FINAL REPORT OF MINE EXPLOSION
GREAT VALLEY MINE
GREAT VALLEY ANTHRACITE COAL CORPORATION
McCOY, MONTGOMERY COUNTY, VIRGINIA

APRIL 18, 1946

By

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

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INTRODUCTION

A gas explosion occurred in the Great Valley mine of the Great Valley Anthracite Coal Corporation at McCoy, Montgomery County, Virginia, at 10:45 a.m., April 18, 1946. At the time of the explosion, 58 men were in the mine, and 46 of them escaped unaided to the surface. Eleven men were killed immediately by the forces emanating from the explosion, by the effects of burns they sustained, or from the effects of after-damp, and one man died the same day in a hospital as a result of burns, injuries, and shock. The men who escaped from the mine were not injured.

The explosion occurred in the 16 east level when a quantity of methane was liberated from a fault in the coal bed. The liberation occurred in a crosscut near the face of 16 east, and there is no evidence that flames extended farther than a few hundred feet from their origin; however, the forces emanating from the explosion destroyed all the stoppings in 16 east, which is about 850 feet in length, a door at the mouth of 15 east, 12 stoppings in 15 east, and an undercast near the mouth of 2 east; the mouth of 2 east is about 4,700 feet from the origin, as measured along the haulageways.

Notice of the disaster was received by a telephone call to the Mount Hope office of the United States Bureau of Mines about 11:00 a.m., April 18, 1946. Within 30 minutes after the message was received, six Bureau of Mines men with complete equipment for recovery operations were en route to the mine. In the meantime, other Bureau of Mines offices at Washington, D. C.; Pittsburgh, Pennsylvania; Norton, Virginia; and Bluefield, West Virginia, were notified of the disaster.

The men and equipment from the Mount Hope and Bluefield stations arrived at McCoy at 3:30 p.m., and entered the mine at 4:20 p.m. Other Bureau of Mines men arrived during the afternoon, during the night, and on the following morning. In all, 14 Bureau of Mines representatives took part in either the recovery operations or the subsequent investigation, or both.

Representatives of the Bureau of Mines are of the opinion that the explosion was caused by the sudden liberation of a large volume of methane, released by the firing of a shot in an uncompleted crosscut, and ignited by an electric spark from an open-type battery locomotive.

GENERAL INFORMATION

Location and Operating Officials

The Great Valley mine is at McCoy, Montgomery County, Virginia, about 13 miles southwest of Blacksburg, Virginia. It is owned and operated by the Great Valley Anthracite Coal Corporation, and is served by the Virginian Railway Company. The officials of the company are:

R. G. Stevens	President	Radford, Virginia
L. I. Cothern	Consulting Engineer	Blacksburg, Virginia
Cloyd Martin	General Manager	Radford, Virginia
T. J. Liddle	Superintendent and Mine Foreman	Blacksburg, Virginia

Employees and Production

One hundred and thirty-three persons were employed on two shifts at the mine, and 99 of them were employed underground. The average daily production was 500 tons of coal.

Openings

The mine is opened by three parallel, timber-lined slopes. One of the slopes is the haulageway and main intake airway; another, used as a manway and intake airway, is only about 250 feet in depth and is connected to the haulage slope; and the third slope is the main return airway. The two main slopes are about 4,900 feet in depth and are driven with the true dip of the coal bed, which declines gradually from 36 degrees at the mine portals to about 13 degrees at the present faces.

Nature of Coal Bed

The mine is operated in the Merrimac coal bed, which averages 84 inches in thickness, contains 13 layers of impurities ranging from 1 inch to 8 inches in thickness, and dips toward the southeast. Three major faults traverse the property; two are on the east side of the slope, and one is on the west side. Each of the faults has a vertical displacement or upthrow of 12 to 20 feet. The face of 16 east entry (the explosion area) was in the first fault east of the slope. The immediate roof is hard, smooth sandstone, and the floor is hard shale. The maximum cover over the present workings is about 2,000 feet thick.

The coal is of subanthracite rank. A proximate analysis of a composite sample of coal from the mine, as listed in Bureau of Mines Technical Paper 656, "Analyses of Virginia Coals", is as follows:

	Percent
Moisture	1.3
Volatile matter	11.9
Fixed carbon	62.2
Ash	24.6

The ratio of volatile matter to total combustible matter of the coal, which is an index of the explosibility of the coal dust, is 0.16.

MINING METHODS, CONDITIONS, AND EQUIPMENT

Methods of Mining

This mine is worked by the room-and-pillar method, and the workings are laid out so as to take advantage of the strike and dip of the bed. Level entries on 300-foot centers are driven in pairs east and west off the main slope, leaving a 15-foot pillar between each pair of entries. These entries are driven 15 feet wide with 90-degree crosscuts every 50 feet, and the crosscuts serve as room necks. Rooms are driven 12 to 25 feet wide and to the rise, and are driven through to the adjacent entry. Crosscuts in the rooms are 50 feet apart, and when a room is completed, a connection is made with the adjacent room to form an airway across the face of the rooms. The pillars are not extracted.

Some of the coal is pick-mined, and some of it is blasted from the solid. That from the haulage entry of each level is loaded directly into mine cars, and the coal from the airway is loaded into a wheelbarrow and then dumped into mine cars in the haulage entry. Coal from the rooms is loaded by hand onto shaker conveyors, which discharge the coal into mine cars.

The faults are fairly uniform in width and extend through the entire property. When a fault is encountered, the direction of the entries is changed so that they may be driven through the fault by the shortest distance.

Ventilation and Gases

Circulation of air in the mine is induced by a 6-foot Aerodyne fan installed on the surface in an incombustible structure and offset 25 feet from the return airway. The fan is run continuously, and it was exhausting 56,700 cubic feet of air a minute at the time of the Federal inspection of June 26, 1945. The intake air was coursed along the main haulageway to near the face of the main entries and about 75 feet inby the mouth of 16 east, where it was divided into two major splits; one split ventilated the working places on the west side of the slope, and the other split was coursed through the east-side workings; thus, 16 east was being ventilated by intake air.

Two blower fans with separate tubing were used in ventilating the face of 16 east haulage entry and the crosscut being driven to the air course. These fans were installed in 16 east haulageway (in intake air) at the second crosscut outby the face, which is also the mouth of 14 room; nevertheless, this crosscut, through which the man driving the air course wheeled his coal, was closed only by a brattice-cloth curtain. Doors used in controlling the main air currents in the level entries were installed singly near the slope.

The mine is rated gassy by the Virginia Department of Labor and Industry and by the United States Bureau of Mines. A fire boss makes a preshift examination of the mine, starting 3 hours before the appointed time for the day shift to enter; and an assistant foreman makes an examination of all the working places, starting approximately 3 hours before the night shift enters the mine. The mine foreman and other officials make examinations for gas in places they visit during the shift.

Air samples were collected in the mine on May 7 and 8 after the mine had partially resumed operation. The results of analyses of the samples are shown in table 1. It will be observed that the mine is liberating methane at the faces quite freely and that the return from 16 east contained 0.24 percent methane in 22,800 cubic feet of air a minute (Sample No. 683-R). A partial return from the east side of the mine sampled in the last crosscut in 13 east (Sample No. 318-Q) contained 1.08 percent methane in 18,700 cubic feet of air a minute. A sample from the main return collected at the bottom of the air shaft (Sample No. 179-Q) contained 0.80 percent methane in 74,000 cubic feet of air per minute. The mine, therefore, was liberating a calculated quantity of 852,480 cubic feet of methane in 24 hours. This represents a considerable increase in liberation since the last Federal inspection, June 25-26, 1945, when the mine was liberating about 670,000 cubic feet of methane in 24 hours.

The analytical results of three air samples collected during the investigation, about 24 hours after the explosion occurred and before normal ventilation had been restored, are shown in table 2. These samples are discussed under the heading "Point of Origin" in this report.

TABLE 1 - Analyses of Air Samples

Bottle No.	Location	Percent in Volume					Cu. Ft. Air A Minute	Cu. Ft. Methane 24 Hrs.
		CO_2	O_2	CH_4	CO	N_2		
179-Q	Return air - main return at the bottom of air shaft.	0.06	20.73	0.80		78.41	74,000	852,480
319-G	Duplicate	0.05	20.70	0.79		78.46	74,000	841,824
180-Q	Face - 26 room off 14 east.	0.05	20.52	1.22		78.21		
305-L	Face - 16 east airway.	0.05	20.83	0.36	0.00	78.76		
318-Q	Return air - last crosscut 13 east return from east side.	0.07	20.64	1.08		78.21	18,700	290,822
367-V	Face - 16 east entry.	0.1	15.3	24.8		59.8		
683-R	Return air from 16 east intake to 15 east - at the first fault - 15 east.	0.03	20.87	0.24		78.86	22,800	78,797
684-R	Face - 14 east airway.	0.05	20.70	1.06		78.19		
175-Z	Face of 15 west entry.	0.04	20.82	0.38		78.76		
176-Z	Face - 9 room 15 west.	0.03	20.81	0.52		78.64		

TABLE 2 - Analyses of Air Samples

Bottle No.	Location	Percent					Cubic Feet Air Per Minute
		CO_2	O_2	CO	CH_4	N_2	
348-S	Near the face of last crosscut 16 east - 2:10 p.m. 4/19/46	0.1	0.4	*0.005	96.2	3.3	
824-F	East-side return, between Nos. 10 and 11 rooms off 16 east. 2:35 p.m. 4/19/46	0.06	20.84	*0.005	0.21	78.89	11,220
825-A	60 ft. outby face of 16 east entry. 10:37 a.m. 4/19/46	0.06	20.64	**0.0025	0.71	78.59	

* Trace, less than 0.005
** Possible trace, less than 0.0025

Drainage

Five pumps were used to dewater the mine, but the working places and haulageways were comparatively dry. Most of the water drains to the face of the slope entries, from where it is pumped to sumps along the slope, and then to the surface. The explosion area was dry.

Dust

The coal in this mine is very dry, and large quantities of fine coal dust are formed during the mining operations. All surfaces, particularly those in the return airways, were covered by heavy deposits of the dust, which was not allayed at any of its sources. The mine has never been rock-dusted.

Six samples of dust were collected in the affected area during the investigation and were sent to Pittsburgh, Pennsylvania, for analyses. The results of the analyses are shown in table 3.

TABLE 3. - Dust Analysis Report. Collected April 1945

Mine Great Valley Company Great Valley Anthracite Coal Corp. Collected by M. J. Ankeny

Lab. No.	Can No.	Sample of	Location in Mine	As-received basis				Percent through 20-mesh
				Moist.	Ash	Comb.	Incomb.	
C-57076	V-575	Rib & Roof	16 East just outby mouth of 14 room	1.2	29.1	69.7	30.3	82.6
C-57077	L-865	Road	do.	1.1	23.3	75.6	24.4	72.5
C-57078	K-862	Rib & Roof	16 East just between Nos. 12 and 13 rooms	1.0	23.8	75.2	24.8	90.0
C-57079	K-615	Road	do.	1.3	22.7	76.0	24.0	76.9
C-57080	T-257	Rib & Roof	16 East just at mouth of No. 2 room	1.7	24.1	74.2	25.8	87.3
C-57081	P-551	Road	do.	0.9	25.4	73.7	26.3	85.2
			ALCOHOL COKE TEST -					
			Coked Particles Present					
C-57076	V-575		Very small amount (next to heaviest)					
C-57077	L-865		Small amount (heaviest)					
C-57078	K-862		Trace					
C-57079	K-615		Trace					
C-57080	T-257		None					
C-57081	P-551		None					

Haulage

Haulage is accomplished by electrically operated hoists and storage-battery locomotives. A hoist on the surface is used to handle cars along the main haulage slope between the portal and 15 east entry. An inside hoist is installed along the slope at 15 east, and is used to handle cars from the entries inby this point.

Nonpermissible storage-battery locomotives are used in handling cars between the slope sidetracks, the entry faces, and the conveyor loading points. The 2-1/2-ton wood-and-steel drop-bottom cars are equipped with brakes and with three-link couplings.

Adequate clearance was provided in most of the mine, but in some places, the clearance space was obstructed by mine refuse and timbers set too close to the tracks.

Shelter holes were provided along the main slope and side entries, but they were not provided at doors and switch throws.

The cars were not overloaded, and coal spillage at conveyors and along the haulageways was not excessive.

Lighting

The underground employees use permissible electric cap lamps, and the fire boss and other mine officials also use permissible flame safety lamps in the performance of their duties. Electric trip lights are not used. Most of the main slope is illuminated by well-installed incandescent electric lights.

Smoking in the mine is prohibited, and the underground employees are searched frequently for matches and other smokers' articles.

Electrical Equipment Underground

Electrical equipment was not used in the rooms, but the battery-type locomotives were occasionally taken to the face of the entries.

The motors for the electrical equipment are not of the permissible type. They are operated by 440 volts alternating current, which is reduced from 2,300 volts by means of a set of transformers installed along the slope. During the June 1945 inspection, a pump in 13 east and the conveyor motors were installed in return air.

All the transmission lines in the mine are insulated and are installed in either intake or return air. Enclosed sectionalizing switches equipped with fuses are provided in each branch circuit.

The air compressor, pumps, and battery-charging stations are not in fireproof rooms. The underground transformer station is ventilated by a separate split of air.

The electrical system and equipment are inspected daily and weekly by the mine electrician.

Three nonpermissible electrically operated shaker conveyors, four nonpermissible battery locomotives, five nonpermissible pumps, and two blower fans with nonpermissible motors were being used. The blower fans and one of the locomotives were in the explosion area.

Explosives and Blasting

Permissible brands of explosives and instantaneous electric detonators are used in blasting coal and rock. Blasting practices observed during the June 1945 inspection were: Shot holes approximately 1-1/2 inches in diameter were drilled by hand to a depth of 6 to 9 feet, and were charged with various amounts of explosives in each hole. An adequate amount of clay was used for stemming each shot. The holes were charged by the miners and fired, by means of permissible single-shot blasting units, at any time during the shift. Tests for gas were not made either immediately before or after shots were fired.

Explosives and detonators, in their original containers, were hauled in regular mine cars and delivered to the underground distributing magazines during the day shift. A day's supply of explosives and detonators was carried in separate containers by the miners from the inside distributing magazines to the working places and were stored in crosscuts, generally 100 feet or more from the working faces and 15 feet apart.

Mine Rescue

Twelve men were trained in mine rescue and recovery operations in 1944, but additional training has not been given.

Gas masks and self-contained oxygen breathing apparatus are not provided at the mine. The nearest mine rescue station is at Mount Hope, West Virginia, about 110 miles from the mine.

Fire Fighting

An underground fire-fighting organization has been formed, but fire drills are not held. Neither rock dust nor fire extinguishers were provided in the mine. Some water lines were available, but taps were not provided in the lines. Adequate lumber and brattice cloth were available on the surface.

Previous Explosions in This and Nearby Mines

A previous explosion, in which two men were killed, occurred at this mine August 25, 1928. Two explosions occurred in the nearby (now abandoned) Parrott mine; in one, August 15, 1915, one person lost his life; and the other, on January 18, 1932, caused the death of six men. Several gas ignitions in which men have been injured have also occurred in mines operated in the same coal bed in this vicinity.

MINE CONDITIONS IMMEDIATELY PRIOR TO EXPLOSION

The weather was clear and warm on the day of the disaster, the mine and the fan were being operated normally, and there was no indication that the mine ventilation had been interrupted. A fire boss made a preshift examination of the mine, and he examined the place where the explosion was initiated about 5:15 a.m.; the mine foreman examined the place about 8:00 a.m.; and the assistant foreman examined it about 10:00 a.m. Each of these officials asserted that the place did not contain an accumulation of gas when he inspected it; moreover, gas accumulations had not been found in any official examination during the previous day.

PROPERTY DAMAGE

The physical damage to the mine and the equipment was comparatively slight, and was confined largely to the 15 and 16 east levels. A door at the mouth of 16 east and two masonry stoppings along the main entry immediately outby the mouth of 16 east were demolished, 12 stoppings in 15 east were torn down, and several undercasts along the main entry were damaged. All the stoppings in 16 east (14 of them) were destroyed, and the line brattices and blower-fan tubing were torn down. Several mine cars along 16 east entry were derailed, but none of them was damaged greatly, and a shaker conveyor in 11 room was thrown out of alinement. Two blower fans opposite the mouth of 14 room were overturned but not damaged seriously, the top shields were blown off the locomotive, and part of the track was blown out of alinement. Practically all the posts in 16 east were blown out, but the roof is strong sandstone and none of it had fallen.

It was estimated that the damage could be repaired and the mine put into operation within three days.

STORY OF EXPLOSION AND RECOVERY OPERATIONS

The general manager of the mine was in the main haulageway when the explosion occurred. He was shaken by the forces but was not injured; he realized, however, what had taken place and returned to the surface from where he communicated immediately with the Bureau of Mines at Mount Hope.

The general mine foreman was visiting the working places in 14 east when he felt the concussion. He made his way through the openings to 12 east and to the main haulageway, and seeing no effects of violence, he then traveled down the slope and into 16 east. Because of the smoke and gases, he was able to go only a short distance into 16 east, and he returned to the main intake airway, which is also the main haulageway. Most of the miners in the unaffected parts of the mine escaped unaided to the surface, but a few of them remained in the mine to assist in restoring the ventilation in 16 east. Other officials, with additional men and supplies, went into the mine about noon.

The local officials and employees repaired several damaged undercasts and stoppings along the main haulageway and along the 16 east haulageway, and as a result, they were enabled to reach the only survivor in 16 east; this man, who was found at the mouth of 9 room, was taken to the surface and

sent to a hospital, where he died the same day. The bodies of three of the deceased were found along 16 east entry, just outby the mouth of 1 room, between 2 and 3 rooms, and just inby the mouth of 7 room, respectively. Two other bodies, the motorman and brakeman, were found near the last completed crosscut between 16 east entry and 16 east air course; and the body of a miner was found about 15 feet inby the crosscut. The six bodies were taken to near the mouth of 16 east, while search for the five other bodies believed to be in No. 11 room was continued.

When the Bureau of Mines representatives reached 16 east, the work toward restoring the ventilation in No. 11 room had been started. Because the methods of recovery operations and the progress made were satisfactory, the Bureau of Mines men offered no suggestions to change, but assisted in the work already underway.

Number 11 room had been driven about 80 feet from the 16 east entry and had crossed the 16 east air course about 30 feet from the mouth of the room, and the line brattice was erected to within 10 feet of the face of the room. One body was found about 40 feet back from the face, and four bodies were found at the face.

All bodies having been recovered, it was decided to postpone further activities until the following day, and everyone returned to the surface at 6:30 p.m.

INVESTIGATION OF CAUSE OF EXPLOSION

An investigation to determine the cause of the explosion was made on April 19, 1946; the investigation was made jointly by representatives of the United States Bureau of Mines, the Virginia Department of Labor and Industry, and officials of the Great Valley Anthracite Coal Corporation.

The United States Bureau of Mines was represented by M. J. Ankeny, H. E. Sanford, C. E. Tibbals, and M. J. Caylor.

The Virginia Department of Labor and Industry was represented by C. P. Kelley, Chief State Mine Inspector, and W. G. Elgin and A. G. St. Clair, Assistant State Mine Inspectors.

The Great Valley Anthracite Coal Corporation was represented by Dr. L. I. Cothern, a faculty member of Virginia Polytechnic Institute and consulting engineer for the coal company, and T. J. Liddle, superintendent and general mine foreman.

DETAILS OF EVIDENCE

The explosion originated at or near the entrance to an uncompleted crosscut which was being driven from 16 east entry, through a fault, toward 16 east air course. The map of the mine, Appendix "A", shows the location of the point of origin, the probable limit of flame, the probable limit of extreme violence, and the direction of forces. Appendix "B", with reference numbers attached, shows additional details of evidence in the immediate explosion area and the locations where dust and air samples were collected

during the investigation. Appendix "C" is a sketch of the face area of 16 east showing the ventilation arrangements, the probable location of the locomotive before the explosion, and the location where it was found after the explosion.

Forces

An open-type battery locomotive with the controller at the "on" position was stalled on debris between Nos. 13 and 14 rooms, but one of the top shields of the locomotive was found on the track inby the locomotive. This shield had been run over by the wheels of the locomotive.

Numbers 12 and 13 rooms had not been turned, but the face of No. 11 room was about 80 feet from the 16 east haulageway, and the face of No. 14 room was about 75 feet from the haulageway. Mechanical equipment was not being used in No. 14 room, but a compressed-air-driven shaker-type conveyor in No. 11 room was blown out of alinement, with the loading head displaced outby; and the positions of empty mine cars at the mouth indicated considerable forces from No. 11 room. Timbers along the 16 east haulageway were blown outby, and all stoppings along that entry outby 11 room were blown in toward 15 east. It was apparent that the forces traveled outby with great velocity, but diminished as they approached the main haulageway and dispersed through the workings outby 16 east. Men in 14 and 15 east were shaken by the forces, but were uninjured. An undercast near the mouth of 2 east was destroyed.

Heat and Flame

The first evidence of flame on 16 east was found a short distance outby the mouth of 11 room. Soot and fragments of burned paper were found throughout the length of 11 room and along the entry and air course inby 11 room. Unquestionably, the 16 east entry and its parallel air course inby No. 11 room, No. 11 room, and No. 14 room were traversed by flame during the explosion. There is evidence, also, that the flame traveled along the air course outby No. 11 room and at least a part of the way through the rooms that were cut through to 15 east.

Point of Origin

By referring to the map of the explosion area, Appendix "B", it will be observed that 16 east entry had been driven up against the fault and stopped. The entry was then turned to the left about 30 feet back from the face and driven directly through the fault and was, at the time of the explosion, being driven in the coal on the other side of the fault.

The face of 16 east entry was about 130 feet inby the last open crosscut, but a new crosscut had been started about 80 feet inby the last open crosscut, and was being driven back toward No. 14 room. The new crosscut had been driven about 25 feet from its mouth, and had encountered the fault. This crosscut and the face of 16 east were being ventilated by means of separate tubing from two blower fans, which were installed in intake air at the mouth of 14 room. Return air from 16 east entry and from the new crosscut was being coursed through the last open crosscut and, by mean of line

brattices, into Nos. 14 and 11 rooms. Numbers 12 and 13 rooms had not been turned off 16 east air course, but 14 room had been driven about 60 feet. A shot had been fired in the crosscut in No. 14 room on the morning of the explosion, but the blasting cable was not in shooting position at the time of the explosion; consequently a shot in No. 14 room was eliminated as a possible ignition source.

A shot had been fired in the new crosscut, which was being driven in the fault near the face of 16 east, immediately or a very short time before the explosion. The shot, evidently, was placed on the solid, overhead, and when fired, resulted in a rush of about 20 tons of material into the working place, and the firing end of the blasting cable was covered by the fallen material. The cable was broken into several pieces, but when the broken ends were matched and the cable extended its full length, the battery end reached a point in the entry near where the body of the miner who probably fired the shot, was found. (See Appendix "C") Parts of the blasting battery were also found near the body of the miner.

It was reported by officials and employees at the mine that methane was frequently liberated in large quantities when shots were fired in other faulted areas in the mine; moreover, an air sample collected above the fallen material at the face of the crosscut 27 hours after the explosion contained 96.2 percent methane. More than 10,00 cubic feet of air a minute had been passing the mouth of the crosscut for more than 18 hours before the sample was collected.

The evidence described in the preceding paragraphs, coupled with the fact that gas was not detected during the three official examinations of the working place on the morning of the explosion, leads to the belief that a comparatively large volume of methane was liberated by the firing of the shot in the crosscut.

Several possible ignition sources were near the point of origin at the time of the explosion. These suspected ignition sources include: (1) the shot that was fired in the crosscut; (2) the possibility of a second shot having been fired in the crosscut after the first shot liberated the gas; (3) the motors of the blower fans at the mouth of No. 14 room; and (4) the nonpermissible storage-battery locomotive operating in return air from the blower fans in 16 east heading.

The possibility that a single shot fired in the crosscut liberated the gas and then ignited it has been under suspicion. However, the crosscut had been examined for gas by three different officials who visited the place between 5:15 a.m., and about 10:00 a.m., and no gas accumulation was found. No change had been made in the working place since the last official visit, that would have caused an accumulation or a sudden liberation of gas, except the shot that was fired in the crosscut; therefore, there is no reason to believe that gas had accumulated before the shot was fired or that the shot was fired in a gas accumulation. If the gas was released by the firing of the shot, with its resulting displacement of a large mass of material, it it unlikely that the gas could have reached the detonating explosive until after the temperature had fallen below the ignition point; moreover, there would not have been sufficient time for the methane issuing from the fault

to have diffused sufficiently with air to form an explosive mixture. If a portion of the charge did not detonate but, instead, began to burn after the shot was fired, it is likely that the falling material would have isolated the burning explosive before the methane could have formed an explosive mixture with air.

A second shot in the crosscut could have ignited the gas after it was libenated by the first shot, but there was no way to determine positively whether or not a second shot had been fired; however, officials at the mine said that not more than one hole at a time is drilled, charged, or fired. The coal bed at the face was pitching heavily; in fact, it was almost vertical, and the miner could not know, even approximately, how much material a single shot would dislodge. It is unlikely, therefore, that more than one hole had been drilled when the shot was fired.

The nonpermissible blower fans situated in intake air at the mouth of No. 14 room were powered by induction-type squirrel cage motors, which would not be likely to ignite methane unless there was some defect in the windings or internal wiring. Tests, made on the motors by a Bureau of Mines electrical engineer after the explosion, disclosed that the motors were not defective, and therefore, were not likely sources of ignition.

A 4-ton, open-type Ironton storage-battery locomotive was operating in the section at the time of the explosion. This locomotive had placed six empty cars at the mouth of No. 11 room and one empty car in the crosscut in 16 east where the shot was fired. Evidence indicates that the locomotive was in 16 east between the last open crosscut and the crosscut in which the shot was fired when the explosion occurred. (See Appendix "C") The bodies of the motorman and brakeman were found in 16 east opposite the last open crosscut and near the body of the miner who had fired the shot. One of the cover shields of the locomotive was also found just outby the last open crosscut. Another of the cover shields of the locomotive was found on the track at the mouth of No. 14 room and inby where the locomotive was found. This shield had been run over by the locomotive, indicating that the locomotive was operating inby the mouth of 14 room when the explosion occurred. The locomotive with the controller at the "on" position was stalled on debris between Nos. 13 and 14 rooms, and there were indications on the rails and on the wheels of the locomotive that the motor of the locomotive continued to run after the locomotive stalled against the debris. An examination of the locomotive revealed that the controller resistance burned open, causing the motor to stop running.

The following is an account of what probably transpired during the few moments preceding the explosion, and is based on details of evidence left by the explosion and described herein: The miner in the crosscut in 16 east was ready to fire a shot. He took a position about 50 feet outby the crosscut and fired the shot, which released the methane from the fault. The locomotive and locomotive crew were near this place at the time. The methane coming from the fault mixed with air which was being discharged from the end of the ventilation tubing. This mixture, when it reached the mouth of the crosscut, then mixed with air coming from the ventilation tubing in the heading. The mixture of air and methane then enveloped and passed the locomotive and extended beyong it entering the return through the last open

crosscut. After the shot, the motorman probably decided to move the locomotive outby the last open crosscut so he would be in intake air and away from the fumes liberated by the blast. It is believed that when the motorman operated the controller to move the locomotive, an arc from the controller fingers ignited the gas, and after the gas was ignited, the motorman and brakeman had time to get off the locomotive before the maximum force of the explosion developed.

The force of the explosion dislodged the two cover plates of the locomotive. One of them was thrown a short distance outby, but the other was thrown violently outby. The locomotive, with the controller at the first point, moved outby a distance of about 180 feet, ran over the cover plate, and stalled on debris at the point indicated in the sketch, Appendix "C". The bodies of the locomotive crew were found near the point where the locomotive must have been when the ignition occurred.

COAL DUST AS A FACTOR IN THE EXPLOSION

The mine was dry and dusty, and the 16 east workings contained heavy deposits of fine coal; however, there was no visible evidence of coke deposits within the explosion area following the explosion. Dust samples collected from within the explosion area were examined for evidence of coke at the Bureau of Mines coal laboratory at Pittsburgh, Pennsylvania. Samples Nos. V-575 and L-865, collected near the mouth of 14 room, contained a small quantity of coked particles; samples Nos. K-862 and K-615, collected along the haulageway between Nos. 12 and 13 rooms, contained only tracks; and samples Nos. T-257 and P-551 from near the mouth of No. 2 room contained no trace of coked particles. It is concluded, therefore, that coal dust did not contribute to the propagation of the explosion or enter into the explosion to any appreciable extent.

As indicated under the heading "Nature of Coal Bed", in this report, the ratio of volatile matter to total combustible matter of a composite sample of coal taken from the mine was 0.16. Tests at the Bureau of Mines experimental mine have proved that coal having a ratio of volatile matter to total combustible matter of 0.12 is, under favorable conditions, capable of entering into and propagating an explosion. It is concluded, therefore, that the coal dust in this mine is well within the range of explosibility.

Tests at the Bureau of Mines experimental mine indicate that coal having a ratio of volatile matter to total combustible matter of 0.16, (the volatile ratio of the coal in this mine) is rendered nonexplosive when it contains 25 percent or more of incombustible matter in the dust. The incombustible content of the six dust samples collected from within the explosion area ranged from a minimum of 24 percent to a maximum of 30.3 percent, with an average of 25.9 percent, despite the fact the mine was not rock-dusted. The incombustible content of the dust in this case proved to be barely enough to prevent the initiation or propagation of a coal-dust explosion; however, the margin of safety was so slight as to be almost non-existant.

The presence of methane in air in which coal dust is suspended increases the explosibility of the coal dust conversely, the quantity of incombustible matter necessary to render the coal dust nonexplosive is increased proportionately. As the Great Valley mine is very gassy and subject to sudden

outbursts of gas in large quantities, it is believed that 65 percent of incombustible matter in the mixed dusts is necessary to provide a reasonable margin of safety.

SUMMARY OF EVIDENCE

Conditions existing inside the mine following the explosion and the fact that none of the workmen within the explosion area survived may leave some doubt as to the exact cause of the explosion. However, certain incontrovertible facts were determined during the investigation and are summarized as follows:

1. The positions of the material and equipment indicated that the forces of the explosion traveled outby from a point near the uncompleted crosscut in 16 east.

2. Evidence of flame was found throughout the area inby No. 10 room.

3. No evidence was found to indicate that dust was an important factor.

4. The uncompleted crosscut was being driven in a fault in the coal bed, and similar places in faults in this mine had liberated large quantities of methane in the past when shots were fired.

5. A sample of air collected at the face of the crosscut 27 hours after the explosion contained 96.2 percent methane.

6. A strung-out blasting cable extended underneath fallen material at the face of the crosscut, and the body of a miner at the battery end of the cable indicated that a shot had been fired shortly before the explosion. This was the only evidence of recent blasting in the explosion area.

7. A test for methane had not been made either immediately before or after the shot was fired in the crosscut.

8. An open-type battery locomotive with its controller at the "on" position was stalled on debris between Nos. 13 and 14 rooms.

9. Wheel marks on a locomotive-top shield found on the track indicated that the locomotive was being operated inby 14 room when the explosion occurred.

10. The location of the bodies of the motorman and brakeman indicated that the locomotive was in return air inby the last open crosscut and within 75 feet of the place where the methane was released.

CAUSE OF THE EXPLOSION

Representatives of the Bureau of Mines are of the opinion that the explosion was caused by the sudden liberation of a large volume of methane, released by the firing of a shot in an uncompleted crosscut, and ignited by an electric spark from an open-type battery locomotive.

CONCLUSIONS OF THE VIRGINIA DEPARTMENT OF LABOR AND INDUSTRY

The investigators of the Virginia Department of Labor and Industry concurred with investigators of the United States Bureau of Mines as to the cause of this explosion.

LESSONS TO BE LEARNED AS THEY RELATE TO THIS EXPLOSION

The recommended practice of testing for gas before and after blasting in gassy mines may or may not have prevented this explosion; however, there is a possibility that if the miner had been equipped with means of testing for gas, the methane would have been discovered before it was ignited.

The disaster at this mine emphasizes the need for excluding all sources of arcs and sparks from return air currents in gassy mines. The exclusion of the open-type battery locomotive from the air current returning from the face of 16 east and the uncompleted crosscut probably would have prevented this explosion. When it is necessary to operate electrical equipment in return air or in face regions, permissible equipment, if properly maintained and operated, is designed to afford the necessary protection against possible gas ignitions until the presence of gas is detected.

Whenever workings approach or are driven through faults in gassy mines, the liberation of gas is usually accelerated. Past experience in this mine has shown that when faults are encountered, methane is often liberated suddenly in large quantities at considerable gas pressure. Such conditions, therefore, call for special precautions. These special precautions might well include the employment of a competent mine official to devote all his time to the supervision of the working places as long as there is danger of sudden liberations, and particular care should be taken to see that arcs, sparks, or other sources of ignition are not present in any place that may be affected by a sudden inrush of gas.

RECOMMENDATIONS

Recommendations concerning the safe operation of the mine were made in reports of previous Federal inspections, the last inspection having been made June 25-26, 1945. Recommendations in this report, therefore, are limited to conditions as they relate to this explosion.

1. Examinations for gas should be made immediately before and after firing each shot, and a shot should not be fired in a place where gas can be detected with a flame safety lamp.

2. Shots should be fired only by authorized shot firers. Persons delegated and authorized to fire shots should be given thorough instructions as to safe procedure in blasting, and before being given such authorization, they should be required to demonstrate their qualifications by means of an oral or written examination, or both, or they should be required to show reasonable evidence of their qualifications.

3. Whenever a working place is approaching or is being driven through a fault, a competent mine official should be assigned to direct and supervise continuously all work being done in that place.

4. Whenever a working place is approaching or is being driven through a fault, blasting and the use of nonpermissible electrically driven equipment in return air from the place should not be permitted.

5. Electrically driven equipment that is operated inby the first open crosscut between entries or rooms, or in air that has ventilated one or more places should be permissible.

6. Each pair of active entries should be ventilated by a separate split of air.

7. Doors used in coursing the air should be erected in pairs to form air locks. The air locks should be ventilated sufficiently to prevent the accumulation of gas within the enclosed areas.

8. In order to provide a reasonable factor of safety to prevent the initiation or propagation of a coal-dust explosion, all open, unsealed places in the mine should be well rock-dusted. The rock dust should be applied on the roof, floor, and sides in such quantity that the mixed dusts will contain at least 65 percent incombustible material.

ACKNOWLEDGMENT

The writers wish to acknowledge the courtesies extended and the help given by the officials and employees of the Great Valley Anthracite Coal Corporation, particularly Mr. Cloyd Martin, General Manager, Mr. L. D. Cothern, Consulting Engineer, and Mr. T. J. Liddle, Mine Superintendent, who gave, without reservation, all information requested in connection with this investigation.

The cooperation of Mr. C. P. Kelley, Chief Mine Inspector of the Virginia Department of Labor and Industry and his associate inspectors is also hereby gratefully acknowledged.

Respectfully submitted,

(Signed)
M. J. Ankeny,
Coal-Mine Inspector.

(Signed)
H. E. Sanford,
Coal-Mine Inspector.

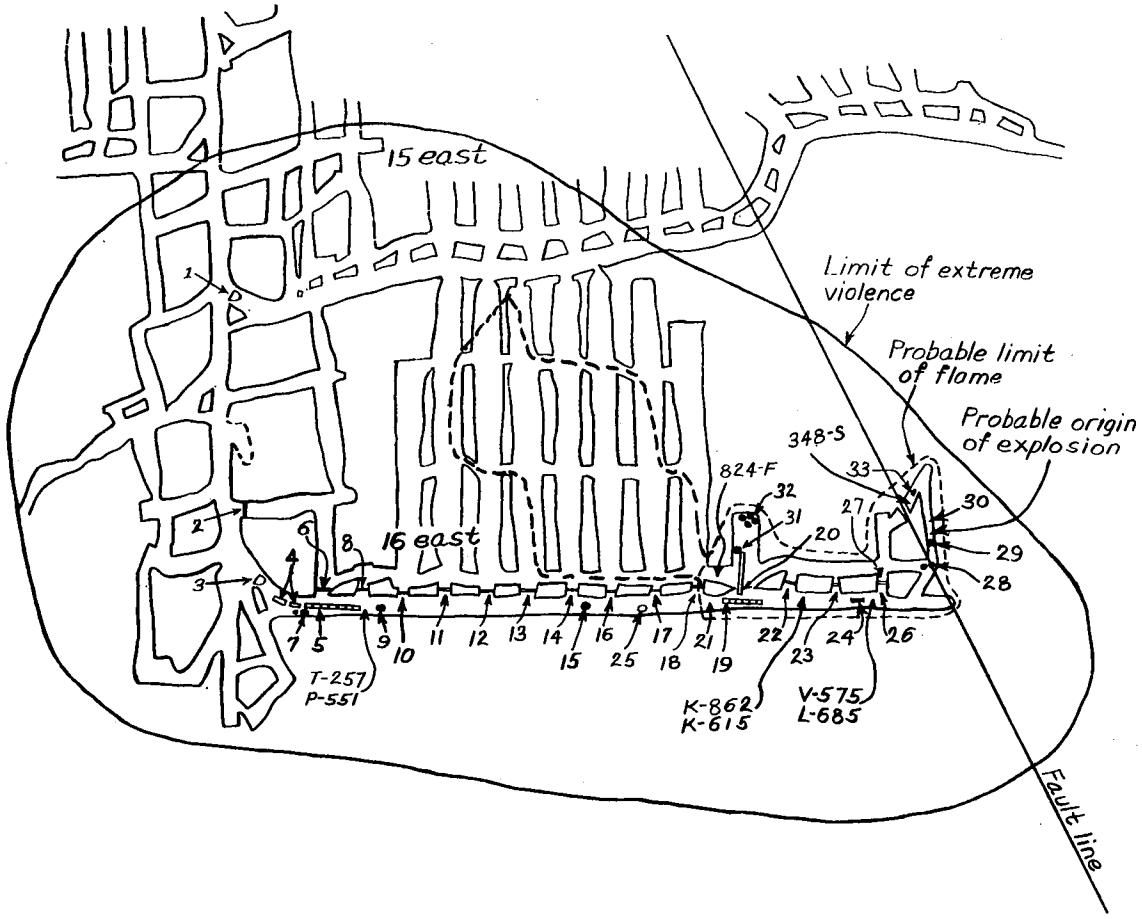
(Signed)
C. E. Tibbals,
Coal-Mine Inspector.

(Signed)
M. J. Caylor,
Coal-Mine Inspector.

Approved:

(Signed)
J. J. Forbes, Chief,
Coal-Mine Inspection Division

(Signed)
D. Harrington, Chief,
Health and Safety Branch.

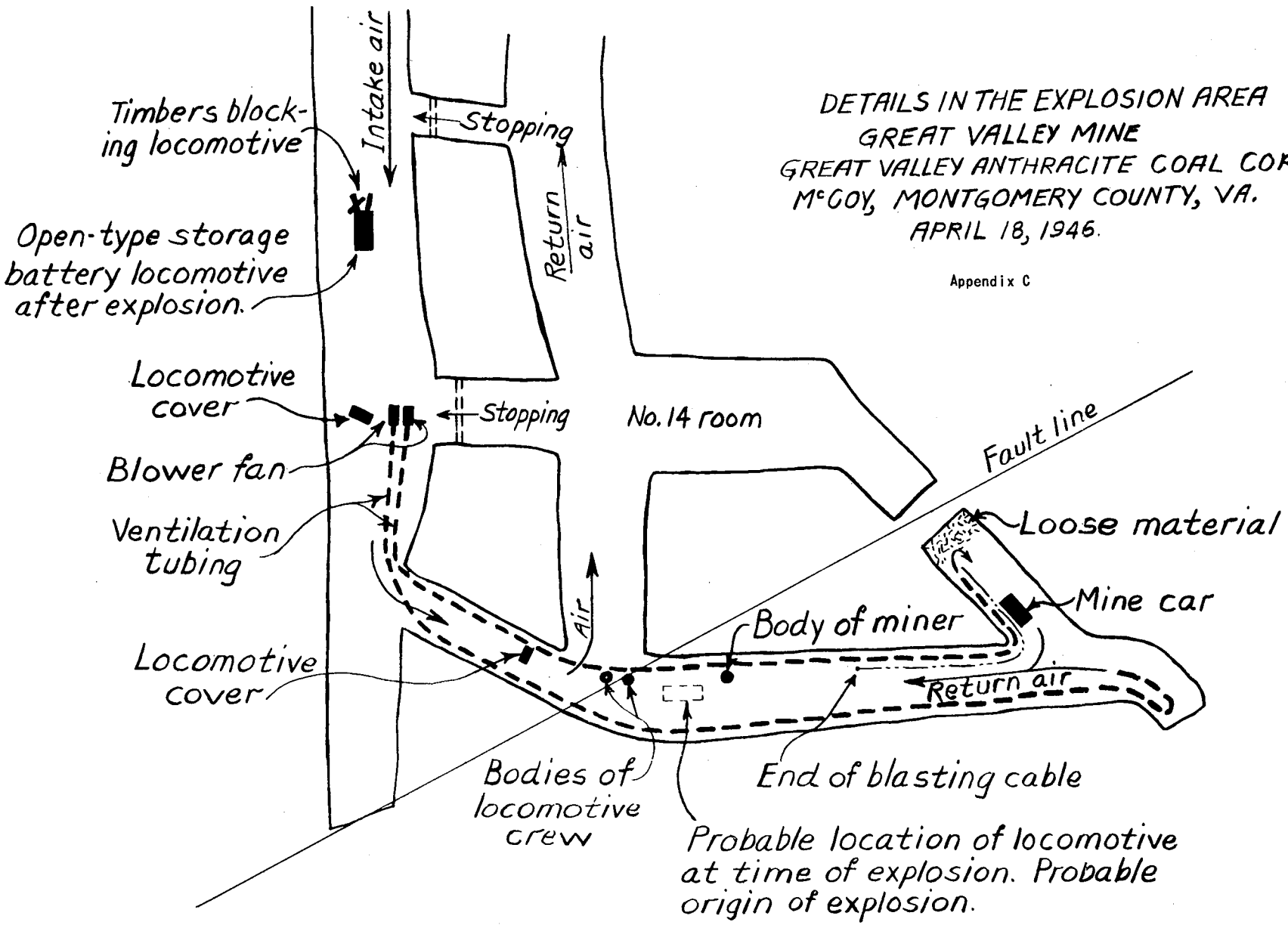


Details of Evidence

1. Door blown out.
2. Masonry stopping blown out.
3. Door blown out.
4. Two loaded cars; inby car off the track; forces traveling outby.
5. Seven empty cars; 3 inby cars off the track; forces traveling outby.
6. Stopping blown in.
7. Body--Timberman.
8. Stopping blown in.
9. Body--Timberman.
10. Stopping blown in.
11. Stopping blown in.
12. Stopping blown in.
13. Stopping blown in.
14. Stopping blown in.
15. Body of miner.
16. Stopping blown in.
17. Stopping blown in.
18. Stopping blown in.
19. Six empty cars, all off the track; forces traveling out of room.
20. Shaker-conveyor drive; out of alinement outby.
21. First evidence of flame.
22. Stopping blown out.
23. Stopping blown out.
24. Stalled locomotive with controller at "on" position and heading outby.
25. Live man; Died later in hospital.
26. Two blower fans.
27. Stopping blown out.
28. Two bodies; Motorman and brakeman.
29. Body of miner.
30. End of blasting cable.
31. Body of miner.
32. Four bodies of miners.
33. Empty car; damaged and off the track.

DETAILS OF EXPLOSION
GREAT VALLEY MINE
GREAT VALLEY ANTHRACITE COAL CORP.
McCOY, MONTGOMERY COUNTY, VA.
APRIL 18, 1946

Appendix B


DETAILS IN THE EXPLOSION AREA
GREAT VALLEY MINE
GREAT VALLEY ANTHRACITE COAL CORP.
McCOY, MONTGOMERY COUNTY, VA.
APRIL 18, 1946.
Appendix C
Timbers blocking locomotive
Intake air
Stopping
Return air
Open-type storage battery locomotive after explosion.
Locomotive cover
Stopping
No. 14 room
Fault line
Blower fan
Ventilation tubing
Loose material
Mine car
Air
Body of miner
Locomotive cover
Return air
Bodies of locomotive crew
End of blasting cable
Probable location of locomotive at time of explosion. Probable origin of explosion.

APPENDIX D

CORONER'S REPORT

STATE OF VIRGINIA
COUNTY OF MONTGOMERY
TO T. L. KEISTER, JUDGE OF THE CIRCUIT COURT

April 20, 1946

Accidental death of R. C. Hancock and 11 others, who died of shock and burns in a mine explosion, Great Valley Mine, Great Valley Anthracite Coal Corporation, McCoy, Montgomery County, Virginia, April 18, 1946:

"A sudden explosion occurred in the mine at about 10:00 a.m., which was presumed to have been due to a blast having opened a compressed vein of gas, causing a severe explosion in a limited portion of the mine, causing above accident. All men in this accident, 12 in all, were instantly killed, except one, Paul Price, who was taken to the Radford Community Hospital, Radford, Virginia, and died a few minutes after arriving at 2:00 p.m., April 18, 1946.

It is recommended that such investigation as is necessary to determine, if possible, anything could have been done to prevent the accident."

Signed: A. M. Showalter, M. D.
Montgomery County Coroner.

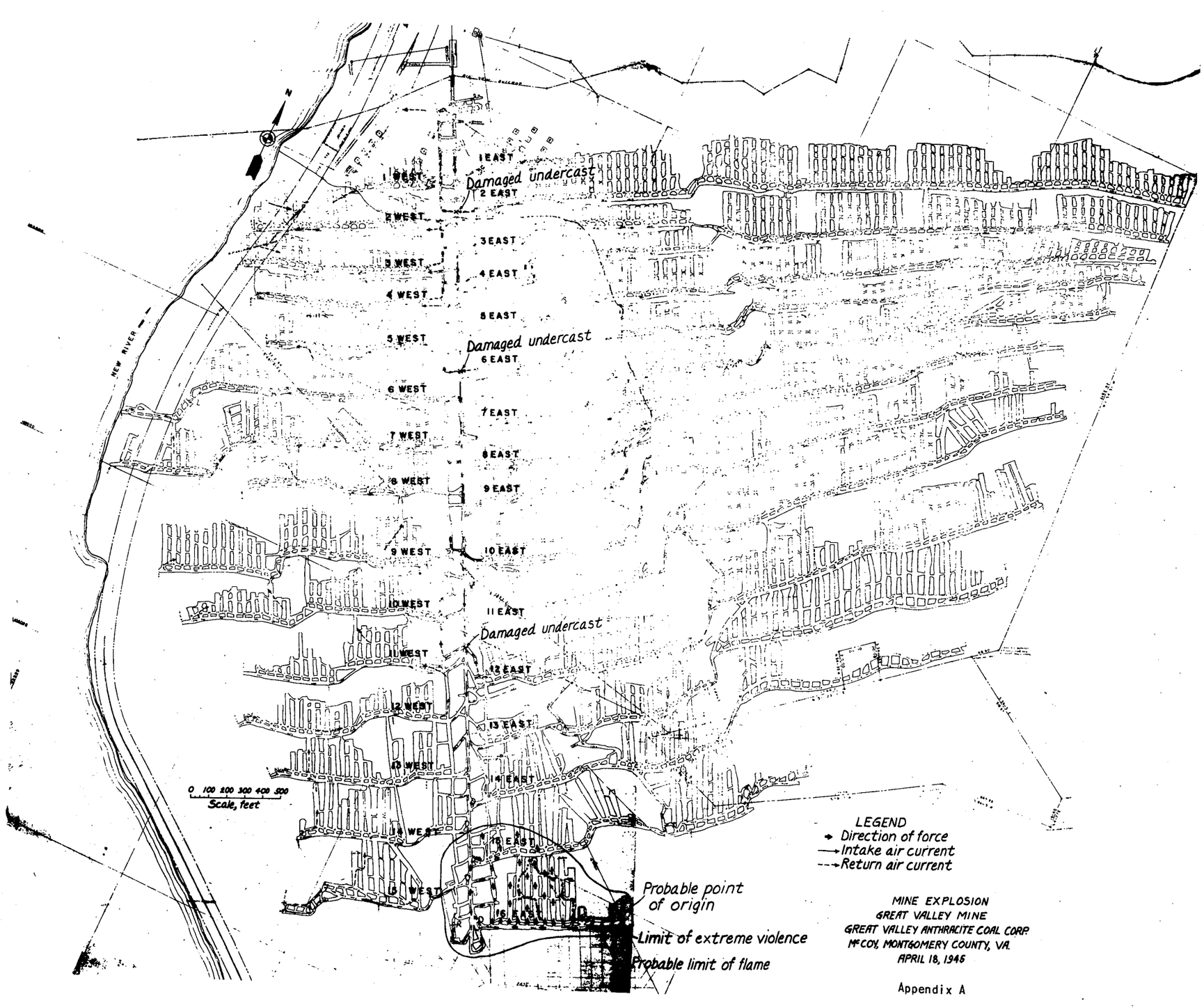
APPENDIX E

Name, Age, and Number of Dependents of Miners Killed at McCoy Mine

April 18, 1946

Name	Age	Dependents	Addresses
John A. Duncan	38	Wife	Parrott, Virginia
C. R. Johnson	37	Wife - 4 children	McCoy, Virginia
J. P. Price	41	Wife - 4 children	Cambria, Virginia, Route 1
*Paul Price	35	Wife - 5 children	McCoy, Virginia
Cecil Hancock	44	Wife - 10 children	Parrott, Virginia
Edd Ritter	64	Wife - 1 child	Parrott, Virginia
Harmon Sifford	39	Wife - 6 children	Parrott, Virginia
George R. Sifford	43	Wife - 7 children	Parrott, Virginia
Dave Graham	47	Wife - 4 children	Cambria, Virginia, Route 1
Frank DeWease	41	Wife - 3 children	Cambria, Virginia, Route 1
J. L. Sarver	43	Wife - 3 children	Parrott, Virginia
Frank Price	38	Wife - 4 children	McCoy, Virginia

* Died in the hospital April 18, 1946



MINE EXPLOSION
GREAT VALLEY MINE
GREAT VALLEY ANTHRACITE COAL CORP.
McCOY, MONTGOMERY COUNTY, VA.
APRIL 18, 1945

Appendix A