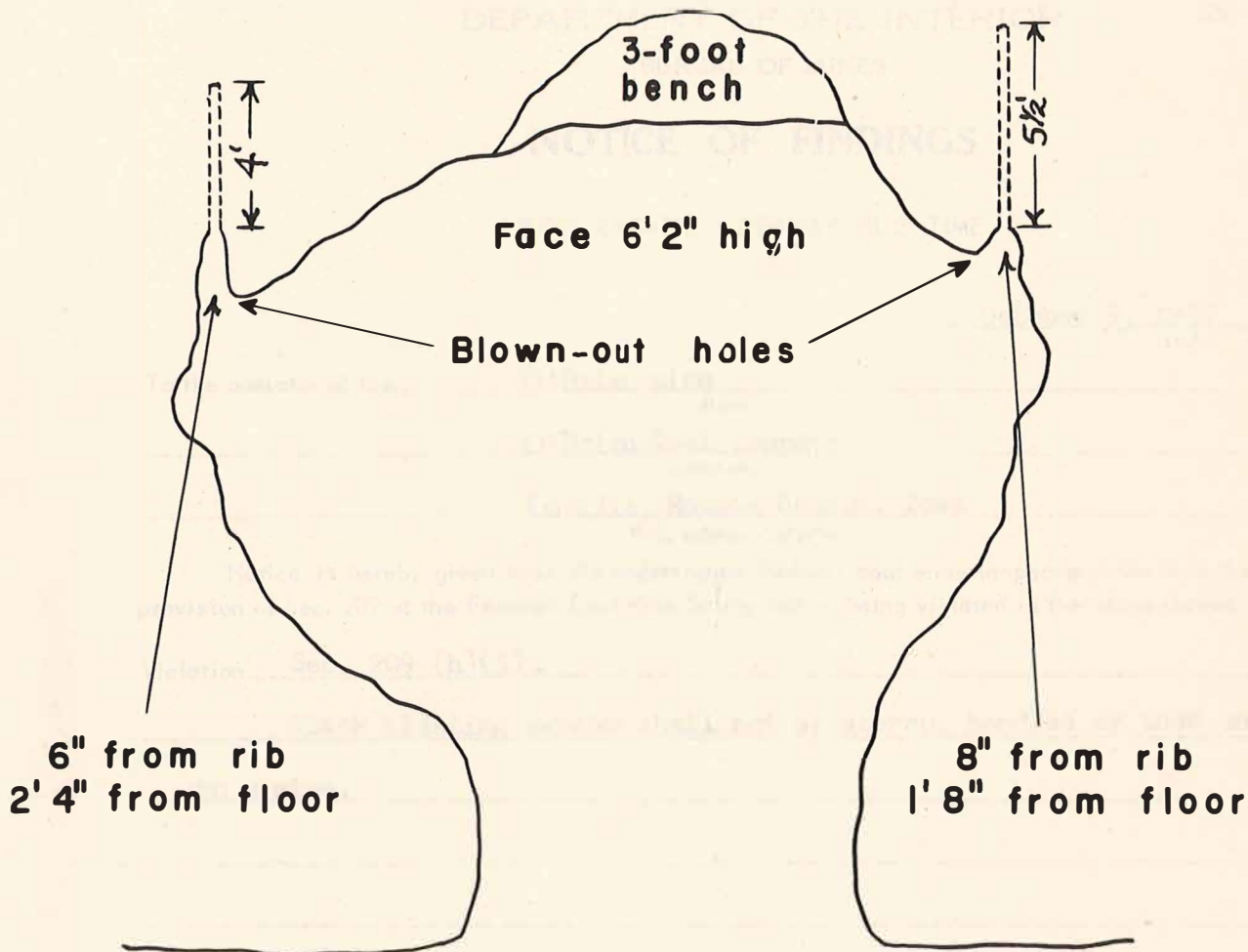
/s/ John A. Johnson
John A. Johnson, Chief
Accident Prevention and
Health Division, Region V

APPENDIX A

VICTIMS OF EXPLOSION, O'BRIEN MINE
O'BRIEN COAL COMPANY
LOVILLIA, MONROE COUNTY, IOWA

March 30, 1953

| <u>NAME</u> | <u>AGE</u> | <u>OCCUPATION</u> | <u>YEARS' EXPERIENCE</u> | <u>DEPENDENTS</u> |
|---------------|------------|--------------------------------|------------------------------|-------------------|
| Harold Barnes | 37 | Mine foreman and Shot firer | 17 | 1 |
| Ben Nichols | 47 | Shot firer | 30 | 1 |
| Gerald Lane | 59 | Mine foreman | 40 | 2 |
| Thomas Little | 48 | Mine foreman | 25 | 1 |
| James Love | 55 | Motorman | 35 | 1 |



10 W. entry

APPENDIX C

SKETCH OF
NO. 4 ROOM OFF 10 W. ENTRY
O'BRIEN MINE, O'BRIEN COAL CO.
LOVILIA, MONROE COUNTY, IOWA

MARCH 30, 1953

SCALE 0 1 3 5'

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

R9-1

NOTICE OF FINDINGS

FOR GRANTING REASONABLE TIME

October 9, 1952

Date

To the operator of the O'Brien mine

Mine

O'Brien Coal Company

Company

Lovilia, Monroe County, Iowa

P.O. address of mine

Notice is hereby given that the undersigned Federal coal mine inspector finds that the following provision of Sec. 209 of the Federal Coal Mine Safety Act is being violated in the above-named mine.

Violation Sec. 209 (e)(3).

All underground mines, except those mines or areas of mines in which
the dust is too wet or too high in incombustible content to propagate an
explosion, shall be rock-dusted to within 40 feet of all faces, and, if open
crosscuts near such faces are less than 40 feet therefrom, such crosscuts shall
be rock-dusted.

Description of conditions

The mine was dry and rock dust had not been applied.**FINDING**

The undersigned inspector finds that a reasonable time within which the foregoing violation of Sec. 209 should be totally abated is by April 9, 1953

Date

Duluth, Minnesota

Originating Office

Signed /s/ W. B. Dalrymple

Federal Coal Mine Inspector

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

R9-1

NOTICE OF FINDINGS

FOR GRANTING REASONABLE TIME

October 9, 1952

Date

To the operator of the O'Brien mine
Mine
O'Brien Coal Company
Company
Lovilia, Monroe County, Iowa
P.O. address of mine

Notice is hereby given that the undersigned Federal coal mine inspector finds that the following provision of Sec. 209 of the Federal Coal Mine Safety Act is being violated in the above-named mine.

Violation Sec. 209 (d)(8)
In nongassy mines, a preshift examination, as prescribed in the Act
shall be made at least once each calendar day during which coal is produced.
Such examination shall be made within 4 hours immediately preceding the
beginning of the first coal-producing shift on such day.

Description of conditions
A preshift examination, as prescribed in the Act, was not made of this
mine on the days that coal was produced, within 4 hours immediately preceding
the beginning of the first coal producing shift on such day.

FINDING

The undersigned inspector finds that a reasonable time within which the foregoing violation of Sec. 209 should be totally abated is by January 16, 1953
Date

Duluth, Minnesota
Originating Office

Signed /s/ W. B. Dalrymple
Federal Coal Mine Inspector

COAL FATAL

1953 0337

COAL FATALITY
MONROE COUNTY, IOWA
O'BRIEN COAL COMPANY
O'BRIEN - #12449
MARCH 30, 1953

Ben Nicholas, Harold Barnes, James Love, Thomas Little, and Gerald Lane were killed in an underground mining explosion at 4:20 P.M.

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