FINAL REPORT OF MINE EXPLOSION
NO. 9 HAVACO MINE
NEW RIVER AND POCAHONTAS CONSOLIDATED COAL COMPANY
HAVACO, McDOWELL COUNTY, WEST VIRGINIA
January 15, 1946

By

M. J. Ankeny
J. L. Gilley
John Zeleskey

Originating Office, Mount Hope, West Virginia
Alex U. Miller, Supervising Engineer

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

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Operating Officials

President	Charles E. Dunlap	Commercial Trust Bldg., Philadelphia, Pennsylvania.
Vice President	Charles Berwind	Commercial Trust Bldg., Philadelphia, Pennsylvania.
General Superintendent	P.P. Kerr	Berwind, West Virginia (McDowell County)
Safety Engineer	C. L. Wilson	Beckley, West Virginia (Raleigh County)
Superintendent	N. R. Decker	Berwind, West Virginia (McDowell County)
Assistant Superintendent	A. R. Miller*	Havaco, West Virginia (McDowell County)
Mine Foreman	Earl Belcher*	Havaco, West Virginia (McDowell County)

*Deceased

This company owns and operates, in addition to the No. 9 Havaco mine, Nos. 1, 5, 10, and 11 mines in McDowell County; Kaymoor, Layland, and Minden Nos. 2, 3, 4, and 5 mines in Fayette County; and Leslie mine in Greenbrier County, West Virginia.

Employees and Production

Five hundred and forty-nine men were employed at this mine, 60 on the surface, and 489 underground. Of the 489 underground employees, 121 worked on the night shift. The average daily production was 2,280 tons of coal, all hand-loaded into mine cars.

Openings and Nature of Coal Beds

The mine is opened by three concrete-lined shafts, consisting of a main hoisting shaft, 276 feet in depth through which coal, supplies, refuse, and employees are handled; a double-compartment down-cast air shaft 276 feet in depth, 200 feet from the hoisting shaft, one compartment equipped with a substantial steel stairway; and an up-cast air shaft 325 feet in depth, 1,700 feet from the hoist shaft. The coal-hoisting shaft serves as one of the two main air inlets. The up-cast shaft extends only to the No. 4 or upper coal bed. The shafts were in good condition.

The upper or No. 4 coal bed is entered through three slopes driven through the intervening strata from the No. 3 coal bed at distances of approximately 1,600 feet from the hoist shaft in the No. 3 bed. The haulage and intake-airway slope is 800 feet in length, on a 1-percent grade for a distance of 100 feet, and on a 7-percent grade for the remaining distance. The return- and the intake-air slopes are 300 feet apart, 85 feet in length, and are on a 40-degree pitch. The haulage slope is 200 feet from the return-air slope.

The mine is operated in the Nos. 3 and 4 Pocahontas low-volatile coal beds in the lower Pocahontas group of the Pottsville formation, and average 56 and 64 inches in thickness, respectively, in the present working areas.

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INTRODUCTION

An explosion occurred in the No. 9 Havaco mine of the New River and Pocahontas Consolidated Coal Company at Havaco, McDowell County, West Virginia, at 9:35 a.m., January 15, 1946. Two hundred and seventy men were in the mine at the time of the explosion. Of this number, 234 escaped to the surface unaided, 24 were injured and had to be rescued, 12 were killed outright by flames, violence, and afterdamp, and 3 died later in the hospital. In addition, 12 employees on the tipple and at the surface plant were seriously injured and 8 customers in the company store about 500 feet from the hoisting shaft were cut by flying glass.

The explosion was caused by the firing of an unconfined, excessive charge of nonpermissible explosive in a dusty location while blasting rock in the empty branch, 640 feet from the bottom of the hoisting shaft. It was a local explosion although exceedingly violent near the shaft bottom, and it released to the surface through the hoisting shaft, wrecking the head frame, steel tipple, and adjacent surface buildings.

Moisture conditions in the mine vary from dry to wet at different locations and measures are not taken to allay the dust at its source. The mine is partially rock-dusted.

A Federal coal-mine inspector first received word of the explosion at 10:00 a.m., on the day of the explosion, and the Mount Hope office of the United States Bureau of Mines obtained official confirmation of the disaster at 11:30 a.m. The first Federal inspector arrived at 11:00 a.m., and additional representatives of the Bureau of Mines arrived at various times during the next 5 hours. The Bureau of Mines mine rescue truck arrived from Mount Hope, West Virginia, at 3:30 p.m. A total of 13 representatives of the Bureau of Mines participated in either the rescue and recovery operations, the investigation, or both.

GENERAL INFORMATION

Location and Ownership

The No. 9 Havaco mine of the New River and Pocahontas Consolidated Coal Company is at Havaco, McDowell County, West Virginia, 1 mile from Welch, West Virginia, and is served by the Norfolk and Western Railway.

The coal beds dip as much as 4 percent toward the northwest. The cover over the No. 3 coal bed ranges from 276 feet to 1,200 feet at this property.

The immediate roof overlying the No. 3 coal bed is soft draw rock ranging from 12 to 40 inches in thickness and has very little strength. The main roof consists of gray sandy shale. Numerous slips. horsebacks. and pots are present.

The floor underlying the No. 3 coal bed is smooth shale.

The immediate roof overlying the No. 4 coal bed, which also is the main roof, is generally massive sandstone. Occasionally slips and horsebacks are encountered.

The floor underlying the No. 4 coal bed is smooth semi-hard shale.

Coal Analysis

The following analysis on an "as received" basis of the Nos. 3 and 4 Pocahontas coal beds were taken from Technical Paper 626, "Analyses of West Virginia Coals." Analysis of the coal from both beds is given consideration because coal dust from both beds was involved in the explosion.

No. 3 Coal Bed

	Percent
Moisture	2.8
Ash	5.7
Volatile Matter	15.0
Fixed Carbon	76.5

No. 4 Coal Bed

Moisture	2.9
Ash	6.5
Volatile Matter	16.0
Fixed Carbon	74.6

The ratio of volatile matter to total combustible matter, as given above.

$$\frac{\text{Volatile Matter}}{\text{Volatile Matter} + \text{Fixed Carbon}}$$

is 0.163 and 0.176 for the Nos. 3 and 4 coal beds, respectively.

Experiments conducted by the Bureau of Mines have shown that dust from coal having a volatile to total combustible ratio as low as 0.12 is explosive when suspended in a cloud of sufficient fineness and density. Also, the explosibility range increases as the ratio increases, and as the size of the particles decreases.

MINING METHODS, CONDITIONS, AND EQUIPMENT

Mining Methods

A room-and-pillar method of mining is used. In the development of this mine the main entries are driven 4 and 6 abreast on 60-foot centers, with room entries driven in pairs to the right and left off main entries at intervals of 300 feet; however, during early development, the interval between room entries in a few instances varied because of adverse conditions. All entries are driven 12 to 14 feet in width.

Rooms, 18 to 22 feet in width, are turned on 75-foot centers off the room headings and are extended until they cut into the air courses of the adjacent entries. Room and entry crosscuts are made at 80-foot intervals.

Room entries are driven their projected distances, then retreating room work is started. The pillars are extracted by open-end pockets driven 18 feet wide across the back end of the pillars. Pillars are extracted systematically. Approximately 30 percent of the coal is extracted during the advance mining and 55 percent during retreat mining.

The coal is undercut to a depth of $6\frac{1}{2}$ feet by nonpermissible shortwall and 2 permissible-type Arcwall mining machines. The coal is drilled by breast augers, and percussion drills are used for drilling rock entries. All coal is hand-loaded into mine cars, but three scraper loaders are used for loading rock in airways and in grading haulageways.

A systematic method is employed in timbering working places. One or more safety posts are required at faces before regular work is performed. Timbering along room entries consists of sawed wooden cross bars and posts. Very little timbering has been done on the main entries, except near the shaft bottoms where steel I-beams supported by rock piers are used.

Ventilation and Gases

Ventilation is induced by a well-installed $6\frac{1}{2}$-by 14-foot centrifugal fan put in operation during August 1945. This fan replaced the original fan at the top of the present down-cast air shaft, which was formerly used as the return air shaft. The new fan is driven by a 450-horsepower 2,200-volt alternating-current motor and is offset 50 feet from the centerline of the shaft. During the time of the last Federal inspection, September 17-25, 1945, the fan was exhausting 435,710 cubic feet of air a minute from the mine at a water-gage pressure of 4.25 inches.

The fan house is of brick construction with a concrete foundation and roof. The air duct of brick and steel is equipped with adequate explosion doors placed directly above the top of the air shaft. The direction of air flow is readily reversible. A water gage, a pressure-recording gage, air-lock doors, and two warning devices, one audible and one visual, are provided. The installation is equipped with a device to deenergize automatically the power underground when the fan slows or stops. The area for a sufficient distance surrounding the fan is clear of combustible materials, and the fan is inspected daily by one of the maintenance men.

The new fan housing is so designed that a fan, similar to the one now in use, can be installed and operated in parallel or as a separate unit.

The workings in the Nos. 3 and 4 coal beds are ventilated by the same fan through slopes connecting the two coal beds, previously mentioned.

A complete split ventilating system, utilizing air crossings and regulators, thereby minimizing the necessity for doors, is used. Approximately 31 air splits, 26 in the No. 3 coal bed and 5 in the No. 4 coal bed, are used. The main, intermediate, and room-entry haulageways are in intake air, and each producing room entry is on a separate split of air.

Crosscuts are made at 80-foot intervals and not more than one open crosscut is permitted between the faces of entries or rooms and the first outby temporary or permanent stoppings.

Stoppings between the main intake and return airways, along main haulageways, along intermediate haulageways, and in the room entries are suitably constructed of masonry or concrete. Stoppings in the room crosscuts are of brattice cloth.

Doors in this mine have virtually been eliminated. Only four check doors installed near the face regions were in use.

Line brattices are used to conduct the air from the last open crosscuts to the faces of the rooms and entries and in the pillars, when deemed necessary.

The mine is classed as gassy by the West Virginia Department of Mines and the Federal Bureau of Mines. Certified fire bosses are employed to make preshift examinations of the mine for gas and to observe and inspect for other hazards. The foremen, the shot firers, and mining-machine operators carry flame safety lamps and make tests for gas during the shift.

During the time of the last Federal inspection, September 17-25, 1945, the mine was liberating methane at a calculated rate of 1,253,651 cubic feet for a 24-hour period. The analyses listed in the Federal inspection report indicate that methane content in the main returns near the bottom of the upcast shaft ranged from 0.13 to 0.21 percent.

Drainage

The undulations of the Nos. 3 and 4 Pocahontas coal beds at this property result in numerous accumulations of water which generally require pumping.

In general, the immediate face regions and most of the haulageways and airways in 3 mains and in north mains in the No. 3 coal bed were dry; however, the surfaces of the workings, including most of the haulageways and airways in 1 mains, old dip mains, and in new dip mains ranged from damp to wet. Large accumulations of water are in the abandoned areas in the right side of 1 mains close to the escapeway and down-cast shaft. Also, a large body of water has collected in the old north dip abandoned area 2,200 feet from the coal-hoisting shaft. The return airways, in the vicinity of the coal-hoisting shaft and extending several hundred feet east and west of this and the escapeway and down-cast shafts, ranged from damp to wet. During the winter and early spring months, dry conditions generally prevail for distances of 500 to 600 feet along the haulageways east of the coal-hoisting shaft; however, the immediate area to the west of the coal-hoisting shaft generally remains damp to wet throughout the year.

A large sump is provided at the foot of the escapeway and down-cast shaft where the main pumping station is located. Also, the mined-out areas of the old dip mains serve as a sump from which the water is pumped through a 15-inch casing by a 6-stage 14-inch, 1,500-gallon capacity pump. Two pumps of 1,000- and 1,200-gallon capacity are provided in the main pumping station to pump water to the surface, and a 250-gallon centrifugal pump, which was stationed in a fireproof structure beside the empty branch 200 feet west of the coal-hoisting shaft, pumps the water from a sump provided to collect the water in this vicinity and discharges into the main sump. In addition to the above stationary pumps, 13 other pumps, consisting of both centrifugal and reciprocating nonpermissible types and ranging from 100- to 1,000 gallon capacity, are stationed at various locations through the mine in intake air. All permanently located pumps are in fireproof structures. All underground pumps, except two in the main pumping station operated on 2,300 volts alternating current, are operated from the mine circuit.

Dust

Large quantities of fine float dust, principally from the hoisting and dumping operations, were deposited in the vicinity of the coal-hoisting shaft and extended along the haulageways and adjacent intake airways for several hundred feet from this shaft. Excessive coal-dust accumulations were not noted along the haulageways inby the areas in which the float dust was deposited, but considerable dust and fine coal, however, were in the face regions in all working sections, except in some of the wet places as in dip mains and in parts of 1 main.

With some exceptions, as in 1 mains, dip mains, in some of the abandoned areas, and in some of the return airways near the shafts, the surfaces of the mine were generally dry.

Means were not provided for allaying coal dust at the principal sources in the face regions and along haulageways, except at two locations near the shaft bottom.

The haulageways, the working sections, and some of the airways have been rock-dusted; however, rock dust is not maintained within the recommended distances of the working faces, and some of the active working places have not been rock-dusted. The quantity of rock dust applied along haulageways, except near the hoisting shaft, however, appeared adequate. (See discussion of dust samples in this report under the heading "Factors That Prevented the Spread of the Explosion.")

Haulage

Main haulage is by electric trolley-pole locomotives over a single-track system from sidetracks to the shaft bottom. Eight explosion-proof cable-reel locomotives, recently obtained, and ten open-type cable-reel locomotives are used for gathering purposes. Hoisting and main and gathering haulage operations are in intake air. Seven hundred steel, end-gate-type mine cars of 3.5-ton capacity are in use.

The cars of coal are weighed near the bottom of the hoisting shaft and hoisted on two self-dumping cages to a distance of 50 feet above ground level where they are dumped. The coal hoist, which is also used for handling men and material, is of the double-drum conical design and is driven by a 600-horsepower, 2,300-volt alternating-current motor. A 300-horsepower electric motor is provided as a standby. One and one-half-inch diameter ropes are used, and the hoist is equipped with automatic overwind, overspeed, and stop controls, and a positive indicator to show the positions of the cages.

Written records filed in the outside foreman's office indicated that the hoisting equipment and appurtenances are inspected daily.

Lighting

Fixed incandescent lights operated from the mine circuit were installed satisfactorily at the shaft bottom, in the underground structures, including pump stations, at derails, and at some of the main-haulage switches. Permissible electric cap lamps are used exclusively for individual illumination underground. The flame safety lamps are of permissible type and are cleaned, filled, and assembled by the lamp-house attendants, then checked by the individual before being taken underground. The flame safety lamps remain in the custody of lamp attendants when not in use.

Smoking is not permitted underground, and the employees are searched periodically before going underground.

Machinery and Electricity Underground

Machinery underground is operated electrically by 250 volts direct current, except two (1,000-and 1,200-gallon capacity) pumps operated by 2,300-volt, 25-cycle alternating-current motors located at the foot of the escapeway compartment of the down-cast air shaft. The transformers and substations are on the surface.

With the exception of two permissible Jeffrey 29-C Arcwall mining machines and eight explosion-proof 8-ton Jeffrey cable-reel gathering locomotives, three explosion-proof scraper loaders, and one rock-dusting machine, all other electrical equipment, including mining machines, locomotives, compressors, and pumps is open type.

The power cables, which enter the mine through the coal-hoisting shaft and through the escapeway compartment of the down-cast shaft, and the underground trolley and feeder lines, at the time of the last Federal inspection, September 17-25, 1945, were well installed and guarded. The 2,300-volt transmission cable entering the escapeway is of the armored type. The power wires, including trolley and feeder lines, were in intake air. Cut-out switches were installed at or near the point where branch lines left the main circuit. Sectionalizing switches were provided at suitable intervals.

Explosives and Blasting

Permissible explosives, Monobel A and American No. 12 in 1-1/8- by 8-inch cartridges, were used for blasting coal. A permissible explosive, Gelobel C, was generally used for blasting rock but in recent weeks DuPont Special Gelatin, 40-percent strength, a nonpermissible explosive, was also used for this purpose. Number 6 electric detonators are used, and the shots are fired during the shift by certified shot firers or by officials who are required to test for gas before and after blasting. Permissible single-shot dry-cell batteries and two-conductor rubber-covered blasting cables, usually 100 feet or more in length, are used in firing the shots. Because of the soft nature of the coal, less than $1\frac{1}{2}$ pounds of explosives are required in each shot. Rock dust is provided for stemming. The primers are prepared by the shot firers at the faces immediately before charging the holes.

Cases of explosives are transported from the surface explosives-storage magazine by motor truck to the mine where they are placed in a well-constructed insulated explosives car, then lowered into the mine. The explosives are transported underground by an electric locomotive to the well-constructed explosives-distributing magazines suitably located at or near the entrance to the working sections. From these magazines, the foremen issue the explosives to the miners. The explosives are attended while in transit and the underground magazines, when not attended, are kept locked. The shot firers receive the detonators at the detonator magazine on the surface at the beginning of each shift and carry them into the mine. The detonators remain in the custody of the foremen or shot firers and are sold to the miners at the faces immediately before the shots are fired. The explosives are stored in canvas bags suspended from posts or placed along the ribs in the working places and in crosscuts. Unused explosives and detonators left at the end of the shift are locked in the respective magazines underground.

During the Federal inspections of this mine, various substandard blasting practices were noted, such as: improper stemming of shots; excessive amounts of explosives stored in the underground magazines; blasting cables less than 100 feet in length used by some shot firers; blasting cables not kept in the clear of pipe lines, rails, and other possible sources of active or stray currents during the blasting procedure; paper, empty containers, and refuse permitted to accumulate in and about the underground magazines; blasting on the solid; and, in some instances, improper storage of explosives in the working places.

Mine Rescue

About 10 men at this mine have received mine rescue training at various times, but none of them has had mine rescue training since 1941.

Gas masks and self-contained oxygen breathing apparatus are not available at this mine; however, there are several State-maintained and privately-owned mine rescue stations and mine rescue teams in the vicinity of the mine.

Fire Fighting

All buildings within 100 feet of the mine openings and vital structures were of fireproof construction. The electrical circuits were enclosed in conduit, and enclosed switches were used. Buildings were steam heated. Quart-size carbon-tetrachloride fire extinguishers were placed in the tipple, shops, supply house, hoist house, substation, and lamp house. Two large water tanks, several fire hydrants, 1,800 feet of municipal fire hose, and 4- and 6-inch water lines, on which a pressure of 57 pounds per square inch is maintained, are provided for fire-fighting purposes near the mine and plant buildings. This equipment is inspected regularly, and records of the inspections are kept.

The underground fire-fighting equipment consists solely of a 500-gallon track-mounted water tank equipped with a high-pressure pump and 25 feet of 2-inch hose. This tank and pump are also used for pumping water out of working places. A fire-fighting organization for the surface or underground is not maintained, and an outline procedure to be followed in case of fire or other emergency is not provided.

PREVIOUS EXPLOSIONS IN THIS OR NEARBY MINES

Numerous explosions of disastrous proportions have occurred in mines in this district operated in the No. 3 Pocahontas coal bed. Prior to this disaster, three other explosions occurred in this mine, as follows: 81 men were killed in 1912; 4 men were killed in 1918; and in December 1941, a local explosion resulted in 2 men being burned.

Other explosions in mines in this district and operated in this same coal bed in which five or more men were killed are as follows:

Date	Name of Mine	Location	Killed
12/29/08	Lick Branch	Switchback, W. Va.	50
1/12/09	Lick Branch	Switchback, W. Va.	67
10/19/11	Bottom Creek	Vivian, W. Va.	18
3/28/16	King	Kimball, W. Va.	10
7/18/19	Carswell	Kimball, W. Va.	6
5/13/27	Shannon Branch No. 3	Caples, W. Va.	8
4/2/28	Keystone No. 2	Keystone, W. Va.	8
1/22/41	Carswell	Kimball, W. Va.	6

MINE CONDITIONS IMMEDIATELY PRIOR TO DISASTER

The mine was operating normally, and no unusual conditions insofar as could be ascertained had been reported prior to the time of the explosion. No interruption had occurred to the ventilation system. The weather was clear and cold, and no sudden changes in barometric pressure or unusual temperature changes had occurred.

A barometer owned by the Koppers Coal Division at Carswell, West Virginia, 8 miles from Havaco, recorded the following pressures:

January 13, 1946	9:30 a.m.	28.60 inches of mercury
January 14, 1946	9:30 a.m.	28.60 " " "
January 14, 1946	9:30 p.m. to	
January 15, 1946*	6:00 a.m.	28.50 " " "
January 15, 1946*	9:30 a.m.	28.50 " " "
January 16, 1946	9:30 a.m.	28.50 " " "

* date of explosion

The following temperature readings were obtained from the official report at Gary, West Virginia, 5 miles from Havaco.

Date	8:00 a.m.	Maximum	Minimum	Rain
January 13, 1946	28	43	24	00
January 14, 1946	15	34	15	00
January 15, 1946	31	50	15	Trace
January 16, 1946	28	42	25	00

Barometric pressure is believed to have had no bearing on the cause of this explosion.

PROPERTY DAMAGE

The explosion, although not extensive, caused considerable property damage underground in the immediate vicinity of the coal-hoisting shaft. Property damage included: the destruction of four thick masonry stoppings between the main intake and return airways; a main overcast was demolished; the tops of two overcasts were torn off and the top of another overcast was buckled near the center and raised 3 inches above the side walls; concrete structures, including the weigh house and two pumping stations, were demolished; one of the cages was badly damaged; and some damage was done to two main haulage locomotives and to a few mine cars. One end of the underground supply room was torn out; several 6- by 15-inch I-beams were dislodged and bent, permitting some slate to fall; trolley and feeder lines were torn down; and the guides near the shaft bottom were torn out.

The damage to property on the surface was extensive. The forces of the explosion, as they reached the surface, demolished the concrete mine office and waiting station near the collar of the coal-hoisting shaft; part of the heavy concrete structure forming the shaft collar was blown outward; and the steel gates and steel fence at the ground landing were blown a considerable distance from the shaft collar. The walls of the two combination buildings which housed the blacksmith shop, machine shop, and supply compartment, and the hoist, substation, bath house, and lamp house were damaged, and the roof on each of these large buildings was virtually blown off. The steel head frame was twisted and bent; some of the main tipple structural columns were bent; the refuse-disposal dump in the tipple 25 feet above the shaft collar was damaged; stairways were torn out; several control switches and wiring in the tipple were damaged and torn from supports; pipe lines in the washer were broken; the dust-collecting system was damaged; and the hot-air heating plant and the brick enclosure beneath the tipple were demolished. The corrugated sheet-metal siding and roof of the tipple were blown off and some of the tipple machinery was out of alinement. A 50-ton railroad car under the tipple and 18 feet from the shaft collar was blown over on its side. Plate glass and window panes in the store 500 feet from the coal-hoisting shaft, and window panes in plant buildings and in some of the dwellings as far as 1,225 feet from the shaft were blown out. The 25-cycle high-potential power circuit and the surface telephone services, except in the store, were disrupted.

It is estimated that three months time will be required to repair the damaged surface plant so that operation of the mine can be resumed.

STORY OF THE EXPLOSION AND RECOVERY OPERATIONS.

The explosion occurred at 9:35 a.m., January 15, 1946. The only official on the surface at the time of the explosion was the outside foreman who was in the foremen's office near the tipple engaged in employing a new man when the forces of the explosion wrecked the building. Both he and the prospective employee, along with numerous other surface employees, were severely injured. The manager of the company store, 500 feet from the hoisting shaft, called the telephone operator at Welch, West Virginia, and requested her to notify the State mine inspectors and the general officials of the company. At 10:00 a.m. an announcement, coming from the local radio station at Welch, West Virginia, to the effect that a disaster had occurred, was heard by J. L. Gilley, Federal Coal-Mine Inspector at Welch, West Virginia. By calling the Welch telephone operator, Mr. Gilley learned that an explosion was reported at Havaco. He made arrangements to proceed to the mine immediately.

The district office of the Federal Bureau of Mines at Mount Hope, West Virginia, first learned of the explosion when someone called the office by telephone and advised that there was a radio announcement to the effect that there had been a mine explosion at Havaco, West Virginia, and that the surface plant had been damaged. Mr. A. U. Miller, Supervising Engineer of District C, verified this report at 11:30 a.m. by telephoning Mr. J. L. Gilley, Federal mine inspector, who was at the mine by this time and also by talking to Mr. G. R. Spindler, Chief of the West Virginia Department of Mines at Charleston, West Virginia. Mr. Miller then ordered additional Federal Coal-Mine Inspectors to the scene, contacting them by telephone, and left Mount Hope for the mine via automobile at 12:30 p.m.; Mr. M. J. Ankeny and Mr. L. G. Fitzgerald left with the mine rescue truck at approximately the same time. This party from Mount Hope arrived at the mine at about 3:15 p.m. Other Bureau of Mines personnel who reported for duty at the mine were Coal-Mine Inspectors John Zeleskey, Chas. E. Tibbals, C. E. Linkous, J. T. Whalen, Lex Trunko, Joseph Ferraro, H. E. Sanford, George Shaw, and Mining-Electrical Engineer T. R. Weichel.

C. L. Wilson, safety engineer of the company, arrived at the mine on routine business shortly after the explosion while fires were still burning in the tipple. Realizing that an explosion had occurred, Wilson checked the fan and found that it was operating properly. He then obtained a gas mask from his automobile and entered the escapeway shaft. About halfway down the shaft he met several men coming up the shaft and he met additional men who were injured on the bottom. He crossed over to the loaded branch above the sidetrack and found the air reasonably clear. He saw injured men and heard men groaning as he passed the place where the weigh office had been before the explosion. He then checked the main overcast for the dip sections and found that it was demolished and most of the air was short-circuiting into the return, carrying dust and fumes with it. Wilson then proceeded into the old main dip haulageway, passing men who were suffering from the effects of afterdamp. Continuing on his trip, Wilson made his way to the junction of the empty branch and the new main dip haulageway where he found additional injured men. Finding that the air was clearing rapidly and that men could travel the haulageways without respiratory protection, Wilson retraced his steps to the entrance of the slope haulageway where he met men coming out of the slope sections. Meeting a section foreman, Andrew Tolley, from one of the slope sections, he directed him to take several men down the old main dip haulageway and explore the workings of the old main dip section for survivors. Wilson then met the section foreman, H. P. Waller, coming from 3 main, who reported that all the men were out of 3 main. Wilson directed Waller to take several men and explore 4 left off the new main dip for survivors and then proceed to the junction of the empty branch and the new main dip to aid injured men. He then directed additional men and doctors to go down the old main dip haulageway and give aid to the injured after which he proceeded to the junction of the empty branch where he met Waller who reported smoke ahead in the new main dip entries.

About twenty minutes after Wilson entered the mine, State Mine Inspectors W. E. White and Jeff Chafin entered the mine through the escapeway compartment of the shaft and proceeded to explore the openings in the vicinity of the two shaft bottoms. They discovered and extinguished 2 fires on the loaded branch during these explorations.

J. L. Gilley entered the mine through the escapeway shaft at about 11:40 a.m. in company with E. L. Chatfield, Inspector-at-Large of the West Virginia Department of Mines. Upon arrival on the bottom, Chatfield ordered a shaft-sinking bucket to be rigged up in the air compartment of the shaft for use in removing injured men and bodies.

J. L. Gilley then proceeded down the empty branch to the junction of new main dip where he met Wilson and others and was soon joined by E. L. Chatfield and other inspectors of the West Virginia Department of Mines. This party of men explored 1 and 2 left off the new main dip, and the new main dip entries, and then proceeded to extinguish three fires inby from the junction of the empty branch and the new main dip and another about midway between the empty branch and the old main dip haulage road. J. L. Gilley on a trip in the empty branch discovered four stoppings blown out between the intake and return for the dip section and on the same trip discovered the rock shot which was later indicated as the point of origin of the explosion.

John Zeleskey, Federal Coal-Mine Inspector, and T. R. Weichel, Mining-Electrical Engineer of the Bureau of Mines, entered the mine about 1:30 p.m. and assisted in giving aid to the injured and in the removal of bodies and injured men to the surface.

In the meantime, Mr. Wilson had ordered officials of the mine to make a thorough examination of all sections to see that all men were out. After these explorations were completed and all known fires were extinguished, E. L. Chatfield ordered all men out of the mine while a check-up was made to ascertain whether all men who were in the mine at the time of the explosion were accounted for. Everyone, including survivors and rescue men, was out of the mine by 4:00 p.m.

At 6:00 p.m., a party of State mine inspectors, Federal coal-mine inspectors, and company officials entered the mine to make an examination of all haulageways and working places for fires, bodies, survivors, or other abnormal conditions. This party completed its examination and returned to the surface at 10:30 p.m., reporting conditions normal in the working sections, except for a reduced quantity of air in circulation. It was decided that an investigating party would enter the mine the next morning to observe conditions and collect evidence relative to the cause of the explosion.

INVESTIGATION OF CAUSE OF EXPLOSION

An investigation to determine the cause of the explosion was conducted jointly by the West Virginia Department of Mines and the United States Bureau of Mines on January 16, 17, and 18, 1946.

Investigators for the West Virginia Department of Mines were: G. R. Spindler, Chief of the Department; E. L. Chatfield, Inspector-at-Large; John Hansford, Jeff Chafin, W. E. White, C. C. Bailey, J. W. Hall, T. J. Lee, W. C. Sturgill, and H. H. Wall, State Mine Inspectors.

Investigators for the Bureau of Mines were: M. J. Ankeny, J. L. Gilley, John Zeleskey, L. G. Fitzgerald, and T. R. Weichel.

A meeting of the investigating parties was held at the State Capitol Building in Charleston, West Virginia, on January 29, 1946, to consider the evidence and arrive at a conclusion as to the cause of the explosion. The following persons were present at this meeting: A. U. Miller, M. J. Ankeny, and J. L. Gilley, representing the Bureau of Mines; and G. R. Spindler, E. L. Chatfield, John Hansford, A. C. Beeson, Jeff Chafin, and W. E. White, representing the West Virginia Department of Mines.

DETAIL OF EVIDENCE

Evidence indicates that the explosion originated in the empty branch for the dip section, about 640 feet inby from the hoisting shaft, and spread toward the workings of the dip section, in the opposite direction toward and beyond the hoisting shaft, and also up the hoisting shaft, and throughout the tipple.

The map of the mine, appendix "A", shows the location of the point of origin. The active and abandoned workings of the portion of the mine operating in the No. 3 bed and the number of employees in the various working sections when the explosion occurred. Appendix "B" is a map of the affected portion of the mine showing the point of origin, probable limits of flame and violence, direction of forces, location of dust samples collected, and other details of evidence obtained during the investigation.

The exact cause of the explosion was determined from details of evidence found after the explosion and from information obtained from survivors who were near the point of origin when the explosion occurred.

Forces

Forces of the explosion are indicated on a map of the explosion area, appendix "B", attached to this report. A study of the movement of materials from underground structures, including stoppings and overcasts that were damaged, the dislodgment of large steel cross bars, the bending of trolley-wire hangers, the wrecking of mine cars, and other evidence of force revealed that the major forces traveled outby the point of origin (see map) toward the hoisting shaft and from there traveled inby through the loaded and empty haulageways and other open passageways. Forces extended as far as the inby end of the new haulageway in 1 main, the main overcast outby north main, a short distance inby the entrance to the slope haulageway, and a short distance into the old main dip haulageway. Forces also traveled inby the point of origin through the empty branch to the new main dip entries and from there spread to the left and right, traveling 300 feet toward the workings of the new main dip section and 1,200 feet toward the workings of the old main dip section.

There was little conflicting evidence of forces throughout the explosion area; however, one of a number of 6- by 15-inch I-beams, near the shaft bottom on the empty branch, was evidently moved inby a short distance on the supporting sidewall pier; three adjacent I-beams of the same size, however, were moved outby on the sidewall piers and two of them were bent in the middle, indicating forces in the direction of the shaft bottom.

One of the bonnet plates on the cage, that was on the bottom at the time of the explosion, was bent downward as though from forces coming down the shaft, but the opposite bonnet plate was torn off and was found resting partly on the empty car on the cage and partly on the shaft landing as though it had been torn off the cage by the initial force of the explosion, was carried for an unknown distance up the shaft, and then fell to the location and position in which it was found. Debris from the walls of the weigh office was blown inby, as were the cover plates of locomotives that were stationed east of the shaft bottom. Trolley-wire hangers along the loaded sidetrack east of the hoisting shaft were bent inby. The mine foreman and the assistant mine superintendent, who were standing in the roadway leading to the motor barn at a point about 75 feet from the hoisting shaft, were blown a distance of 50 feet into the motor barn where their bodies were found, one in a mine car and the other under the car.

The forces of the explosion were probably violent as they traveled up the hoisting shaft; however, due to sturdy construction within the shaft and lack of timbering other than steel cross-buntons which were imbedded in the concrete lining of the shaft there was little damage and therefore little evidence of force in the shaft. The forces of the explosion, however, broke off some feeder cables that were suspended in the cable compartment of the shaft and a one million circular mil feeder cable carrying direct current at a potential of 250 volts was burned off about 70 feet below the collar of the shaft. There was evidence that the cable had been in contact with the bunton causing a direct short circuit to ground.

It is believed by the investigators that the forces coming up the shaft may have forced the cable out of its insulated hanger at the bunton and caused it to make contact with the bunton. There is evidence that the insulation on the cable was defective before the explosion at the point where the cable was supported by the hanger.

There was no evidence of violence at the foot of the escapeway shaft situated 200 feet from the hoisting shaft; in addition, there were two men in the mine foreman's office about 50 feet from the escapeway shaft when the explosion occurred, and these men were injured only slightly by the forces of the explosion. The flame and full force of the explosion failed to reach the bottom of the downcast escapeway shaft because of the apparent lack of coal dust and the presence of rock dust in ample quantities in the vicinity of the shaft.

Forces emerging from the hoisting shaft on the surface upset a 50-ton railroad car under the tipple, bent the structural columns and other structural members of the head frame and, undoubtedly, put the fine dust in the tipple into suspension. It is evident that the dust thrown into suspension was ignited, probably by the flame coming from the shaft, and the resulting explosion, together with the forces coming out of the shaft, created the surface damage described under the heading "Property Damage" in this report.

Heat and Flame

The location of several fires discovered while recovery operations were in process, the location of burned bits of paper and of slightly charred timbers, and the burned condition of most of the bodies and several of the survivors indicate that heat and flame traversed approximately the same area as that covered by the forces of the explosion, (see map appendix "B"). Fortunately, the flame did not reach any of the working faces or pillar sections of the mine; the nearest the flame approached any working face was in the dip heading where a timber fire was discovered about 800 feet outby the face. The flame extended up the hoisting shaft and was seen by a reliable eye-witness to emerge from the collar of the shaft and project upward a considerable height above the head frame. Immediately thereafter the entire tipple burst into flame, according to reliable reports.

Heavy coke deposits were not found in the mine after the explosion but there was evidence of fine coked particles in the dust throughout the explosion area.

Point of Origin

Two large pieces of rock and a number of smaller pieces evidently from a rock shot were found on the track in the empty branch 640 feet west of the hoisting shaft. It is estimated that the total weight of the pieces of rock was about 800 pounds. The maximum thickness was 10 inches. A blasting cable, 125 feet long, extended from near the broken rock to a recess in the rib 68 feet toward the hoisting shaft. The blasting cable was not short-circuited at either end when found. The body of Ernest Bell, employed as a rockman, was found near the recess in the rib during recovery operations. Luke Tolley, another rockman, who died later at the shaft bottom was also found at this point during recovery operations. Nine cartridges of DuPont Special Gelatin Dynamite, 40-percent strength, were found lying on the bottom in the recess in the rib. Numerous No. 6 electric detonators, probably about forty, were found in the same recess in the rib and scattered along the entry between the recess and the broken rock. About 75 feet beyond this recess in the rib, toward the shaft and around the curve, was another recess in the rib. Five cartridges of permissible explosives were found lying on the floor in this recess. The explosives were covered with fine coal, had been water-soaked, and had the appearance of having been in the mine for a long time.

About 125 feet inby the point where the rock was shot down, at the junction of the empty branch with the new main dip haulage road, just around the curve and out of line with the shot, was an 8-ton explosion-tested locomotive. The trolley pole was "dogged," the controller was in the "off" position, the return hook was attached to the switch bridle, and the "hot" nip was lying on the bottom 15 feet from the end of the locomotive. The locomotive operator, William Bradley, and the brakeman, James Williams, who were standing near the locomotive when the explosion occurred, survived the explosion although they were badly burned.

About 150 feet inby the locomotive, mentioned in the preceding paragraph, on the main dip haulage road was the end of a trip of 22 empty cars. Between the trip of empty cars and the locomotive was a loaded sand car. The locomotive was an 8-ton cable-reel explosion-tested type. The trolley pole was "dogged" and the brake was partly set. The operator of this locomotive was C. P. Dillon. Dillon was blown out of the deck of his locomotive but was not severely injured and was burned only to a slight degree. Dillon and his locomotive were about 575 feet from the rock shot when the explosion occurred.

From the black appearance of heavy dust deposits at the point of origin, throughout the length of the empty branch, and in the haulage roads and intake airways to the east of the hoisting shaft it was evident that there was sufficient combustible dust to propagate a dust explosion. Representative dust samples collected from within the explosion area contained from 27.4 to 46.4 percent incombustible material.

Conditions surrounding the suspected point of origin as described herein indicate that a rock shot consisting of a charge of dynamite was fired in the empty branch immediately before or a very short time before the dust explosion occurred. All of the elements necessary for the initiation and propagation of a dust explosion were present. The exact time of the firing of the rock shot was correlated to the time of ignition of the coal dust by the questioning of survivors who distinctly heard the charge of explosives detonate.

Information Obtained From Survivors

Information contained in this section of the report was obtained from survivors of the explosion who were near the point of origin immediately before and during the explosion. These survivors were as follows:

James Dixon, a workman, who was assigned by the mine foreman to assist Ernest Bell and Luke Tolley in removing a dangerous piece of overhanging rock from the empty branch about 640 feet from the hoisting shaft.

William Bradley, motorman on the locomotive that was found at the junction of the empty branch and new main dip haulage road, 125 feet inby the rock shot.

James Williams was the brakeman on the locomotive which William Bradley was operating.

C. P. Dillon, motorman on the locomotive that was found on the main dip haulage road about 575 feet from the point where the rock shot was fired.

Hobart Cordea, office clerk, who saw the flames of the explosion come out of the collar of the shaft.

On the morning of January 9, 1946, a piece of bad roof was discovered by a fire boss on the empty branch about 640 feet west of the hoist shaft. A "Danger" board was placed a short distance outby this location, and a report of the condition was made in the official record book. Subsequent reports were made of the condition on January 10, 11, 12, 14, and 15. Regardless of the "Danger" board, however, the use of this part of the empty branch was continued in supplying empty cars to the main dip sections.

On the morning of January 15, Luke Tolley and Ernest Bell were ordered by the mine foreman to go to the empty branch and remove the dangerous condition reported by the fire boss. The exact orders given these men could not be determined because they were killed in the explosion as was the mine foreman. Later, the mine foreman ordered Charles Dixon to go to the empty branch to help Tolley and Bell remove the loose rock.

Dixon reached the place on the empty branch where Tolley and Bell were making up a charge of four 1-1/4-by 8-inch cartridges of dynamite (Special Gelatin, 40-percent strength). A piece of shale about 10 inches thick at the front edge and weighing 800 pounds (estimated) had separated from the main roof approximately 4 inches at the front and a crevice between the loose rock and the main roof extended back 3 feet or more.

At this time a locomotive, operated by C. P. Dillon, came into the place and was coupled to a nearby sand car. The sand car was moved under the loose rock and while the locomotive was coupled to the car, Dixon climbed up on the car and placed the charge of explosives in the crevice, using a scotch block to push it back into place. Dillon saw Dixon place the explosive in the crevice and then saw him put a piece of rock against the explosive. Presumably, the rock was to act as stemming. Dixon admitted that he put the dynamite in the crevice and he stated further that the rock surfaces within the crevice were laden with coal dust. After Dixon got off the sand car Dillon pushed it back toward the shaft bottom with the locomotive and waited for empty cars. While he was waiting one of the men shouted and warned him that they were going to fire the shot, but Dillon told them to wait until he got his empties because his miners were waiting for cars. The men then deferred firing the shot so as not to block the road until the locomotive and empties passed out of the empty branch. Dixon followed the trip of empty cars to the junction of the empty branch and the main dip haulage road to guard the entrance while the shot was being fired. At this junction he met another locomotive which had just come out of the new main dip and had headed into the empty branch to obtain empty cars for the section. The motorman on this locomotive was William Bradley and the brakeman was James Williams. Dixon warned the locomotive crew of the impending shot and they dismounted from the locomotive and were standing with Dixon just around the curve from the entrance to the empty branch when the shot was fired. They were not more than 125 feet from the rock shot at this point. All three were knocked down by the force coming out of the empty branch immediately after the shot. Bradley and Williams were seriously burned about the hands and face, and Dixon was seriously burned on the hands, face, and legs. These men stayed where they were in a dazed condition until rescued. All three stated that they distinctly heard the rock shot and were hit by the force of the explosion immediately afterward.

Dillon had reached 3 left on the dip mains with his trip of empty cars, about 575 feet inby the rock shot, when the explosion occurred. He had stopped his trip to switch the sand car into 3 left. He stated that he heard the rock shot distinctly and almost immediately thereafter was blown out of the cab of his locomotive into the middle of the track. He escaped with slight injuries and light burns.

The explosion came out of the hoisting shaft, wrecking the head frame, part of the tipple, and other surface buildings, as described elsewhere in this report. Hobart Cordea, a clerk in the mine office, situated 350 feet from and in direct line of vision with the shaft, was standing at a desk looking directly at the head frame when the explosion occurred. Cordea later told investigators (M. J. Ankeny and J. L. Gilley of the United States Bureau of Mines) that he saw the flame emerge from the collar of the shaft and project upward, extending for a considerable height above the head sheaves. He said he then saw the tipple burst into flame and heard the report of the explosion. He was cut by flying glass from one of the windows in the office.

This information, obtained through the questioning of survivors, indicates that the shot was charged with Special Gelatin Dynamite, 40-percent strength; a nonpermissible explosive; that the shot was overcharged and the charge unconfined; that coal dust in dangerous quantities surrounded the charge in the crevice in the roof; that the coal-dust explosion followed immediately the firing of the charge; and that the force and flame of the explosion emerged from the collar of the shaft.

Factors That Prevented the Spread of the Explosion

Spread of the explosion into the working sections of the mine was prevented by a favorable combination of circumstances. As the explosion traveled from the point of origin toward the 1 main, 3 main, and the north main sections, and to the slope entrance to the No. 4 coal bed, the main overcast for the dip section collapsed, releasing pressure into the extensive abandoned areas of the 1 main section, which were partially inundated. The release of pressure at the overcast, in addition to well-rock-dusted haulageways and adjacent entries inby the explosion area, prevented the propagation of the explosion into the active workings of 3 main, north main, and into the No. 4 coal bed.

As the explosion traveled from the point of origin toward the main dip entries, propagation was confined to the empty branch because its parallel entry was used as a sump and drainway for the west side of the shaft and it was in a damp to wet condition. The explosion failed to reach the working places of the new main dip and old main dip sections because of existing damp to wet conditions and the presence of rock dust along the entries between the explosion area and the workings.

Flame and violence of the explosion failed to reach the foot of the downcast escapeway shaft 200 feet from the main hoisting shaft because of the apparent lack of coal dust and the presence of rock dust in ample quantities in the vicinity of the shaft.

That coal-dust accumulations in the vicinity of the shaft bottom were the primary cause of this explosion and that rock dust prevented its spread into the working sections is substantiated by dust samples collected during the investigation and analyzed in the Bureau of Mines Coal Laboratory at Pittsburgh, Pennsylvania. Results of analyses of these samples are shown in table 1 and the locations where they were collected are shown on the map, appendix "B", attached to this report. Table 2 indicates the extent of coked-particles present in the samples. Experimental work done by the Bureau of Mines has proven that explosions will not propagate through coal-dust mixtures in which the incombustible content of the dust is 65 percent or more, unless methane is present in the air.

Samples collected from the loaded branch 50 feet inby the hoisting shaft (Nos. P-898 and W-469) contained 32.1 percent incombustible matter in the roof-and-rib sample and 29.6 percent in the road sample. These samples contained a medium amount of coked particles. Samples from the empty sidetrack entry at the manway crossover near the shaft bottom (Nos. V-777 and P-968) contained 34.0 percent incombustible matter in the rib-and-roof sample and 27.4 percent in the road sample. Traces of coked particles were present. Samples from the empty branch, 300 feet inby the shaft or 340 feet outby where the dust was ignited (V-237 and V-554) contained 42.1 percent incombustible matter in the roof-and-rib sample and 37.3 percent in the road sample. A small amount of coked particles was present. Samples from the empty branch 20 feet outby the new dip haulageway (Nos. E-648 and M-360), still within the explosion area, contained 37.4 percent incombustible matter in the rib-and-roof sample and 35.4 percent in the road sample. A medium amount of coked particles was present. Samples from the 2 main loaded branch at the cross-over (Nos. J-579 and T-142), 370 feet inby the shaft and within the explosion area west of the shaft, contained 50.5 percent incombustible matter in the rib-and-roof sample and 46.4 percent in the road sample; traces of coked particles were present.

From the preceding discussion of samples, all taken within the explosion area, the conclusion is reached that the incombustible content of the dust in the vicinity of the shaft bottom, in the empty branch to the west of the shaft bottom, and in the haulageways to the east of the shaft bottom was not sufficient to prevent the initiation or propagation of a coal-dust explosion.

Dust samples were also collected near the edge or outside of the limits of flame and violence of the explosion. Samples collected in the new dip haulageway 300 feet inby the overcast that was damaged (Nos. M-320 and R-667) contained 58.0 percent incombustible matter in the rib-and-roof sample and 78.8 percent in the road sample; coked particles were not present. Samples collected on the main dip haulageway near 5 left just outby the working section (Nos. L-210 and F-548) contained 92.6 percent incombustible matter in the rib-and-roof samples and 86.3 percent in the road sample. The rib-and-roof sample contained no coked particles, but traces of coke were present in the road samples. A sample collected on the main dip haulageway 600 feet inby the entrance to the slope haulageway (No. H-369) contained 90.7 percent incombustible material, with no coked particles present. The road was too wet to sample. Samples collected 400 feet inby the entrance to the slope haulageway (Nos. M-476 and M-785) contained 74.3 percent incombustible matter in the rib-and-roof sample and 74.7 percent in the road sample; coked particles were not present. Samples collected in the 3 main haulageway 50 feet outby the main north (Nos. U-652 and X-929) contained 92.5 percent incombustible matter in the rib-and-roof sample and 70.6 percent in the road, with no coke particles in the roof-and-rib sample and traces of coke in the road sample. Samples collected from 1 main haulageway at 1 right (Nos. L-815 and K-789) contained 80.0 percent incombustible matter in the rib-and roof sample and 77.8 percent in the road sample; coked particles were not present in either sample.

TABLE 1 - DUST ANALYSIS REPORT. COLLECTED JANUARY 1946

Mine No. 9 Havaco. Company New River and Pocahontas Consolidated Coal Co.
Collected by J. L. Gilley

Lab. No.	Can No.	Sample of	Location in mine	As-received basis Moist.	Ash	Comb.	In-comb.	Percent through 20-mesh
C-53214*	L-815	Roof and rib	1 main haulageway at 1 right	1.9	78.1	20.0	80.0	80.2
C-53215*	K-789	Road	do.	3.4	74.4	22.2	77.8	88.3
C-53216*	U-652	Roof and rib	3 main haulageway 50 feet outby main north	0.3	92.2	7.5	92.5	95.1
C-53217*	X-929	Road	do.	0.7	69.9	29.4	70.6	88.9
C-53218*	M-476	Roof and rib	400 feet inby entrance of slope haulageway	0.5	73.8	25.7	74.3	85.2
C-53219*	M-785	Road	do.	0.4	74.3	25.3	74.7	88.7
C-53220*	L-210	Roof and rib	Main dip haulway at 5 left	1.1	91.5	7.4	92.6	90.7
C-53221*	F-548	Road	do.	0.8	85.5	13.7	86.3	85.5
C-53222*	E-648	Roof and rib	Empty branch 20 feet outby new dip haulageway	1.4	36.0	62.6	37.4	74.4
C-53223*	M-360	Road	do.	1.1	34.3	64.6	35.4	65.9
C-53224*	M-320	Roof and rib	New dip haulageway 300 feet inby overcast	0.6	57.4	42.0	58.0	72.5
C-53225*	R-667	Road	do.	0.8	78.0	21.2	78.8	80.8
C-53226*	V-237	Roof and rib	Empty branch, 300 feet inby shaft at outby pick-up	1.6	40.5	57.9	42.1	84.6
C-53227*	V-554	Road	do.	1.2	36.1	62.7	37.3	83.7
C-53228*	V-777	Roof and rib	Empty sidetrack at manway crossover	0.8	33.2	68.0	34.0	95.3
C-53229*	P-968	Road	do.	0.7	26.7	72.6	27.4	97.1
C-53230*	J-579	Roof and rib	2 main loaded branch at crossover 370 feet inby shaft	0.6	49.9	49.5	50.5	92.2
C-53231*	T-142	Road	do.	0.6	45.8	53.6	46.4	91.2
C-43232*	P-898	Roof and rib	50 feet from bottom of shaft	0.8	31.3	67.9	32.1	98.9
C-53233*	W-469	Road	do.	1.0	28.6	70.4	29.6	93.8
C-53234*	H-369	Roof and rib	Main dip haulageway 600 feet inby entrance to slope haulageway	1.6	89.1	9.3	90.7	86.4

*Sample rock-dusted.

TABLE 2 DUST ANALYSIS REPORT. COLLECTED JANUARY 1946

Mine No. 9 Havaco. Company New River and Pocahontas Consolidated C. Co.
Collected by J. L. Gilley

Lab. No.	Can No.	Sample of	ALCOHOL COKE TEST COKED PARTICLES PRESENT
*C-53214	L-815	Roof and Rib	None
*C-53215	K-789	Road	None
*C-53216	U-652	Roof and Rib	None
*C-53217	X-929	Road	Trace
*C-53218	M-476	Roof and Rib	None
*C-53219	M-785	Road	None
*C-53220	L-210	Roof and Rib	None
*C-53221	F-548	Road	Trace
*C-53222	E-648	Roof and Rib	Medium Amt. (Largest)
*C-53223	M-360	Road	Medium Amt.
*C-53224	M-320	Roof and Rib	None
*C-53225	R-667	Road	None
*C-53226	V-237	Roof and Rib	Small Amt.
*C-53227	V-554	Road	Small Amt.
*C-53228	V-777	Roof and Rib	Trace
*C-53229	P-968	Road	Small Amt.
*C-53230	J-579	Roof and Rib	Trace
*C-53231	T-142	Road	Trace
*C-53232	P-898	Roof and Rib	Medium Amt.
*C-53233	W-469	Road	Medium Amt. (Next to Largest)
*C-53234	H-369	Roof and Rib	None

Since the entire explosion area was circumscribed by entries that contained more than 65 percent incombustible or by entries that were wet, it is concluded that rock dust or damp to wet conditions of surfaces arrested the explosion before it reached the working sections.

SUMMARY OF EVIDENCE

Conditions observed in the mine following the explosion, together with information obtained from certain workmen who were involved, provide ample evidence as to the point of origin of the explosion. Facts based on evidence obtained during the investigation are summarized as follows:

1. No evidence was found to indicate that methane was involved in this explosion. The dust ignition occurred in an intake airway in which approximately 109,440 cubic feet of fresh intake air a minute was passing at a velocity of about 1,140 feet a minute.

2. Major forces of the explosion radiated from a point in the empty branch 640 feet west of the main hoisting shaft with little conflicting evidence of force.

3. Forces and flame died away before reaching active workings in the producing sections or adjacent mined-out areas.

4. A charge of nonpermissible explosive, designed to bring down a piece of loose rock, was fired in the empty branch 640 feet from the hoisting shaft immediately before the mine explosion occurred.

5. The explosives charge was excessive and it was not properly confined in a borehole. Instead, it was placed in a crevice between the loose rock and main roof and it was not suitably stemmed.

6. The opening of the crevice was toward the hoisting shaft so that coal dust carried by the intake air would accumulate in the crevice. The crevice was laden with coal dust at the time the charge of explosive was inserted.

7. Excessive deposits of fine coal dust were present on the ribs and roof for several hundred feet on each side of the hoisting shaft, including the area in which the unconfined, overloaded rock shot was fired.

8. Dust samples collected within the explosion area ranged from 27.4 to 46.4 percent incombustible matter.

CAUSE OF THE EXPLOSION

Representatives of the United States Bureau of Mines are of the opinion that the explosion was strictly a local coal-dust explosion originating in the empty branch about 640 feet from the hoisting shaft and that the initial dust cloud and subsequent ignition thereof was caused by the firing of an unconfined and overloaded charge of nonpermissible explosive placed in a crevice between a piece of loose rock and the main roof. The explosion was propagated through the entries to the east and west of the hoisting shaft, up the hoisting shaft, and throughout the tipple by coal dust.

CONCLUSIONS OF THE WEST VIRGINIA DEPARTMENT OF MINES

Investigators of the West Virginia Department of Mines concurred with investigators of the United States Bureau of Mines as to the cause of this explosion.

LESSONS TO BE LEARNED FROM THE CONDITIONS AS THEY RELATE TO THE EXPLOSION

1. The outstanding lesson to be learned from this explosion is that low-volatile bituminous coal dust is capable, under favorable conditions, of initiating and propagating an explosion, and that the presence of methane is not essential for the initiation or propagation of coal-dust explosions. A substandard amount of inert material in the mixed dust will not prevent propagation, even if the dust is low in volatile matter.

2. Effective dust-allaying methods, when properly carried out in face regions, along haulage roads, and in the tipple, would reduce the dustiness of hoisting operations, and would, therefore, minimize dust deposits around the shaft bottom.

3. Occasional or even frequent washing down of coal dust in the vicinity of dusty shaft bottoms is not effective unless the combustible content of subsequent dust deposits is maintained below prescribed limits by the application of rock dust.

4. While it is a recognized fact that permissible explosives are capable of igniting coal dust under certain favorable conditions, it is also known that dynamite, in any form, is much more likely to ignite coal dust because of the higher temperature, longer duration, and greater volume of the flame produced by the detonation of dynamite.

5. A well-designed ventilation system, such as the one in use at this mine, is almost certain to minimize the severity of explosions, regardless of whether they are due to methane or coal-dust. The modern design of the ventilation system at this mine, together with the fortunate collapse of the main dip overcast at the time of the explosion, prevented the afterdamp from entering the working sections in dangerous concentrations and also greatly facilitated rescue work.

6. The installation, in intake air, of a substantial stairway, which served as an escapeway and as a way of access to the mine, undoubtedly saved several lives in this explosion.

7. The application of rock dust in haulage entries and in parallel intake entries intervening between the shaft bottom and the working sections was an important factor in preventing the spread of the explosion to the working faces.

8. Practical knowledge of first aid on the part of some of the survivors, who administered first aid and contributed to the comfort of some of the injured, was undoubtedly responsible for saving several lives.

RECOMMENDATIONS

Recommendations concerning the safe operation of this mine were made in reports of previous Federal inspections, the last inspection having been made September 17-25, 1945. Recommendations in this report, therefore, are limited to conditions as they relate to this explosion.

Explosives and Blasting

1. Dynamite or other explosives, except permissible explosives or permissible blasting devices, should not be used for blasting in coal mines.

2. Each charge of explosive, fired in any coal mine, should be confined in a properly drilled borehole by means of incombustible stemming. Mine employees should not charge or fire open unconfined shots, such as crevice, adobe, mudcap, or any form of bulldozing shots.

3. Boreholes should be sufficient in number, adequate in depth, and placed properly in relation to the burden so as to minimize overcharged or undercharged shots.

4. Boreholes should be stemmed either with at least 24 inches of incombustible material, or one-half the length of the hole should be filled with incombustible stemming if the hole is less than 4 feet in depth.

5. The region in which blasting is done should be rock-dusted to the extent that the incombustible content of the mixed dust in the immediate area in which blasting is done will be at least 65 percent, unless the mine surfaces in such areas are wet.

6. Persons delegated and authorized to charge and 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.

Control of Coal Dust

1. Means should be provided to suppress the coal dust at all sources of formation in the face regions, such as the cutting and loading operations, blasting, and transportation.

2. Adequate provision should be made to prevent the dust raised by the dumping and screening processes in the tipple from entering the mine. The installation of an effective dust-collecting system or water sprays placed at strategic locations, or both, is desirable.

3. All ledges and flat surfaces of horizontal structural members in the tipple should be kept free of coal dust; or such surfaces should be kept covered with rock dust to the normal angle of repose of the dust.

4. A pipe line, equipped with outlets and suitable connections at 100-foot intervals, should extend a sufficient distance along the haulageways on each side of the hoisting shaft to enable the washing down of coal dust as frequently as may be necessary. Water sprays should be installed at appropriate intervals along the entries on each side of the shaft.

5. All areas in the mine, including the vicinity of the hoisting shaft, when not actually wet, should be rock-dusted thoroughly to within 40 feet of the working faces. Rock dust should be applied in such quantity and with such frequency as to assure an incombustible content of the mixed dust of at least 65 percent, plus 1 percent incombustible matter for each 0.1 percent methane in the air current.

6. Samples of the mixed dusts should be collected frequently at representative locations to ascertain when redusting is necessary to maintain the dust in a nonexplosive condition.

Miscellaneous

1. When a dangerous condition is reported in the fire-boss record book, every effort should be made to correct the condition immediately.

2. A "danger board" posted at the entrance to a place or along a haulageway by a fire boss should not be removed or otherwise disregarded until the dangerous condition has been corrected and the place found to be in a safe condition by a responsible mine official.

ACKNOWLEDGMENT

The writers acknowledge the courtesies extended and the help given by the officials and employees of the New River and Pocahontas Consolidated Coal Company, particularly Mr. C. L. Wilson, Safety Engineer, who gave, without reservation, all information requested in connection with this investigation.

The cooperation of Mr. G. R. Spindler, Chief of the West Virginia Department of Mines, and his staff of inspectors is also hereby gratefully acknowledged.

Respectfully submitted,

M. J. Ankeny,
Coal-Mine Inspector.

J. L. Gilley,
Coal-Mine Inspector.

John Zeleskey,
Coal-Mine Inspector.

Approved:

Alex U. Miller,
Supervising Engineer, District C.

J. J. Forbes, Chief,
Coal-Mine Inspection Division.

D. Harrington, Chief,
Health and Safety Branch.

APPENDIX B

DETAIL OF EVIDENCE - See reference numbers on map.

1. Recess in right rib; 12 detonators; end of blasting cable.
2. Nine sticks of dynamite.
3. Twelve detonators.
4. Broken rock from shot.
5. Two broken electric light bulbs. Derail switch.
6. Eight-ton explosion-tested cable-reel locomotive. Trolley "dogged" down. Controller off. Return hook under switch bridle. "Hot" nip on bottom 15 feet from end of locomotive.
7. One broken electric light bulb.
8. End of empty trip. Cars 18 and 17 off track. Twenty-two empties and sand car in trip.
9. Eight-ton explosion-tested cable-reel locomotive. Trolley "dogged" down. Brake partially set.
10. Body of timberman who traveled from face of new dip heading, and was overcome by afterdamp.
11. Trolley wire down.
12. Timbers showing evidence of flame.
13. Small fire.
14. Small fire.
15. Top of overcast blown out; small crack in left side.
16. Stopping bulged in about four inches.
17. Recess in rib - five sticks of permissible explosive.
18. End of trolley wire.
19. Stopping bulged and cracked.
20. Trolley and feeder lines down from this point to shaft.
21. Stopping slightly damaged.
22. End of trip of cars. Endgate resting on sides of car in reverse position. [redacted].
23. I-beam dislodged, moved 30 feet toward shaft. 20# rail in vertical position bent toward shaft.
24. I-beam dislodged 4 feet east. Stopping intact. Steel door from shaft curtain wall.
25. First two I-beams bent slightly inby. Trolley wire dislodged inby.
26. Weigh house, ends blown inby.
27. Ten loads on left track. Last car inby wrecked. Left rail looking inby turned out under this car.
28. Loads and locomotive. Covers off locomotive. Blown inby twenty feet. Controller dislodged inby. Timber dislodged inby. First car off track; second car front end off track.
29. Fourteen loads on track. Trolley guard broken half way along trip.
30. Overcast blown out. Cutting machine at overcast. One car with locomotive trucks; inby end off. One car junk, off both ends (force inby). Trolley and feeder line down.
31. Two loads off, right side. Door, 2nd car raised, car three-fourths empty. One car on opposite track. One portable pump. Trolley and light wire down.
32. Twenty-ton Westinghouse tramming locomotive. Motorman's leg and arm were broken. Front end of locomotive caved in against contactors. Force inby. Covers blown inby. Pole broken, cable blown inby. Controller in neutral. Reverse lever gone.

APPENDIX B - (Continued)

33. Six-ton Jeffrey cable-reel locomotive. Trolley wire down.
34. Motor barn. Locomotive moved about five feet inby. One car moved inby about six feet (Belcher & Miller). One compressor. One six-ton Jeffrey locomotive.
35. Body of cager.
36. Body of weighman.
37. Body of pusher motorman.
38. Door blown out.
39. Top of overcast damaged.
40. Small fire.
41. Body of mine foreman.
42. Body of assistant superintendent.
43. Body of cager's helper.
44. Body of trackman.
45. Body of brakeman.
46. Body of car coupler.
47. Body of shot firer.
48. Body of rock man.
49. Top of overcast damaged.

APPENDIX C

CORONER'S VERDICT

STATE OF WEST VIRGINIA)
: TO-WIT
COUNTY OF McDOWELL)

An inquisition taken at Welch, West Virginia, in the County of McDowell, on the 18th day of February, 1946, before J. A. Bennett, County Coroner of the said County of McDowell.

The Jury sworn to inquire when, how, and by what means the said Albert Amburn and fourteen other persons came to their deaths, upon their oaths do say:

We, the Jury, find that the explosion at Havaco No. 9 Mine, of the New River and Pocahontas Consolidated Coal Company, at Havaco, McDowell County, West Virginia, on the 15th day of January, 1946, was caused by the ignition of coal dust as a result of an unconfined shot in an over-hanging brow of loose rock, and that the explosion occurred in what is known as the kick-back or empty branch, and that Albert Amburn and fourteen other persons came to their deaths as a result thereof.

IN TESTIMONY WHEREOF, the said J. A. Bennett, County Coroner, and the Jurors have hereunto set their hands, this 18th day of February, 1946.

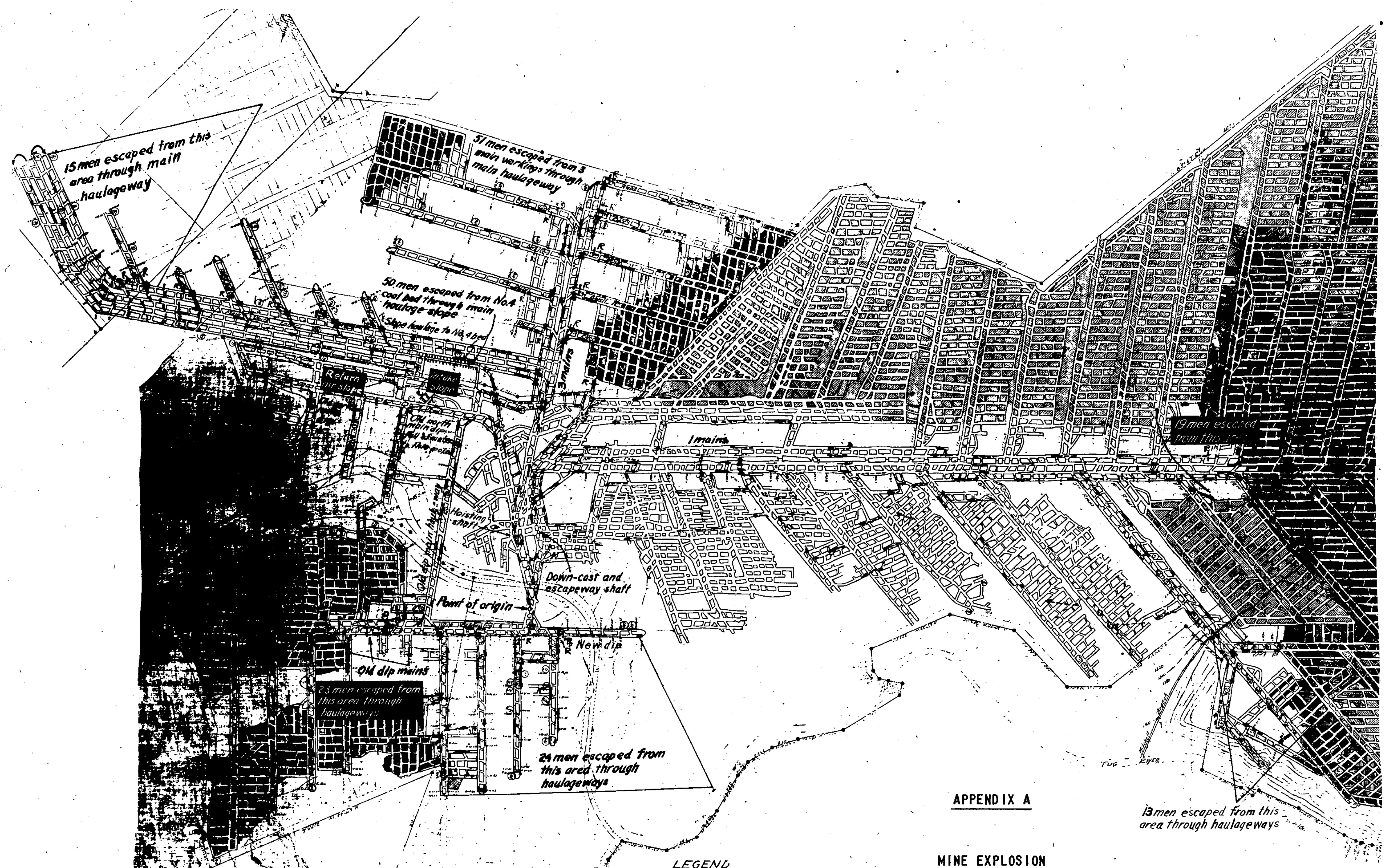
/s/ J. A. Bennett
County Coroner, of McDowell
County West Virginia

/s/ C. Robt. Angove
/s/ R. O. Dove
/s/ W. R. Keyser
/s/ James Willis
/s/ J. A. Tyson
/s/ Garnett Flippin

APPENDIX D

List of Men Killed (or Died) Mine Explosion No. 9 Havaco, New River and Pocahontas Consolidated Coal Company January 15, 1946

Name	Age	Killed or Died	Occupation	Number of dependents
John L. Smith	62	Killed	Coal inspector	Widow
Ernest Bell	38	Killed	Driller	Widow and 2 children
Albert Amburn	34	Killed	Brattice helper	Widow and 2 children
Walter Bell	37	Killed	Cager helper	Widow
Earl Frank Belcher	35	Killed	Mine foreman	Widow and 4 children
Cleveland Hale	56	Killed	Bottom motorman	Widow and 9 children
Luther Tolley	34	Killed	Driller	Widow and 4 children
M. Lawrence Carper	33	Died 1/16/46	Union checkweighman	Widow and 2 children
Clarence Hale	24	Died 1/16/46	Cager	Widow
Pete J. Morgan	50	Killed	Brakeman	Widow and 2 children
William Cooper	33	Died 1/16/46	Main-line motorman	Widow and 4 children
Ira James Alderson	18	Killed	Check puller	Single
Albert Miller	51	Killed	Assistant superintendent	Widow and 4 children
James G. Gibson	54	Killed	Weigh boss	Widow and 3 children
Luther Talent	42	Killed	Car-dropper	Widow and 3 children
				39 children 14 widows 53



APPENDIX A

LEGEND

- → Intake air currents
- - - → Return air currents
- Slope between coal beds
- D Ventilation door
- X Overcast
- R Regulator

MINE EXPLOSION
HAVACO NO. 9 MINE
NEW RIVER AND POCAHONTAS CONSOLIDATED
COAL COMPANY
HAVACO, McDOWELL COUNTY, WEST VIRGINIA
JANUARY 15, 1946

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