UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

District D

FINAL REPORT OF COAL-MINE METHANE EXPLOSION IN RAW-COAL TUNNEL UNDER SURFACE COAL STORAGE PILE ORIENT MINE NO. 5 FREEMAN COAL MINING CORPORATION BENTON, FRANKLIN COUNTY, ILLINOIS

August 15, 1968

by

Paul H. Tisdale
Federal Coal-Mine Inspector

Originating Office - Bureau of Mines
302 North Second Street, Vincennes, Indiana 47591
H. A. Schrecengost, District Manager
Health and Safety District D

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INTRODUCTION

This report is based on an investigation made in accordance with provisions of the Federal Coal Mine Safety Act (66 Stat. 692; 30 U.S.C. Secs. 451-483) as amended.

A methane-gas and coal-dust explosion occurred about 11:40 a.m., Thursday, August 15, 1968, at Orient Mine No. 5, in the raw-coal tunnel, approximately 12 feet below the surface raw-coal storage pile. The explosion was confined to the tunnel, and areas immediately in line with its openings. Other surface areas and the underground workings were unaffected. There were four persons in the tunnel, all of whom were injured fatally. Two of the victims died instantly, one died soon after being admitted to the hospital, and the fourth died August 24, 1968. The names of the victims, their ages, occupations, experience, and number of their dependents are listed in Appendix A of this report.

The explosion apparently occurred when an explosive mixture of methane and air in the tunnel was ignited by the flame from an oxyacetylene torch, or spark from the igniter, being used to make repairs on the belt feeder.

GENERAL INFORMATION

The mine, located 3 miles east of Benton, Illinois, is opened by two shafts into the Illinois No. 6 coalbed. A total of 452 men were employed, 68 on the surface and 384 underground, and produced a daily average of 8,500 tons of coal, all loaded mechanically. This mine is served by the Illinois Central railroad.

The operating officials are:

N. T. Camicia	President	307 North Michigan Avenue Chicago, Illinois 60601
M. V. Harrell	Manager of Mines	1100 North Douglas Street West Frankfort, Illinois 62896

Paul Budzak	Safety Director	1100 North Douglas Street West Frankfort, Illinois 62896
Earl Willis	Superintendent	1100 North Douglas Street West Frankfort, Illinois 62896
Clifford Fry	Assistant Superintendent	1100 North Douglas Street West Frankfort, Illinois 62896
Gene Hagston	Mine Manager	1100 North Douglas Street West Frankfort, Illinois 62896

The coal is high-volatile bituminous with a volatile ratio of 0.40. Numerous tests by the Bureau of Mines have shown that coal dust having a volatile ratio of 0.12 is explosive, and that the explosibility increases with an increase in the volatile ratio.

The preceding Federal inspection was completed April 5, 1968. An inspection of the mine was in progress, and the Federal inspector was underground at the time of the explosion.

MINING METHODS, CONDITIONS, AND EQUIPMENT

Surface Coal Handling

The coal was transported from the mine in 15-ton skips by an automatic hoist and dumped into a rotary coal breaker. The existing preparation plant can be bypassed, allowing raw coal to be transported by a belt conveyor and "stacked" in an open storage pile over openings in the surface leading into the tunnel. A system of vibrators and feeders moved the raw coal down onto a belt conveyor, thence to the railroad-car unit-train loading surge bin. The raw-coal, unit-train loading facilities were just recently constructed, and were in operation on a limited basis.

Ventilation and Mine Gases

The mine is classed gassy by the State.

Air samples collected during the preceding Federal inspection in April 1968 showed a total of 1,123,000 cubic feet of methane was being liberated by the mine each 24 hours.

The enclosed area of the raw-coal tunnel had two access openings to the surface, the entrance containing the belt conveyor, and a 30-inch concrete pipe. Mechanical ventilation was not provided for the tunnel. (See Appendixes B and C.)

Dust

The surfaces within the tunnel area were either concrete or steel. Coal dust was evident throughout the area, on the feeders, conveyors, floor, walls, and ceiling.

Electricity

The electrical equipment and installations in the tunnel were of reasonably dusttight construction. Switches and wiring were approved for gassy and dusty locations by Underwriters Laboratory.

Illumination and Smoking

The lighting fixtures were of reasonably dusttight construction, and also approved by Underwriters Laboratory for gassy and dusty locations. Evidence of smoking in the tunnel was not observed.

Mine Rescue

Gas masks and self-rescuers were readily available at the mine. Most of the company officials and some of the workmen were well-trained in the use of gas masks and rescue procedures.

A State-owned, mine rescue station, staffed with two well-trained mine rescue teams on 24-hour alert, located at Benton, Illinois, were available and assisted in the recovery operations.

STORY OF EXPLOSION AND RECOVERY OPERATIONS

Participating Organizations

Officials of the Freeman Coal Mining Corporation, representatives of the United Mine Workers of America, the Illinois Department of Mines and Minerals, and the United States Bureau of Mines participated in recovery work and the investigation.

Activities of Bureau of Mines Personnel

Paul H. Tisdale, Federal Coal-Mine Inspector, was in the mine and was notified of the occurrence by a message from Earl Willis, mine superintendent. After ascertaining what had happened, Tisdale reported the incident by telephone to the District Manager at Vincennes, Indiana. J. R. Summary, Coal-Mine Inspection Supervisor, and M. R. Messersmith, Federal Coal-Mine Inspector (Roof Control), arrived at the scene about 1 p.m. J. A. O'Connor, Supervisory Mining Engineer, and S. J. Douglas, Federal Coal-Mine Inspector (Electrical), Vincennes, Indiana, arrived about 4 p.m., and participated

in the investigation and conference. Donald S. Kingery, Chief, Ventilation Section, U. S. Bureau of Mines, Pittsburgh, Pennsylvania, arrived in Benton, Illinois, about 4 p.m., Friday, August 16, 1968, and made some valuable suggestions regarding ventilating the tunnel.

Evidence of Activities and Story of Explosion

The unit-train coal-loading facilities had been designed and installed by Roberts and Shaefer Company, Contractors, Chicago, Illinois, and, although several unit-trains had been loaded on a trial basis, these facilities had not been accepted as operational by Freeman Coal Mining Corporation. There were several small repairs and adjustments that needed to be made, according to William H. Mullins, Chief Engineer, Freeman Coal Mining Corporation.

Mr. Charles Collins was sent to the plant by General Kinematics Corporation, of Barrington, Illinois, who had installed the vibrating feeders. He had made some adjustments to the machinery on August 14, 1968.

On Thursday, August 15, 1968, at 10 a.m., the loading of a unit-train was begun, and Mr. Collins, along with Messrs. Mullins and Boyette, chief engineer and maintenance superintendent, respectively, were observing various functions of the equipment in the tunnel, and found that minor repairs to the vibrator would have to be made to prevent dampening the action of both feeders. It was decided that the trouble could be corrected readily by cutting out a small gusset on the edge of the chute. Rather than wait until the next day when the contractor's employees could come to make the adjustments, it was decided that the mine could supply the oxyacetylene torch and personnel to assist Mr. Collins. Mr. Mullins, who had other commitments, talked to Mr. Willis, mine superintendent, about what was needed, and left the premises. Mr. Willis gave instructions for James A. Walker and James Nealon to get an oxyacetylene torch and to follow Mr. Collins' directions in cutting the obstruction of metal from the vibrator. Messrs. Collins and Boyette reentered the tunnel, and Walker and Nealon followed, bringing with them the torch and hoses, leaving the oxygen and acetylene tanks outside in the bed of the pickup truck.

Mr. Willis was standing on a platform above the unit-train watching the loading operations, while the above work schedule was being done, and about 5 to 10 minutes had elapsed when flame and smoke suddenly erupted from the mouth of the tunnel with great force, traveling approximately 100 feet across the mine yards.

Mr. Robert Boyette was visited by Earl Willis, superintendent, at Barnes Hospital, in St. Louis, Missouri, on August 18, 1968. Mr. Boyette told him that he was standing behind David A. Walker when Walker lighted the acetylene torch, and that a ball of fire appeared immediately and continued to burn and grow larger until the whole tunnel was aflame.

Mr. Boyette told Mr. Willis that both he and Walker fell to the floor with Walker on top, and that as he arose Walker asked for help, but Mr. Boyette realized he was badly burned and seriously injured, and told Walker he would escape from the area and send help, which he did.

Recovery Operations

Mr. Willis hurriedly left the platform and ran to the mouth of the tunnel where Mr. Boyette was found, apparently having escaped unassisted from the explosion area by crawling up the stairway to the surface. He was given first aid and taken by ambulance to the Franklin Hospital in Benton, Illinois, in serious condition, and later transferred to Barnes Hospital in St. Louis, Missouri, where he died on August 24, 1968. The body of one of the victims had been blown from the tunnel and was hanging from the superstructure outside. Several surface and office employees were summoned, universal gas masks were quickly brought to the scene, and rescue operations were organized and led by Superintendent Willis.

A rescue team wearing gas masks entered the area and brought out another live man, but he died soon after reaching the hospital. The body of Mr. Collins was then located and removed from the area by the rescue workers. At this time, equipment and a rescue team arrived from the State mine rescue station in Benton, Illinois, and the team, wearing self-contained oxygen-breathing apparatus, entered the area and searched for a man who was missing and thought to be in the tunnel; however, the missing man appeared on the scene, and the rescue operations were secured at approximately 1 p.m.

After the last body was removed from the tunnel on August 15, 1968, a small fan was placed over the concrete pipe and operated blowing; however, only a small amount of air passed through the tunnel. Representatives of the company and union, and State and Federal inspectors, using universal gas masks, then made an investigation of the explosion area in the tunnel. A conference was held the following day, Friday, August 16, 1968.

The investigators found the oxyacetylene torch with the valves open near the bottom of the stairway (the valves on the tanks had been closed and the tanks removed from the area); however, the igniting device was found in the yard several feet from the mouth of the tunnel in the line of blast, along with other small pieces of debris and coke particles. Air and dust samples were collected near the ignition point, which was at the first Para-mount feeder. (See tables 1 and 2.) Evidence of flame was observed on the plastic jerk-wire control line in the form of small blisters and on the surface of coal dust on the feeder conveyors; however, several sheets of paper from a pocket notebook were scattered about in the ignition area and were not burned excessively.

INVESTIGATION OF CAUSE OF EXPLOSION

Investigation Committee

Freeman Coal Mining Corporation

M. V. Harrell	Manager of Mines
Earl Willis	Mine Superintendent
Clifford Fry	Assistant Mine Superintendent
Gene Hagston	Mine Manager
Paul Budzak	Safety Director

United Mine Workers of America

Steve Stewart	Mine Safety Committeeman
Harry Koonce	Mine Safety Committeeman
Vernon McDanial	Mine Safety Committeeman

Illinois Department of Mines and Minerals

W. O. Johnston	District Inspector
Joe Williams	District Inspector
Robert Jones	District Inspector
Dayton McReaken	District Inspector

United States Bureau of Mines

Paul H. Tisdale	Federal Coal-Mine Inspector
J. A. O'Connor	Supervisory Mining Engineer
S. J. Douglas	Federal Coal-Mine Inspector (Electrical)

A detailed examination of the area affected by the explosion was carefully made by the investigating committee.

A conference was conducted on August 16, 1968, at the mine office of Orient Mine No. 5, Freeman Coal Mining Corporation, at Benton, Illinois. Persons who might have knowledge of events prior to the explosion or practices which might have set the stage for the disaster were interrogated.

The meeting was attended by the investigating committee, and the following additional persons:

Freeman Coal Mining Corporation

William H. Mullins	Chief Engineer

United Mine Workers of America

Kenneth Wells	International Representative
Ferrell Whitlow	President, Local Union 1284
Davis Warren	Vice President, Local Union 1284
Robert Newborn	Mine Committeeman
George Williams	Recording Secretary

Illinois Department of Mines and Minerals

L. Leon Ruff	Director
Roscoe Moore	Assistant Director

Pertinent information disclosed during the conference is as follows:

1. Tests for gas were not made before igniting the acetylene torch in the tunnel.

2. A ventilating fan had not been provided for the tunnel.

3. Coal dust was present, but in most instances was not in suspension to the extent that cap lamps were required.

4. A test made with a glass jug partly filled with coal from the pile near the stacker, which supplied the chute in the tunnel, contained an explosive mixture of more than 10 percent of methane after being closed airtight for 12 hours.

5. Evidence indicated no cutting had been done in the tunnel and that the explosion had occurred immediately after the torch was ignited. Since the hearing was held, tests and examinations by company, State, and Federal mine officials were made on August 23, 1968, while another unit-train was being loaded, and the results of these tests are listed next under the heading Methane and Dust.

Methane and Dust as Factors in the Explosion

On August 23, 1968, after a larger fan had been installed, which circulated approximately 8,000 cubic feet of air a minute through the tunnel, the system was put into operation and another unit-train was loaded. After approximately 30 minutes of intermittent operation of the feeders in the tunnel, 4.5 percent of methane gas was detected with permissible methane detectors near the feeder about 20 feet inby the ignition point of the explosion. Other tests made in the area ranged from 0.4 to 0.8 percent methane. These tests indicated that approximately 48 cubic feet of methane a minute was being liberated in the tunnel from the broken coal. If this amount of gas was liberated without ventilation over a

period of 100 minutes, more than 4,000 cubic feet of gas would accumulate. In a tunnel this size, more than the 5 percent of methane required for an explosion would have accumulated. Although the tunnel machinery was operated intermittently during the 1 hour and 45 minutes in which the train was being loaded on the day of the explosion, without positive ventilation, the gas accumulated to more than the lower explosive limit (5 percent gas with normal air). Approximately 65 tons of coal a minute pass through the tunnel over the feeders when the operations are proceeding in a normal manner, and methane is liberated rapidly in the tunnel during such operations.

Coal dust entered into the explosion. The three dust samples collected in the explosion area showed coke. (See table 2.)

Flame

Coke on the surface of coal dust and fine coal on the feeders, plastic tubes at each belt conveyor roller mount distorted, blisters on a plastic-covered control line to a switch along the conveyor, and scorched paper currency on the floor in the tunnel, as well as reports of eyewitnesses, indicated flame was present in most of the tunnel.

Forces

Forces developed by the explosion were evident in that witnesses on the surface observed the smoke and flame erupt from the mouth of the tunnel. A victim was blown violently from the tunnel, dislodging two stairsteps and severely mangling his body before his body lodged in the superstructure. Also, the damaged scales, the end of the conveyor, and the damaged canopy at the 30-inch end of the tunnel all indicate severe forces in the tunnel.

Probable Point of Origin

The explosion originated near the Para-mount vibrating feeder at the bottom of the stairway about 70 feet from the mouth of the tunnel. (See Appendix C.)

Factors Preventing Spread of Explosion

The explosion spread throughout the tunnel area and about 100 feet across the mine yard in a northeasterly direction from the stairway portal, and it dissipated into the atmosphere in a vertical direction at the other end.

Summary of Evidence

Conditions observed in the tunnel during the investigation following the explosion, together with information available from previous Federal coal-mine inspection reports, and that obtained from a hearing, and from

company officials, workmen, and from tests and examinations made during a subsequent train-loading operation, provided evidence as to the cause and origin of the explosion. The evidence from which the conclusions of the Federal investigators are drawn is summarized as follows:

1. Loading of a unit-train through the raw-coal tunnel had been in progress for about 1 hour 45 minutes.

2. Methane was liberated in the tunnel during loading operations.

3. Positive ventilation had not been provided to remove gas and dust from the tunnel.

4. An examination for gas had not been made before the cutting torch was taken into the area and lighted.

5. There were dangerous accumulations of coal dust and fine coal throughout the tunnel.

6. An eyewitness account fixed the origin of flame at the torch.

7. Coal dust in suspension was not dense enough to be explosive by itself.

Cause of Explosion

The explosion occurred when an explosive mixture of methane and air in the tunnel, near the first Para-mount coal feeder, was ignited by the flame of an oxyacetylene torch, or spark from the igniter, being used to make repairs on the belt feeder.

RECOMMENDATIONS

The following recommendations are made to prevent similar occurrences:

1. Positive effective ventilation should be provided for the tunnel area with a fan adequate in size.

2. Cutting torches, welding equipment, or other maintenance equipment, such as electric drills, should not be taken into the tunnel area until an examination by a qualified person finds the area free of methane and excessive dust accumulations. Such examination should include a test with a permissible flame safety lamp, or permissible methane detector.

3. An examination should be made for methane immediately prior to use of cutting or welding equipment in the tunnel.

4. Maintenance work should not be done in the tunnel while coal is being loaded.

5. Open-type electrical equipment should not be allowed in the tunnel while coal is being loaded.

6. After trains are loaded, any open feeder hole should be filled with coal by pushing with a bulldozer to prevent a sudden slide from raising a dense dust cloud inside the tunnel. Coal dust should not be allowed to accumulate in excessive amounts inside the tunnel.

7. "No Smoking" and "No Admittance" signs should be posted at the entrance to the tunnel, and unauthorized persons should not be allowed in the tunnel.

8. Consideration should be given to the installation of a methane monitor to give alarm, should the methane concentration in the tunnel become excessive.

9. Acetylene and oxygen hoses should be inspected for leaks prior to use in the tunnel.

The company has replaced the 30-inch-diameter concrete pipe with one 48 inches in diameter, and installed a 48-inch-diameter fan. Air measurements on September 9, 1968, indicated the fan was moving 27,000 cubic feet of air a minute through the tunnel, with a methane content of 0.19 percent.

ACKNOWLEDGMENT

The cooperation and assistance of the officials and employees of Freeman Coal Mining Corporation, the United Mine Workers of America, and the Illinois Department of Mines and Minerals is gratefully acknowledged.

Respectfully submitted,

/s/ Paul H. Tisdale

Paul H. Tisdale
Federal Coal-Mine Inspector

Approved by:

Acting District Manager
Health and Safety District D

ANALYSES OF AIR SAMPLES

TABLE 1

DATE COLLECTED August 15, 1968

MINE Orient Mine No. 5 COMPANY Freeman Coal Mining Corporation COLLECTED BY J. R. Summary

BOTTLE NO.	LABORATORY NO.	LOCATION IN MINE	PERCENT IN VOLUME						CUBIC FEET AIR PER MINUTE	CUBIC FEET METHANE IN 24 HOURS
			CARBON DIOXIDE	OXYGEN	METHANE	CARBON MONOXIDE	NITROGEN	H_2		
		EXPLOSION SAMPLES								
I4274	92633	underground tunnel of coal stacker on surface	0.06	20.90	0.00	none	79.04	0.00		
F2634	92634	underground tunnel of coal stacker on surface	0.06	20.90	0.00	none	79.04	0.00		

LAB. NOS. 276223-276225

TABLE 2 ANALYSES OF DUST SAMPLES DATE COLLECTED August 15, 1968

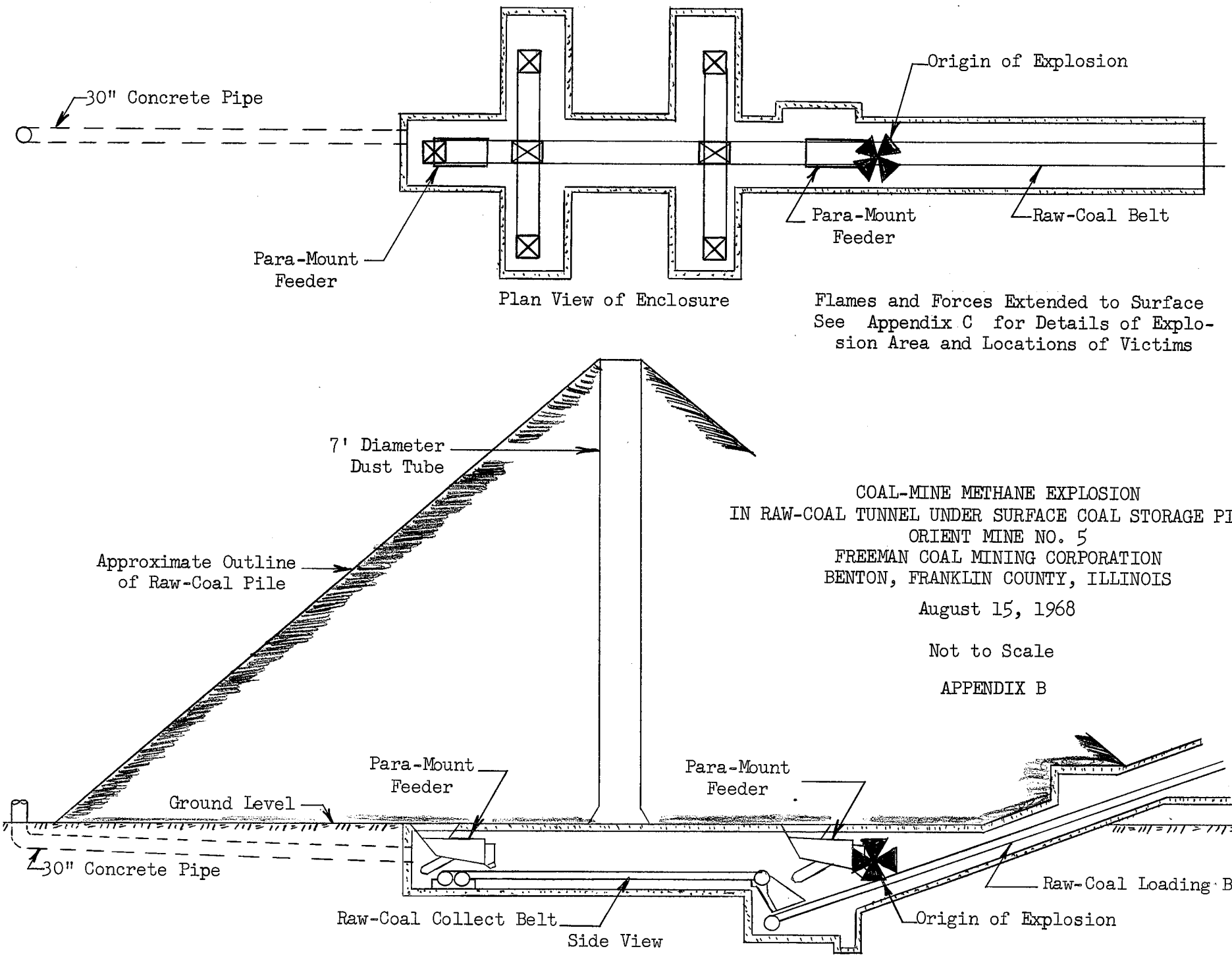
MINE Orient Mine No. 5 COMPANY Freeman Coal Mining Corporation COLLECTED BY Paul H. Tisdale

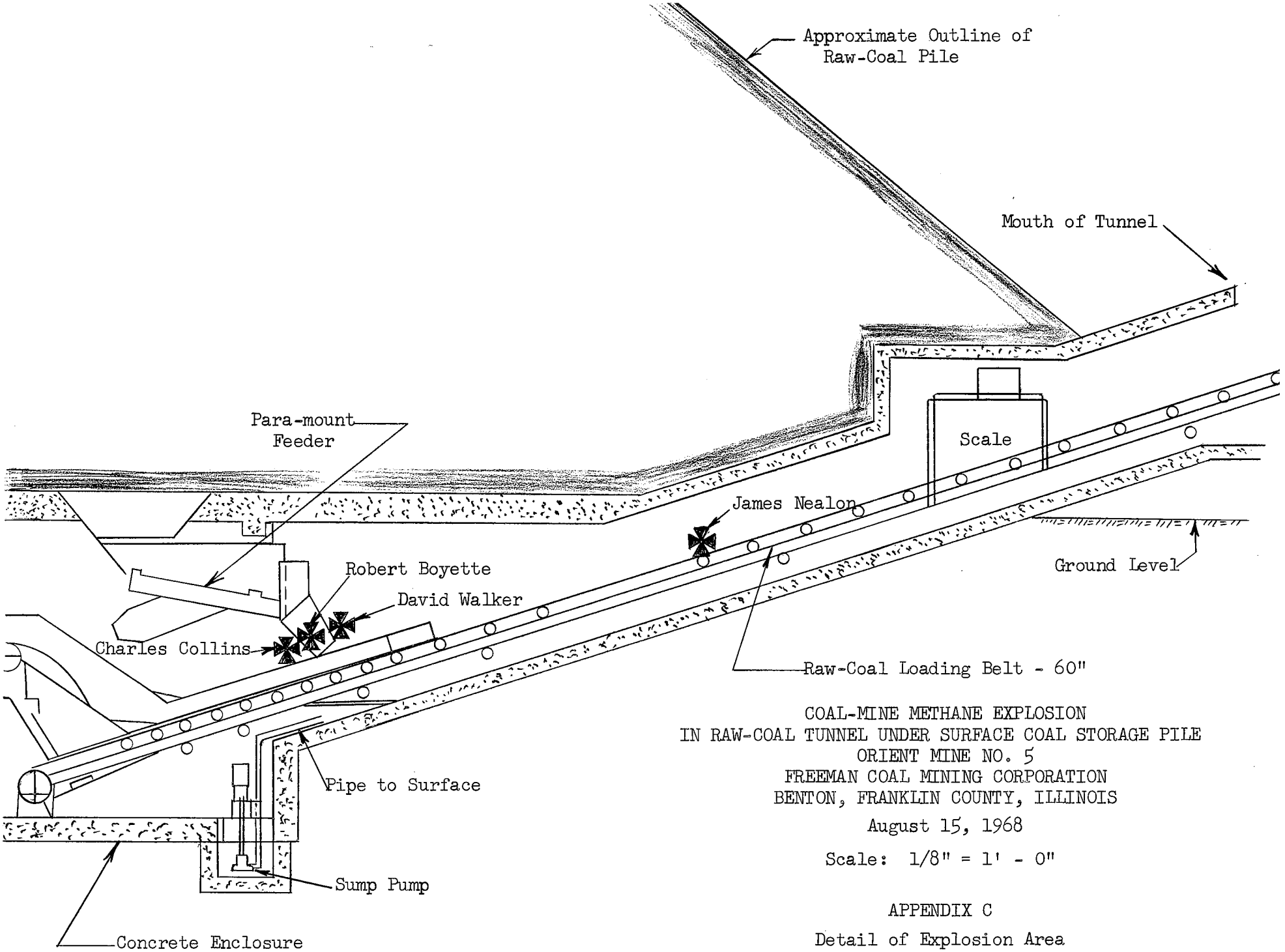
LAB. NO.	CAN NO.	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	AS-RECEIVED PERCENT INCOMBUSTIBLE
			EXPLOSION SAMPLES in tunnel underneath coal stacker on the surface after an explosion		
276223	1		10 feet inby the feeder underneath the vibrating conveyor	extra large	28.0
276224	2		10 feet outby feeder under conveyor	large	21.2
276225	3		10 feet along stairway above vibrator under belt conveyor	large	26.5

APPENDIX A

Victims of tunnel explosion, Orient Mine No. 5, Freeman Coal Mining Corporation, August 15, 1968:

Name	Age	Number of Dependents	Occupation	Mining Experience
Robert Boyette	55	Wife	Maintenance Superintendent	41 years
Charles Collins	Not Known		Maintenance Superintendent (General Kinematics Corporation)	
David A. Walker	46	Wife	Welder	18 years
James Nealon	46	None	Mechanic	25 years


30" Concrete Pipe
Origin of Explosion
Para-Mount Feeder
Para-Mount Feeder
Raw-Coal Belt
Plan View of Enclosure
Flames and Forces Extended to Surface
See Appendix C for Details of Explosion Area and Locations of Victims
7' Diameter Dust Tube
Approximate Outline of Raw-Coal Pile
COAL-MINE METHANE EXPLOSION
IN RAW-COAL TUNNEL UNDER SURFACE COAL STORAGE PILE
ORIENT MINE NO. 5
FREEMAN COAL MINING CORPORATION
BENTON, FRANKLIN COUNTY, ILLINOIS
August 15, 1968
Not to Scale
APPENDIX B
Para-Mount Feeder
Para-Mount Feeder
Ground Level
30" Concrete Pipe
Raw-Coal Loading Belt
Raw-Coal Collect Belt
Origin of Explosion
Side View



COAL-MINE METHANE EXPLOSION
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August 15, 1968

Scale: 1/8" = 1' - 0"

APPENDIX C

Detail of Explosion Area