UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
REGION VIII

FINAL REPORT ON MAJOR EXPLOSION DISASTER
BUNKER MINE
TROTTER COAL COMPANY
CASSVILLE, MONONGALIA COUNTY, WEST VIRGINIA

October 15, 1951

By

T. J. McDonald
Acting Chief

F. E. Riley
F. D. Baker
Coal-Mine Inspectors

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Introduction

An explosion occurred in the A west section of the Bunker mine, Trotter Coal Company, at Cassville, Monongalia County, West Virginia, about 6:45 a.m., Monday, October 15, 1951. There were 40 men in the mine at the time, 10 of whom were killed by violence in the explosion area. The remaining 30 were uninjured and escaped without assistance. The names of the men who were killed, their ages, occupations, mining experience, and the number of dependents are shown in Appendix A of this report.

The explosion was caused by the ignition of methane which had accumulated in a pillared area. The exact source of ignition cannot be stated definitely, but the most likely source was an open-type combination trolley-pole and cable-reel locomotive; however, there were other sources of electric arcs in the ignition area. The explosion was confined to the A west section. The section consisted of four parallel entries, which had been driven 1,725 feet from the 6 south entries to the boundary where pillaring was started. The pillared area was about 600 feet deep and 700 feet wide. The area affected by the explosion is shown on a map. (See Appendix C.)

General Information

The Bunker mine of the Trotter Coal Company is at Cassville, Monongalia County, West Virginia, along State Route 7, and is serviced by the Monongahela Railroad.

The operating officials and their addresses are as follows:

James F. Trotter	President	Morgantown, W. Va.
E. W. St. Clair	General Superintendent	Morgantown, W. Va.
Lowell Conner	Superintendent	Morgantown, W. Va.
Howard McKelrath	Mine Foreman	Morgantown, W. Va.

A total of 310 men was employed; 37 worked on the surface and 273 worked underground, 3 shifts a day, 5 days a week, and produced an average of 3,800 tons of coal daily, all loaded by caterpillar-mounted loading machines.

The mine was opened by the Bunker Coal Company of Pittsburgh, Pennsylvania, in 1918 and was acquired by the present operating company in 1930.

The mine is opened by a slope, 311 feet in length, and two shafts, 110 and 220 feet deep, into the high-volatile Sewickley coal bed, which, in this mine, averages about 66 inches in thickness.

The immediate roof of dark shale averages 7 feet in thickness, and the main roof is a hard gray sandstone about 53 feet in thickness. The mine floor is a hard shale.

The West Virginia Geological Survey reports the coal from this mine as having the following analysis:

	Percent
Volatile Matter	37.95
Moisture	.95
Ash	12.30
Fixed Carbon	48.80

The ratio of volatile matter to total combustible matter of this coal, which is an index of the explosibility of the coal dust, is shown by the following formula:

$$\text{Volatile Ratio} = \frac{\text{Volatile Matter}}{\text{Volatile Matter + Fixed Carbon}} = \frac{37.95}{37.95 + 48.80} = 0.44$$

Bureau of Mines tests and experiments have shown that coal dust having a ratio of volatile to total combustible in excess of 0.12 is explosive. The explosibility of coal dust increases as the ratio increases. It is obvious, therefore, that the coal dust in this mine is explosive and would readily propagate an explosion.

Mining Methods, Conditions, and Equipment

Mine development was done by a block system, and pillar extraction was by the pocket-and-fender method. Entries were in sets of four and five, about 16 feet wide. Rooms, when driven, were 16 feet wide. Crosscuts were about 80 feet apart. Roof bolting and timbers were used to control the roof; and roof bolting was done along roadways, at intersections, and in the face regions. All coal was loaded by crawler-type loading machines directly into mine cars.

Explosives

Blasting was done on shift with permissible explosives and No. 6 electric detonators, and these were fired with permissible blasting units by shot firers. Explosives and detonators were satisfactorily transported and stored on the surface and underground. Tests for methane were made immediately before and after each shot was fired during the last Federal inspection, which was completed July 24, 1951. Incombustible material was used for stemming boreholes.

Ventilation and Mine Gases

Ventilation was induced by an axial-flow fan operated exhausting. The fan was satisfactorily installed in a fireproof building on the surface, equipped with necessary safety features, and operated continuously. The fan was inducing the circulation of 138,450 cubic feet of air a minute at the time of the last Federal inspection. Four splits of air were used to ventilate the mine workings. One split of air was used to ventilate the B west solid section and then used to ventilate the A west pillar section. Main stoppings and overcasts were built of concrete blocks, and main doors were installed in pairs to form air locks.

The mine is rated gassy by the West Virginia Department of Mines. Methane had frequently been detected with permissible flame safety lamps. The mine was liberating methane at the approximate rate of 600,000 cubic feet in a 24-hour period. Records at the mine indicated that preshift, onshift, and weekly examinations for methane and other hazards were made. Methane was detected with a permissible flame safety lamp at two working faces during the last Federal inspection, and two air samples collected in the main return contained 0.15 and 0.45 percent methane.

Active and abandoned gas wells penetrated the coal bed; however, they were protected by suitable pillars of coal.

Dust

During the last Federal inspection, the mine surfaces varied from dry to wet, excessive coal-dust accumulations did not exist, and dust-allaying methods were not used or needed. The areas that were not definitely wet were well rock-dusted to within 70 feet of the faces. Two track-mounted high-pressure permissible-type rock-dusting machines were used to apply rock dust to the mine surfaces.

Transportation

Trolley-pole locomotives were used on main and secondary haulageways, and combination trolley-pole and cable-reel locomotives were used in the face regions. Steel mine cars were used to transport coal from the face regions to the slope bottom, and a belt conveyor transported the coal from the slope bottom to the surface tipple.

Electricity

Electric power, at 2,200, 400, 220, and 110 volts alternating current, was used on the surface, and 440 volts alternating current and 250 volts direct current were used underground. Power wires were installed on insulators and provided with cut-out switches. Both permissible and nonpermissible electric face equipment was used. At the time of the last Federal inspection, the permissible-type loading machines, cutting machines, and hand-held drills were not maintained in permissible condition due to openings in excess of 0.004 inch in electrical compartments and missing seals. Temporary splices in trailing cables were made with splicing rings and insulated with friction tape.

Illumination and Smoking

All employees used permissible electric cap lamps for portable illumination underground; smoking was not permitted or practiced underground, and there was no evidence to indicate that smokers' articles were being carried into the mine.

Mine Rescue

A few universal gas masks were available at the mine, and, at some previous date, some of the mine personnel had received mine rescue training. Several trained mine rescue teams from nearby mines and self-contained oxygen breathing apparatus were immediately available. Some of this equipment was owned by the West Virginia Department of Mines, and some was owned by the nearby Christopher Coal Company. Several portable fire extinguishers and supplies of rock dust were available in the mine for fire-fighting purposes.

Previous Explosions at This or Nearby Mines

This is the second explosion in this mine; the first occurred September 13, 1951, in a different section, and this resulted in three men being burned. Two of these have recovered, but one has not been released from the hospital. This mine is in an area which has experienced numerous other explosions and other-type disasters.

Following is a partial list of explosions which have occurred in nearby mines:

Mine	Year	Killed
Osage No. 3	1942	56
Pursglove No. 2	1942	20
Pursglove No. 15	1935	3
Pursglove No. 15	1943	1

Mine Conditions Immediately Prior to Disaster

Weather and barometric conditions were normal, with no unusual variations for several days before the explosion, at the time of the explosion, and for several days after the explosion. Atmospheric pressure is believed to have had no bearing on this explosion. The mine was being operated normally at the time of the explosion, and the fan was in operation. The mine was fire-bossed before the start of the shift, and no unusual conditions were reported.

Story of Explosion and Recovery Operations

The mine was idle from about 8 a.m., Saturday, October 13, 1951, until about 12:15 a.m., Monday, October 15, 1951, at which time four working crews went underground. A fire-boss examination had been made before these men entered the mine, and the records indicate that methane was not detected in the A west section. The helper on the mining machine in A west section was injured during the shift and was transported to the surface about 2 a.m., October 15, 1951. This man stated that the section had been well rock-dusted, and normal mining operations were continued until he left the section. He further stated that a pillar fall was "hanging," and the section foreman remained with the mining machine all the time it was operating in No. 16 chute making continuous tests for gas; however, this would indicate that frequent tests were not made where the loading machine and open-type locomotive were operating, because the foreman had the only flame safety lamp on the section. The motorman on the secondary haulage locomotive testified that he was in the section shortly before the explosion occurred and talked with the section foreman. He also stated that when he entered No. 4 entry from No. 14 chute he could see a locomotive headlight. This would not have been possible had the door on No. 4 entry between Nos. 14 and 15 chutes been closed; however, this door was used only to course the air around one pillar, and it being open would not seriously affect the ventilation in the section. After leaving the A west section with two loaded cars, he traveled to the B west section, stopped the locomotive and trip inby B west section, and had walked up into the section when the explosion occurred. The shift mine foreman stated that, at about 6:35 a.m., the A west section foreman telephoned him at the underground bosses' shanty and gave the fire-boss report, which stated that the section was free of gas, but that the roof along the pillar line was "working," and a pillar fall was expected. This was the last information received from the section before the explosion occurred at 6:45 a.m. It was the practice for each section foreman to make a fire-boss examination of his particular section and telephone his report to the shift mine foreman, and he in turn telephoned the reports to another man on the surface, who recorded the information in the fire-boss book. Records of the fire-boss examinations were not kept underground. At about 6:37 a.m., the B west section foreman phoned the shift mine foreman and reported the B west section free of gas. Then, in a very few minutes, the B west section foreman phoned again and reported that the B west section was filling with smoke and wanted to know what to do. The shift mine foreman stated that he told him to bring his men out and that he would start in to meet them. The ventilation in the

B west section, on the intake side of A west, was not seriously interrupted, thereby permitting the smoke in the mouth of B west section to clear quickly, which in turn allowed the B west crew members to escape unharmed. The shift mine foreman met the B west crew as it was leaving 6 south heading and asked one of the crew to accompany him. They went on inby the mouth of B west section and encountered smoke, heat, and damaged stoppings. The power-line cut-out switches were pulled as they advanced, and at the entrance to B west section a locomotive was discovered on fire. They put out the fire and notified the outside mine office. Messrs. E. W. St. Clair, general superintendent, Lowell Conner, superintendent, and Howard McKelrath, mine foreman, went underground immediately. Upon arrival underground, they met the shift mine foreman outby the entrance of A west section. Rescue and recovery operations were started at once. Temporary stoppings were erected to replace those blown out by the force of the explosion along the 6 south and A west haulageways. This work was under the supervision of the mine foreman, and the ventilation was restored along the 6 south and A west haulageways, which permitted the crew to advance without the aid of respiratory equipment. Nineteen temporary stoppings were erected, and about 9:30 a.m., the same day, five bodies were located and recovered. The rescue party was joined at this time by Messrs. T. J. McDonald, acting chief, Fairmont Section, F. D. Baker and F. E. Riley, Federal coal-mine inspectors. William Berry, George Benson, and E. H. John of the West Virginia Department of Mines, had arrived a short time before. An examination was made of the area, fires were not found, and methane was not detected. During this exploration, the five remaining bodies were located, and all bodies were recovered and sent to the surface at about 1:30 p.m. A mine rescue team with self-contained oxygen-breathing apparatus from the Christopher Coal Company entered the mine shortly before the last bodies were recovered but were not needed in the recovery operations.

Activities of Bureau of Mines Personnel

The Fairmont office of the Bureau of Mines learned of the explosion at 8:05 a.m., October 15, 1951, through a telephone call from an official of the Trotter Coal Company, and Messrs. McDonald, Riley, and Baker of the Fairmont office arrived at the mine about 9:30 a.m., October 15, 1951. After obtaining the available information concerning the disaster, they entered the mine at 10 a.m., arrived at the explosion area at 10:30 a.m., and immediately assisted in recovery operations. At 10:10 a.m., October 15, 1951, Messrs. R. C. Estep and J. F. Orlando, coal-mine inspectors, Fairmont Section, arrived at the mine and proceeded underground to assist in recovery operations. Mr. W. Dan Walker, Jr., Chief, Pittsburgh Branch, Accident Prevention and Health Division, Bureau of Mines, arrived at the mine about 2 p.m., on the day of the explosion and assisted with the preliminary investigation and attended conferences. Mr. James Westfield, Chief of the Accident Prevention and Health Division, Bureau of Mines, Region VIII, accompanied by Mr. Marion T. Pyles, mining engineer, arrived at the mine about 6 p.m. on the day of the explosion. Mr. Westfield held several conferences with officials of the Trotter Coal Company, West Virginia Department of Mines, and Bureau of Mines regarding details of the explosion and the rescue and recovery operation. Messrs. C. L. Brown, mining engineer (electrical), R. S. James, mechanical engineer, and D. H. Zellers, electrical engineer, of the Pittsburgh Station, Bureau of Mines, arrived at 8 a.m., October 16, and made an inspection of the electrical equipment. Mr. P. M. Shay, coal-mine inspector, Fairmont Section, arrived at the mine at 8 a.m., October 17, and assisted in the investigation.

Investigation of Cause of Explosion

The investigation of the disaster was started about 9 a.m., October 16, by representatives of the West Virginia Department of Mines, officials of the Trotter Coal Company, and representatives of the Bureau of Mines. The names of the persons in the investigation party are as follows:

West Virginia Department of Mines

Arch J. Alexander	Chief, Department of Mines
Joseph Bierer	Administrative Assistant
William Berry	Inspector-At-Large
George Benson	District Mine Inspector
E. H. John	District Mine Inspector
M. J. Dobbie	District Mine Inspector

Trotter Coal Company

E. W. St. Clair	General Superintendent
Lowell Conner	Superintendent
Howard McKelrath	Mine Foreman
Robert Rackley	Shift Mine Foreman

Bureau of Mines

James Westfield	Chief, Accident Prevention and Health Division, Region VIII
W. Dan Walker, Jr.	Chief, Pittsburgh Branch, Accident Prevention and Health Division
Clyde L. Brown	Mining Engineer (Electrical)
R. S. James	Mechanical Engineer
D. H. Zellers	Electrical Engineer
Marion T. Pyles	Mining Engineer
T. J. McDonald	Acting Chief, Fairmont Section, Accident Prevention and Health Division
F. E. Riley	Coal-Mine Inspector
F. D. Baker	Coal-Mine Inspector
R. C. Estep	Coal-Mine Inspector
P. M. Shay	Coal-Mine Inspector
J. F. Orlando	Coal-Mine Inspector

Testimony given during a hearing conducted by Mr. Arch J. Alexander, Chief, West Virginia Department of Mines, was not available when this report was written, and the coroner's inquest had not been held.

The investigation of the explosion area revealed the following damage: All stoppings between No. 1 and No. 2 entries on A west section, one stopping between No. 1 and No. 2 entries on No. 6 south, and two stoppings between No. 1 and No. 2 entries in the B west section were blown out (see Appendix C); one mine car was derailed in the empty track inby the entrance to B west section, and several cars were damaged and derailed in No. 12 crosscut in the A west section; the wooden section boxes for explosives and detonators were destroyed; and the cable-reel of the locomotive just outby the A west loading machine was blown off the top of the locomotive and damaged. The majority of the roof in the explosion area was supported by roof bolting, and very few wooden timbers were used. Some timbers were blown down or out of alinement. Very few falls of roof were encountered. The presence of roof bolts rather than timber aided greatly in the rapid recovery of the bodies and the mine. The management decided to move the equipment out of the A west section, which will be temporarily abandoned. Production of coal was resumed in the other sections of the mine on October 22.

A study of the movement of materials in the affected area indicated that the forces radiated from the vicinity of the loading machine and locomotive in 4 entry A west. The details of the direction of forces are shown on the map referred to as Appendix C.

Evidence of heat and flame, such as deposits of coke and charred ribs, burned and charred paper, and burns on the bodies of the victims, determined the limits of the flame. Deposits of coke were very much in evidence on the ribs and timber in No. 16 and No. 17 crosscuts off No. 1 entry, on the locomotive and mining machine, and at several locations along the A west entries as far outby as 1,400 feet.

This was primarily a gas explosion, and although coal dust did enter into it, this was not a major factor. It is believed that the spread of flame was limited by the rock-dust applications on the surfaces in the affected area. Dust samples were collected in the explosion area, and the analytical results of 18 representative samples are listed in table 2. Eight of these samples contained 65 percent incombustible material or more. The high combustible content of the remaining samples was due to disturbances created by the explosion, which stirred coal dust from the newly exposed surfaces. Special tests indicated that 23 dust samples contained coke particles of varying amounts, as shown in table 3.

Ten men were in the area where the explosion occurred, and it was very evident from the locations of the bodies after the explosion (see Appendix C) that the men were in the act of moving outby from where they would be stationed during normal operations. This, very likely, was due to the roof "working" where a pillar fall was expected. The mining machine had cut the pillar split between Nos. 15 and 16 crosscuts and was parked in No. 15 crosscut. The loading machine was in a pillar split off 4 entry, as shown on the map. The tramming controls were in the reverse position, and the cable power tap was on the trolley wire. The locomotive was found coupled to a mine car which was partly loaded about 30 feet outby the loaded machine. The main controller was in the off position with the reverse lever in the position for outby travel. The switch in the control circuit to the reel motor was in the on position. The trolley pole was hooked in the down position, the brake was set, the battery-powered headlight was burning, and the cable power tap was on the trolley wire. The trackmen and timbermen had completed preparations for a cut in a pillar split between Nos. 14 and 15 crosscuts off No. 5 entry.

The Nos. 1, 2, 3, and 4 A west entries were driven to the boundary, and pillaring operations had been started without provision of a bleeder system to ventilate the mined-out area. (See Appendix C.) The records indicated that accumulations of methane had been detected frequently with permissible flame safety lamps along the pillar line, the last dates methane was recorded in the fire-boss record book being October 7, 8, 9, and 13; however, there is no record of the accumulations having been removed. Methane was detected with a permissible flame safety lamp in the explosion area during the investigation, even though ventilation had been increased from 12,000 cubic feet of air a minute, which was used to ventilate the area prior to the explosion, to 19,000 cubic feet a minute. This additional air was not great enough to prevent methane from accumulating at the edges of the pillar falls. Methane was detected with a permissible flame safety lamp at two locations on Wednesday, October 17, and on Thursday, October 18, the accumulation had increased to such an extent that the pillared area was "loaded" to the outby edges of the falls.

Following the explosion and during the investigation, 11 air samples were collected by Bureau of Mines representatives at several locations along the pillar line in the explosion area. These samples were analyzed at the Bureau of Mines laboratory at Pittsburgh, Pennsylvania, and the results are listed in table 1. One air sample

(bottle No. 6456) was collected on October 15. This sample contained 0.58 percent methane. Three air samples (bottles Nos. 3624, 7508, and 7717) were collected on October 16. These samples contained methane ranging from 0.73 to 1.79 percent. Three samples (bottles Nos. 5875, 5236, and 0280) were collected on October 17. These samples contained methane ranging from 2.61 to 6.98 percent. Four samples (bottles Nos. 8458, A-1451, A-1452, and 8608) were collected on October 18. These samples contained methane ranging from 0.21 to 10.1 percent.

Point of Origin and Possible Source of Ignition

All evidence indicates that the explosion originated in the vicinity of the loading machine and cable-reel locomotive. The exact ignition source has not been established, but it can be stated that it was of an electrical origin. There were numerous ignition sources in the immediate area; however, some of the sources can be eliminated, such as the permissible-type mining machine and permissible-type hand-held electric drill. These two pieces of equipment were unattended, and the controls were in the off position.

The possibility of smokers' articles as a source of ignition was considered, but was ruled out because there was no evidence to indicate that smokers' articles were being carried into the mine. The permissible flame safety lamp which was carried by the section foreman was not a source of ignition because it was found outside of the ignition area, and an examination disclosed that it was in permissible condition. Explosives were discounted as the source of ignition because no evidence was found to indicate that blasting was being done at the time of the explosion. The permissible-type loading machine was a possible source of ignition, because it was not in permissible condition. Seals and locking screws were missing from compartment covers, and an opening of 0.008 inch approximately 3 inches long was found under the controller cover. The open-type cable-reel locomotive or the cable attached thereto was the most likely source of ignition, because electrical arcs of sufficient intensity to ignite explosive methane-air mixtures would normally be made by the following parts of the locomotive: controller, commutators and brushes of main and reel motor units, and the contact between wheels and rails, since the trailing cable was a single conductor. The trailing cable was broken at two places, and one of the places showed evidence of slight fusing of the ends. The trolley wire was in return air, in the ignition area, and equipment-power taps were hung on the wire. Arcs from the power taps cannot be completely ruled out as a possible source of ignition. The trolley wire was terminated 100 feet from a pillar fall.

Summary of Evidence

1. The pillared area contained an accumulation of methane of unknown proportions or concentrations, but it is known that as much as 10.1 percent of methne was found at the edge of the piller falls within 82 hours after the explosion, and methane had been detected and recorded on numerous occasions previous to the explosion.

2. Air that had been used to ventilate a pillared area that was known to be liberating methane was being passed over mining machinery and the trolley wire.

3. Mining machinery was not maintained in permissible condition.

4. The direction of forces radiated from the loading machine and the cable-reel locomotive.

5. The location of the 10 bodies after the explosion indicated that the men were making an effort to move away from the pillared area, which indicates that the roof may have been "working."

6. There was evidence that blasting was not being done at the time of the explosion.

7. Deposits of coke indicated that coal dust did enter into the explosion to some extent, but it was not a major factor.

8. The door in No. 4 entry between Nos. 14 and 15 chutes was left open.

9. The results of fire-boss examinations were relayed to the surface verbally through the night-shift foreman, and the men who made the fire-boss examinations did not personally record their findings.

Conclusions

After carefully considering the evidence and information obtained during the investigation, the Bureau of Mines investigators believe that the explosion originated at or near the intersection of No. 4 entry and No. 15 crosscut. The explosion was caused by the ignition of a body of methane that was forced into the active workings by a large pillar fall. The exact ignition source could not be established; however, it can be stated that it was of electrical origin. Although there were numerous potential sources of electrical arcs in the ignition area, it is concluded that the most likely source was the electrical parts of the open-type locomotive or the cable attached thereto.

Recommendations

The following recommendations relate to conditions that are believed to have been directly or indirectly responsible for the disaster and compliance therewith may prevent a recurrence:

1. The ventilation system to be used should be considered at the time that mining projections are planned, and where pillaring operations are to be done, provisions should be made to bleed methane from the area directly into the return airways.

2. Examination for gas should be made in all working places before electrical equipment is taken into the places and at frequent intervals during the operation of such equipment. It is not possible for the section foreman to do this; therefore, the machine operators should be required to carry flame safety lamps and should test for gas before taking any electrical equipment to a working face and, moreover, make frequent tests during the operation of such equipment. They should also be trained in the use of such lamps.

3. Whenever it is necessary for the person making fire-boss examinations to transmit the report of the examination by telephone, the report should be made by him directly to the surface and a written record should be entered on the official fire-boss record book by an authorized person. In such instances, a duplicate record should be entered by the person making fire-boss examinations in a record book kept underground in a strong, fireproof container.

4. Where an accumulation of methane is found, it should be removed promptly, and the official records should indicate what action was taken.

5. Doors should be kept closed, except when men or equipment are passing through the doorways.

6. Trolley wire should not be installed in other than pure intake air, fresh from the outside, but in any case it should not be closer than 150 feet from pillar workings.

7. Electric equipment used in other than pure intake air should be of the permissible type approved by the U. S. Bureau of Mines, except that explosion-tested cable-reel locomotives and shuttle cars may be used.

8. Permissible equipment should be maintained in permissible condition, and explosion-tested equipment should be maintained in a good state of repair and free from possible ignition sources.

Acknowledgment

The cooperation received from representatives of the West Virginia Department of Mines, the Trotter Coal Company, and the mine employees is gratefully acknowledged.

Respectfully submitted,

/s/ T. J. McDonald

T. J. McDonald
Acting Chief

/s/ F. E. Riley

F. E. Riley
Coal-Mine Inspector

/s/ F. D. Baker

F. D. Baker
Coal-Mine Inspector

Approved by:

/s/ W. Dan Walker, Jr.

W. Dan Walker, Jr., Chief
Pittsburgh Branch, Accident
Prevention and Health Division

TABLE 1 ANALYSES OF AIR SAMPLES COLLECTED October 16-18, 1951

MINE Bunker COMPANY Trotter Coal Company COLLECTED BY F. D. Baker, T. J. McDonald and F. E. Riley

Bottle No.	Laboratory No.	LOCATION IN MINE	PERCENT IN VOLUME					Cubic ft. Air per minute	Cubic Ft. Methane in 24 hrs.
			Carbon Dioxide	Oxygen	Methane	Carbon Monoxide	Nitrogen		
0280	213837	Pillar fall, at face of No. 15 crosscut	0.34	17.91	6.98		74.77		
A-1451	213838	Pillar fall, No. 16 crosscut 100 ft. inby cutting machine	0.28	19.52	3.08		77.12		
3624	213839	Edge of pillar fall, inby loading machine No. 4 entry on A-west section	0.13	20.46	0.78		78.63		
5236	213840	Pillar fall, A-west section No. 14 crosscut	0.27	18.91	4.58		76.24		
5875	213841	Pillar fall, No. 16 crosscut 100 ft. inby cutting machine	0.32	19.38	2.61		77.69		
A-1452	213842	Pillar fall, No. 1 entry at 17-1/2 crosscut.	0.26	19.28	5.12		75.34		
6456	213843	100 ft. inby loading machine	0.36	20.36	0.58		78.70		
7508	213844	Return, No. 16 crosscut between Nos. 3 and 4 entries in A-West section	0.14	20.56	0.73		78.57	7,000	73,584
7717	213845	Pillar fall 16 crosscut 100 ft. inby cutting machine	0.27	19.96	1.79		77.98		
8458	213846	Return No. 4 entry at No. 14 chute	0.07	20.73	0.21		78.99	20,000	60,480
8608	213847	Pillar fall in No. 14 chute in A-west section	0.3	17.4	10.1		72.2		

TABLE 2 ANALYSES OF DUST SAMPLES. COLLECTED October 17-18, 1951

Mine Bunker Company Trotter Coal Company Collected by F. D. Baker & F. E. Riley

Can No.	Samples of dust from	Location in mine	AS-RECEIVED BASIS, PERCENT Moist.	Ash	Comb.	Incomb.
H-568	Roof & Rib	15 ft. inby No. 17 No. 1 entry A west section	1.2	66.9	31.9	68.1
P-580	Floor	do do	1.4	19.1	79.5	20.5
M-886	Roof & Rib	No. 14 crosscut 75 ft. inby No. 4 entry	.9	61.2	37.9	62.1
J-39	Floor	do do	1.3	39.7	59.0	41.0
J-555	Roof & Rib	No. 1 entry between 12 and 13 crosscuts	1.0	51.6	47.4	52.6
H-272	Floor	do do	1.3	63.0	35.7	64.3
G-653	Roof & Rib	No. 1 entry between 5 and 6 crosscuts	1.4	77.8	20.8	79.2
H-13	Floor	do do	.8	66.8	32.4	67.6
V-967	Roof & Rib	Entrance to 4 west between 1 and 2 crosscuts	1.6	23.7	74.7	25.3
Y-643	Floor	do do	1.0	55.2	43.8	56.2
G-419	Roof & Rib	No. 6 south entry 80 ft. outby B west haulageway	.6	82.7	16.7	83.3
B-387	Floor	do do	.8	66.5	32.7	67.3
C-669	Roof & Rib	No. 3 entry 6 south just outby entrances to B west section	1.2	71.5	27.3	72.7
G-319	Floor	do do	1.1	59.6	39.3	60.7
F-209	Roof & Rib	No. 6 entry 6 south just outby entrance to B west section	.8	84.0	15.2	84.8
V-900	Floor	do do	1.1	55.4	43.5	56.5
X-394	Roof & Rib	No. 2 entry 6 south 100 ft. outby entrance to B west section	.4	91.3	8.3	91.7
U-695	Floor	do do	1.2	63.7	35.1	64.9

TABLE 3 ALCOHOL COKE TEST COLLECTED October 17-18, 1951

MINE Bunker COMPANY Trotter Coal Company COLLECTED BY F. D. Baker & F. E. Riley

Can No.	Sample of dust from	Location in mine	Amount of coked particles present
H-568	Roof & Rib	15 ft. inby No. 17, No. 1 entry A west section	Small
P-580	Floor	15 ft. inby No. 17, No. 1 entry A west section	Small
B-585	Grab	Coke from below No. 17 pillar split	None
F-80	Grab	Coke from loading machine	None
L-184	Grab	Coke from locomotive front end	Small
L-355	Grab	Coke from cutting machine back end	Small
C-826	Roof & Rib	No. 17 crosscut at No. 3 entry	None
B-291	Floor	No. 17 crosscut at No. 3 entry	Small
M-886	Roof & Rib	No. 14 chute, 75 ft. inby No. 4 entry	None
J-39	Floor	No. 14 chute, 75 ft. inby No. 4 entry	None
J-555	Roof & Rib	No. 1 entry between 12 and 13 crosscuts	None
H-272	Floor	No. 1 entry between 12 and 13 crosscuts	None
Y-861	Roof & Rib	No. 2 entry between 12 and 13 crosscuts	Small
F-808	Floor	No. 2 entry between 12 and 13 crosscuts	Small
T-695	Roof & Rib	No. 3 entry between 12 and 13 crosscuts	Small
T-53	Floor	No. 3 entry between 12 and 13 crosscuts	Small
U-439	Roof & Rib	No. 4 entry between 12 and 13 crosscuts	None
H-355	Floor	No. 4 entry between 12 and 13 crosscuts	None
M-406	Floor	No. 1 entry between 8 and 9 crosscuts	None
R-729	Roof & Rib	No. 2 entry between 8 and 9 crosscuts	None
T-223	Floor	No. 2 entry between 8 and 9 crosscuts	None
X-659	Roof & Rib	No. 3 entry between 8 and 9 crosscuts	Small
E-242	Floor	No. 3 entry between 8 and 9 crosscuts	Very large
H-299	Roof & Rib	No. 4 entry between 8 and 9 crosscuts	None
P-292	Floor	No. 4 entry between 8 and 9 crosscuts	Small
G-653	Roof & Rib	No. 1 entry between 5 and 6 crosscuts	None
H-13	Floor	No. 1 entry between 5 and 6 crosscuts	None
U-520	Roof & Rib	No. 2 entry between 5 and 6 crosscuts	Large
C-558	Floor	No. 2 entry between 5 and 6 crosscuts	Large
R-691	Roof & Rib	No. 3 entry between 5 and 6 crosscuts	Small
E-538	Floor	No. 3 entry between 5 and 6 crosscuts	Small
T-856	Roof & Rib	No. 4 entry between 5 and 6 crosscuts	None
J-51	Floor	No. 4 entry between 5 and 6 crosscuts	None
V-967	Roof & Rib	No. 1 entry between 1 and 2 crosscuts	None
Y-643	Floor	No. 1 entry between 1 and 2 crosscuts	Small
T-543	Roof & Rib	No. 2 entry between 1 and 2 crosscuts	Small
L-14	Floor	No. 2 entry between 1 and 2 crosscuts	Small
C-492	Roof & Rib	No. 3 entry between 1 and 2 crosscuts	Small
K-826	Floor	No. 3 entry between 1 and 2 crosscuts	Small
B-969	Roof & Rib	No. 4 entry between 1 and 2 crosscuts	Small
Q-568	Floor	No. 4 entry between 1 and 2 crosscuts	Large

TABLE 3 (Cont.) ALCOHOL COKE TEST COLLECTED October 17-18, 1951

MINE Bunker COMPANY Trotter Coal Company COLLECTED BY F. D. Baker & F. E. Riley

Can No.	Sample of dust from	Location in mine	Amount of coked particles present
G-419	Roof & Rib	No. 6 south entry 80 ft. outby B west haulageway	None
B-387	Floor	No. 6 south entry 80 ft. outby B west haulageway	None
X-394	Roof & Rib	No. 2 entry 6 south 100 ft. outby entrance to B west section	None
U-695	Floor	No. 2 entry 6 south 100 ft. outby entrance to B west section	None
C-669	Roof & Rib	No. 3 entry 6 south just outby entrance to B west section	None
G-319	Floor	No. 3 entry 6 south just outby entrance to B west section	None
F-209	Roof & Rib	No. 6 entry 6 south just outby entrance to B west section	None
V-900	Floor	No. 6 entry 6 south just outby entrance to B west section	None
U-750	Roof & Rib	No. 1 entry 6 south 100 ft. inby No. 4 entry A west section	None
X-11	Floor	No. 1 entry 6 south 100 ft. inby No. 4 entry A west section	None
V-169	Roof & Rib	No. 2 entry 6 south 100 ft. inby No. 4 entry A west section	None
S-157	Floor	No. 2 entry 6 south 100 ft. inby No. 4 entry A west section	None
C-427	Roof & Rib	No. 5 entry 6 south 100 ft. inby No. 4 entry A west section	None
J-304	Floor	No. 5 entry 6 south 100 ft. inby No. 4 entry A west section	None

APPENDIX A

VICTIMS OF EXPLOSION, BUNKER MINE
TROTTER COAL COMPANY

October 15, 1951

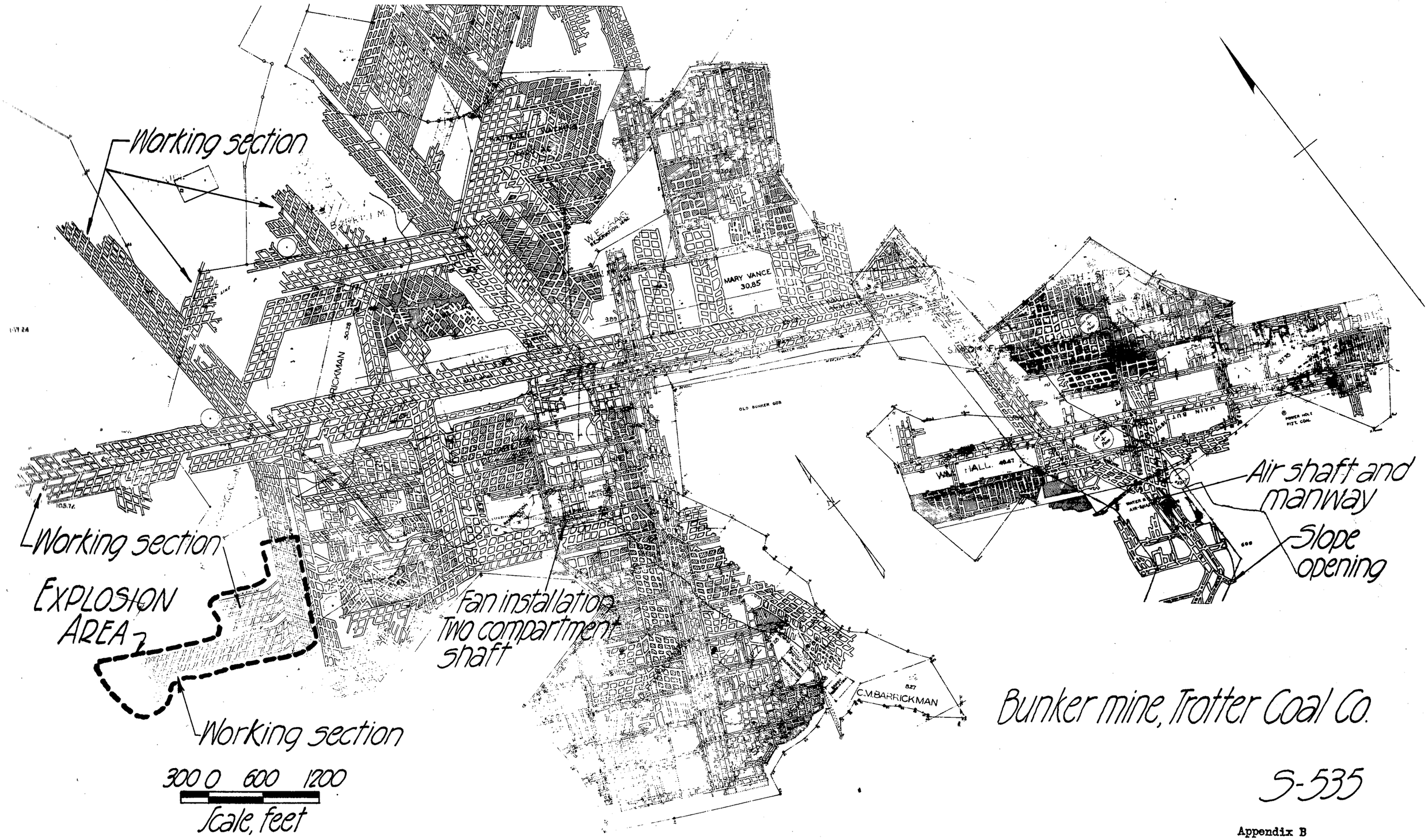
Name	Age	Occupation	Dependents	Years Experience
Joseph Slavensky	33	Section Foreman	3	10
James W. Keener	29	Motorman	5	6
Lee E. Brown	35	Machineman	3	16
Leroy H. Compton	29	Faceman	4	8
Walter Pozza	29	Loader Operator	2	11
Donald Lee Shaw	22	Timberman	1	2
Ernest J. Sanders	25	Snapper	3	6
Albert Morant	45	Trackman	4	25
Laurence Aronholt	20	Trackman	1	1
Shallis E. Shirley	26	Timberman	3	2

Average age of victims 29.3 years

Average mining experience 8.7 years

Total number of dependents - 29

Interior - Bureau of Mines, Pittsburgh, Pa.



Bunker mine, Trotter Coal Co.

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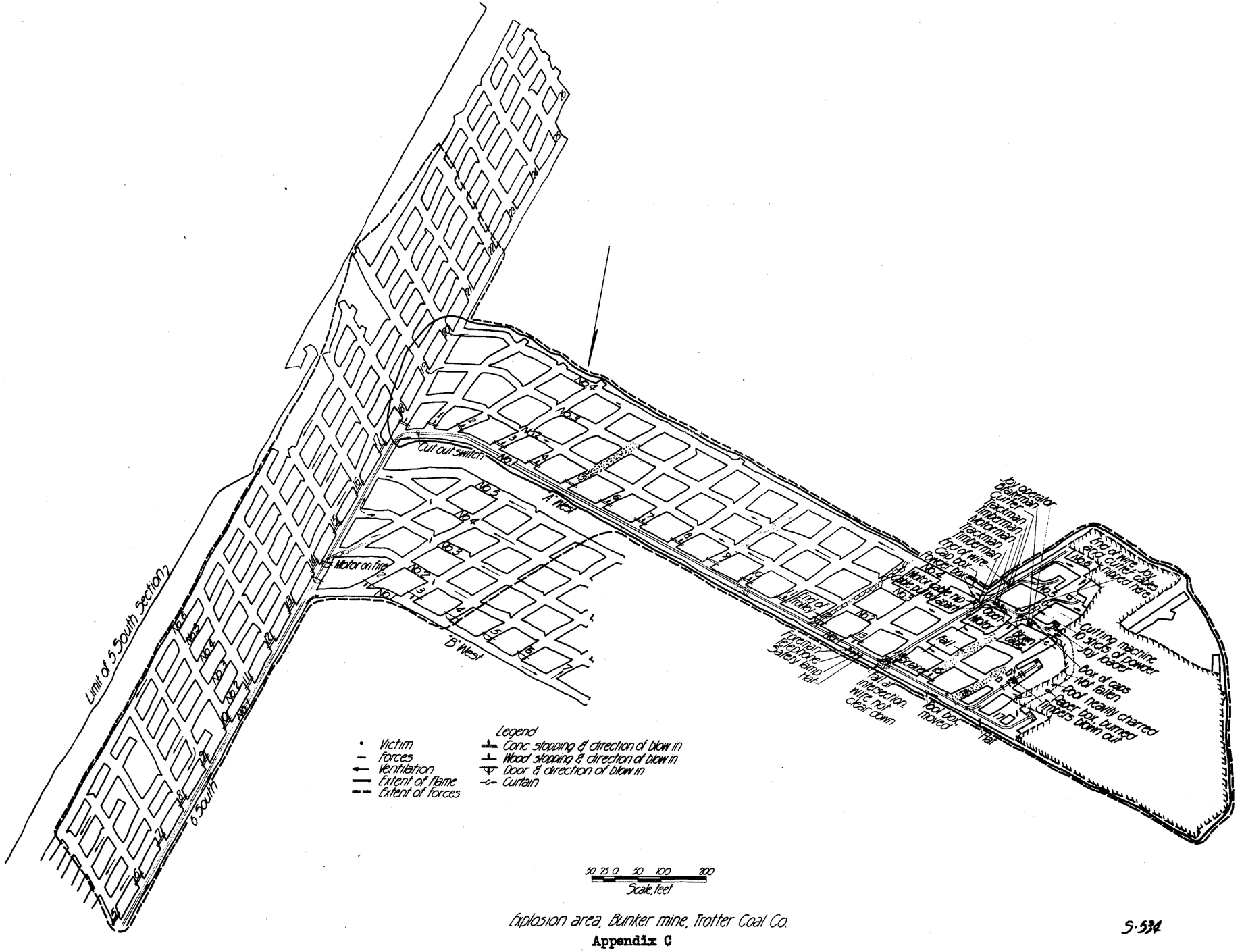

Explosion area, Bunker mine, Trotter Coal Co.

Appendix C

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Interior - Bureau of Mines, Pittsburgh, Pa.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
REGION VIII

REPORT ON FINDINGS OF INSPECTION OF ELECTRICAL EQUIPMENT IN EXPLOSION AREA BUNKER MINE TROTTER COAL COMPANY CASSVILLE, MONONGALIA COUNTY, WEST VIRGINIA

October 15, 1951

By

C. L. Brown
Mining Engineer (Electrical)

R. S. James
Mechanical Engineer

D. H. Zellers
Electrical Engineer

REPORT ON FINDINGS OF INSPECTION OF ELECTRICAL EQUIPMENT IN EXPLOSION AREA BUNKER MINE TROTTER COAL COMPANY CASSVILLE, MONONGALIA COUNTY, WEST VIRGINIA

October 15, 1951

By

C. L. Brown
Mining Engineer (Electrical)

R. S. James
Mechanical Engineer

D. H. Zellers
Electrical Engineer

Introduction

On October 16, 1951, C. L. Brown, D. H. Zellers, and R. S. James, at the request of Mr. James Westfield, Chief, Accident Prevention and Health Division, Region VIII, inspected the electrical equipment at or near the explosion area where 10 men were killed at the Bunker mine of the Trotter Coal Company, Cassville, West Virginia. The explosion was reported to have occurred at approximately 6:45 a.m. on Monday, October 15, 1951.

This report will be confined as nearly as possible to facts relating to the electrical equipment in the affected area and the possible sources of ignition of the gas which caused the disaster.

Description of Equipment

The following electrical equipment was at or near the location where the gas was probably ignited:

One Sullivan (Claremont built) 7-AU cutting machine, permissible type, with take-off for drill cable and Jeffrey hand-held drill connected

One cable-reel gathering locomotive (open type)

One Joy 14-BU (apparently 14-BU7 type) loading machine, permissible type

One open-type hand-held drill, with the power cable coiled, lying along the haulageway a considerable distance outby the cable-reel locomotive

The trolley wire was terminated a few feet outby No. 15 place on No. 4 heading.

A Sullivan 7-AU track-mounted mining machine with drill cable take-off, covered by approval No. 297, had an approval plate attached. This machine with the drill attached was parked in No. 15 place between No. 4 and No. 5 entries, 85 feet from the end of the trolley wire. The shot-firing cable was found reeled up on top of the machine. The machine controls were in the off position, and all evidence indicates that this equipment was unattended at the time of the explosion. The machine was found to be in good condition as to permissibility requirements, except that the seals were missing from compartment openings and the heads of six adjacent bolts had been sheared off the bottom of the compartment on the right side. The two-conductor trailing cable was unreeled to the trolley wire outby. The cable power tap was found off the trolley wire. The "live" conductor in the trailing cable was not equipped with a fuse or other device for protection against short circuits. The hand-held drill was of permissible-type construction but did not have a fuse in the drill, a seal on the inspection cover, or an approval plate. No evidence was found that would indicate that this equipment was energized at the time of the explosion.

An open-type cable-reel locomotive with the trolley pole hooked in the down position was found inby the track switch to No. 15 place on No. 4 entry A west. The main controller was in the off position with the reverse lever in the position for outby travel. The switch in the control circuit to the reel motor was thrown to the left position. It was reported that the left position of the switch is the on position. The cable power tap was not equipped with a fuse or other device for protection against short circuits. The power tap was not attached to the trolley wire; however, it is possible that it may have been blown off by the force of the explosion. A short section of the single-conductor trailing cable had been cut out by inspectors of the West Virginia Department of Mines because of evidence that the cable was severed by an electric arc at this point. A visual examination of these pieces of cable revealed that one end of each had the appearance of burns that might result from an electric arc. The vertical-type cable reel was found on the mine floor on the left side of the locomotive; it had been dislodged from its usual position on top of the locomotive. Electric arcs of sufficient intensity to ignite methane-air mixtures could normally be made by the following parts of the locomotive:

1. Controller.
2. Commutators and brushes of main motor units.
3. Reel-motor commutator and brushes.
4. Current collectors and brushes on the reel.
5. Reel-motor control and transfer of switch.
6. Controls in headlight circuits.
7. Contact between wheels and track (cable was single conductor).

The permissible-type caterpillar-mounted loading machine, without approval plate, was 100 feet from the end of the trolley wire and had been loading from a pillar on the left side of No. 4 heading. The machine was in good electrical condition except for the following:

1. Seals and locking screws were missing from inspection covers to enclosed compartments.

2. Two fuses in the control circuit were bridged with copper wire.

3. An opening of 0.008 inch approximately 3 inches long was found under the controller cover.

4. Two cap screws were missing from a cable connection-box cover on the right-side head motor.

The controller was found in an on position for reverse tramming. The trailing cable attached was constructed with two parallel power conductors and a grounding conductor. The grounding conductor was not maintained continuous through splices. One defective splice was found where the "live" conductor insulation was bare adjacent to the grounding conductor. Contact between these conductors, without a continuous grounding conductor to the rail, would produce arcing between the loading machine and mine cars or track upon contact. The power tap was not equipped with a fuse or other device for protection against short circuits. The loading-boom conveyor was empty, and a partly loaded car attached to the locomotive was standing several feet outby the end of the loading boom. The loading machine was not in contact with the track. Tests on the loading machine made by the electrical inspector for the West Virginia Department of Mines indicated that the equipment was free of ground faults.

Although the open-type drill found outby the locomotive had not been in immediate use, it was in the working section.

The trolley wire was terminated 25 feet outby the open-type locomotive.

Conclusions

1. If more logical possible sources of ignition had not been found, the trolley wire would have been considered as a probable source.

2. It is believed that the open-type drill was not in use at the time because of its location and the fact that the coiled cable had no means of power attachment on the free end.

3. All evidence gathered would indicate that the cutting machine with the drill attached did not initiate this explosion. The shot-firing cable found coiled on the machine would indicate that no blasting was being done at the time of the explosion.

4. Although evidence indicates that the 14-BU loading machine was energized, conditions found were such that it was an improbable source of the ignition.

5. It is concluded that the most probable source of ignition of the explosive methane-air mixture was the electrical parts of the open-type locomotive or the cable attached thereto.

Recommendations

1. Open-type electrical equipment should not be used in areas where methane is being liberated.

2. Trolley wires should be kept at least 150 feet from pillar workings.

3. Permissible equipment should have approval plates and be kept in permissible condition.

4. Short-circuit protection should be provided for all trailing cables.

5. Correct fuses should be maintained in circuits as originally provided.

6. Where temporary splices in trailing cables are necessary, the splices should have adequate mechanical strength, electrical conductivity, and electrical insulation.

7. The frame-grounding conductor in trailing cables of off-track equipment should be maintained electrically continuous from the machine frame to the rail.

Acknowledgment

The cooperation of the representatives of the West Virginia Department of Mines, the Trotter Coal Company, and the mine employees is gratefully acknowledged.

Respectfully submitted,

/s/ C. L. Brown

C. L. Brown
Mining Engineer (Electrical)

/s/ R. S. James

R. S. James
Mechanical Engineer

/s/ D. H. Zellers

D. H. Zellers
Electrical Engineer

Approved by:

/s/ W. Dan Walker, Jr.

W. Dan Walker, Jr., Chief
Pittsburgh Branch, Accident
Prevention and Health Division

Interior - Bureau of Mines, Pittsburgh, Pa.