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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

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FINAL REPORT OF MAJOR MINE EXPLOSION DISASTER
NO. 1 MINE
PHILLIPS AND WEST COAL COMPANY
(NEAR) ROBBINS, SCOTT COUNTY, TENNESSEE

March 23, 1959

By

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INTRODUCTION

An explosion occurred in the No. 1 mine, Phillips and West Coal Company, formerly the No. 1 mine, Phillips Coal Company, 9 miles southeast of Robbins, Scott County, Tennessee, about 7:30 a.m. (CST), Monday, March 23, 1959, and killed 9 men instantly. These nine were the only men in the mine and all died from burns and gases from the explosion.

The names of the victims, their ages, marital status, occupations, and the number of their dependents are listed in Appendix B of this report.

Bureau of Mines investigators believe that the explosion originated in the haulageway entry when an explosive mixture of methane and air was ignited by an electric arc or spark from the trolley wheel of the locomotive, or from the lighting of matches or cigarettes in the same vicinity. Forces of the explosion started from the vicinity of the

locomotive, proceeded on the haulageway inby towards the face and outby towards the portal. The forces also spread into the abandoned rooms on the right and left and were dissipated in these rooms.

GENERAL INFORMATION

The No. 1 mine, Phillips and West Coal Company, formerly the Phillips Coal Company, is off the Brimstone road, 9 miles southeast of Robbins, Scott County, Tennessee. Coal was transported from the mine in autotrucks.

The names and addresses of the co-operators on March 23, 1959, were as follows:

Oscar West	Oneida, Tennessee
W. O. West	Oneida, Tennessee
Hubert D. Phillips	Route No. 1, Helenwood, Tennessee
Burl Phillips	Route No. 1, Helenwood, Tennessee

A total of 10 men was employed, 9 of whom worked underground on one shift and produced an average of 50 tons of coal a day. Production in 1958, as given by the management, was 9,478 tons. Access to the mine is by 3 drifts in the Glen Mary coal bed, which averaged 32 inches in thickness in the area being mined. The drifts dipped slightly to the east for the first 500 feet, and the grade on the remaining 2,750 feet of the main entry was irregular.

The immediate roof is medium-firm shale. The main roof is laminated shale and sandstone beddings. Kettlebottoms, slips, and slickenside formations are prevalent in the immediate roof. Cover over the coal bed was inclined from the outcrop to various thicknesses and averaged approximately 250 feet over the area being worked in this mine. The floor is either sandstone or shale.

The analysis of a coal sample taken by the Bureau of Mines from the Glen Mary coal bed at a nearby mine was as follows:

	<u>Percent</u>
Moisture	2.1
Volatile Matter	36.9
Fixed Carbon	57.4
Ash	3.6
	<hr/>
	100.0

Numerous tests by the Bureau of Mines have shown that coal dust having a volatile ratio of 0.12 is explosive and that the explosibility increases with an increase in the volatile ratio. The volatile ratio of the coal in this mine, as determined from the aforementioned analysis, is 0.39, indicating that the dust from this coal is explosive.

There is no record of an explosion nor an ignition having occurred in this mine prior to March 23, 1959; however, gas ignitions occurred in the No. 2 mine, Terry Coal Company, during February 1956, January 31, 1958, and October 17, 1958; open-flame (carbide) lamps ignited the gas, and the flame burned out immediately in each of the ignitions without causing personal injury or property damage. The No. 2 mine, Terry Coal Company is in the Glen Mary coal bed and is in the nearby vicinity of the No. 1 mine, Phillips and West Coal Company.

The last Federal inspection of this mine prior to the disaster was made May 2, 1958.

MINING METHODS, CONDITIONS, AND EQUIPMENT

Mining Methods: The mine was developed by a room-and-pillar method. Main entries, 10 to 12 feet wide, on 35-foot centers, were driven in sets of 2 or 3. From 30 to 48 inches of the roof was brushed along the haulageway to obtain the necessary height. Rooms, turned right and left off the main entry, 24 to 30 feet wide, on 35-foot centers, were driven to depths of 280 to 418 feet. Crosscuts in the rooms were made at various intervals, ranging from 35 to 100 feet apart. The coal was loaded by hand onto shaker conveyors, which discharged into mine cars, then hauled to the surface in steel drop-bottom mine cars.

Minimum standards for roof support were adopted and followed. Permanent timbering required posts to be set on 4-foot centers. Safety posts were required on not more than 4-foot centers, and set close to the working faces. The roof in the working places and along the active roadways and travelways was supported adequately at the close of the May 1958 Federal inspection.

Explosives: Explosives and detonators, delivered to the mine daily, were carried into the mine in suitable containers and were kept in wooden boxes stored in an entry crosscut. Explosives and detonators

were carried from the wooden storage-boxes to the face in cardboard containers. Permissible explosives and electric detonators were used, and an electric cap lamp battery, with the cover removed, was used for firing the shots. Shots were fired onshift by the workmen.

Ventilation and Gases: Ventilation was induced by a 5-foot disk-type fan driven electrically. The fan was usually started shortly before the men entered the mine each morning, and stopped when the shift was over in the afternoon. It was not operated from Friday afternoon until Monday, except when work was being done on week ends. The fan was installed in a concrete-block structure, was offset more than 15 feet, and was provided with pressure-relief and air-lock doors. The fan was unattended and was not provided with a device to give alarm when the fan slows or stops. At the time of the May 1958 Federal inspection the fan was exhausting 24,700 cubic feet of air a minute, and more than 6,000 cubic feet of air a minute was passing through the last open crosscut of the working entry. The main entry had been driven about 100 feet beyond the last open crosscut, and crosscuts in the rooms were more than 60 feet apart at numerous places. Permanent stoppings were of combustible construction. Brattice cloth was generally used in several crosscuts until permanent stoppings were erected. Ventilation was by a continuous system. The air was drawn into the mine through the main haulageway and through the abandoned workings on the right of the main entry. A drop-curtain was used across the main entry outby the conveyor to direct the air into the active workings on the right side, and into the return air course on the left. Means were not provided to direct the ventilation through the worked out rooms on the left, except some of the air passed through the last open crosscut of the first room inby the fanway. The mine was classed nongassy by the Tennessee Division of Mines. Preshift, on shift, and weekly examinations for gas and other hazards were not made. Flame safety lamps were not available at the mine. The mine foreman's safety lamp was left at home on the day of the explosion. Analysis of an air sample collected at the face of No. 14 room off the main haulageway May 21, 1957, contained 0.05 percent methane. A Jeffrey Aerodyne midget blower fan with a 12-inch diameter outlet, which the operator stated had been taken into the mine on Thursday, March 19, 1959, was in the right conveyor room.

Dust: The mine in general was dry; however, water was present on the floor in small areas at some locations along the main haulageway

and in the return airway, and at the face of the main entry. The active room workings and the worked-out rooms on the left and right were dry and dusty. Loose coal and coal dust accumulations were present at various locations in both the active and worked-out rooms, and along the sidetrack of the main entry. Float-dust was present on the roof, ribs, timbers, and bottom, throughout the area affected by the explosion. Applications of rock dust were not observed at any point covered by the investigation. During the May 1958 Federal inspection the mine was reported as wet throughout.

Transportation: The coal was transported to the surface from the shaker conveyor loading-head in steel drop-bottom mine cars hauled by a locomotive.

Electricity: Electric power, as 110 and 220 volts alternating current, and 275 volts direct current, was used on the surface, and 275 volts direct current was used underground. The two 35-L Jeffrey undercutting machines, properly fused, were of permissible-type, but were not maintained in a permissible manner. The two hand-held electric drills and the blower-fan were nonpermissible; the drills and the blower-fan were connected to the machine cables by Miller-plugs. Only one rail of the main line track was bonded and crossbonds were not used except at the switches. A lightning arrester was provided in the trolley wire circuit leading underground. The cutting machines and the hand-held electric drills were frame grounded, but the pumps, spotter-hoist, conveyor motors, blower fan, and the switchboxes were not grounded. Operating controls were not provided for the spotter-hoist, conveyor motors, and one of the pumps. Insulating protection was not provided at the controls of the pumps, hoist, blower fan, and conveyor drives. Communication facilities were not provided between the surface and the underground working section, which is more than 1,500 feet from the mine portal. The trailing cables were of flame resistant material; the trailing cables to the hand-held electric drills were not provided with short-circuit protection, and numerous splices were not properly insulated.

Illumination and Smoking: All persons used permissible electric cap lamps underground. Smoking was permitted and practiced in the mine.

Mine Rescue: A mine-rescue team was not maintained at the mine, nor in this vicinity. A mine-rescue team, paid by the State and trained regularly by Bureau of Mines personnel, was available. A 7-1/2-pound carbon dioxide fire-extinguisher, and two powder-type fire-extinguishers near the shaker-conveyor loading-head (in cans which were damp) were the only fire-fighting equipment discovered. The mine map was not up-to-date. Two escapeways were available from the mine; however, direction signs were not posted to indicate the escapeway. A check-in and check-out system was in force, but a written record was not kept of the men in the mine.

STORY OF EXPLOSION AND RECOVERY OPERATIONS

Participating Organizations: Recovery work was started promptly by miners from nearby mines. Audie Acres, mine foreman, Kline Coal Company, and George Lewis, general manager, and Jack King, electrician, Laddie Coal & Mining Company, directed operations until the arrival underground of Bureau of Mines personnel led by Eric H. Brown, subdistrict supervisor.

Activities of Bureau of Mines Personnel: L. E. Gazay, superintendent, Scott Coal Company, notified the Jellico office of the Bureau of Mines of the explosion about 40 minutes after it happened, or at 9:10 a.m. (EST). Eric H. Brown, subdistrict supervisor, immediately dispatched the Bureau rescue truck with equipment to the mine and left soon after with other Bureau of Mines personnel. Electrical Inspector C. E. Estep arrived at the mine in the truck at 11:10 a.m. (EST). Eric H. Brown and Inspectors Stephen J. Bukovitz, Joseph Neal, and Dee Zimmermann arrived at 11:15 a.m. (EST). One body had been removed from the mine, and after obtaining information, Brown, Bukovitz, and Zimmermann entered the mine equipped with all-service gas masks to assist with the recovery. Neal assisted with work on the surface and Estep took charge of the equipment. As the inspectors came close to the explosion area, three bodies were on the way to the surface, 2 bodies had been located, so they continued to the face area and helped locate the last 3 bodies, which were brought out of the mine at 2:30 p.m. (CST). Dean Stewart, State mine inspector, arrived at the mine about 11:30 a.m. (CST) and entered later with James Sisson, assistant chief inspector, Tennessee Division of Mines.

Mine Conditions Immediately Prior to Explosion: The weather on March 23, 1959 was fair. The temperature at Knoxville, Tennessee, about 40 air-miles from the mine, ranged from a low of 33 to a high of 69 degrees Fahrenheit. Records of barometric pressure taken by the U. S. Weather Bureau at Knoxville were as follows:

<u>Sunday, March 22, 1959</u>		<u>Monday, March 23, 1959</u>	
<u>Time</u>	<u>Barometric Pressure</u>	<u>Time</u>	<u>Barometric Pressure</u>
8 a.m. (EST)	29.090	8 a.m. (EST)	29.210

It is believed that the slight change in atmospheric pressure in the 24 hours prior to the explosion was not a contributing factor.

Evidence of Activities and Story of Explosion: W. O. West, one of the mine operators, stated that on March 23, 1959, the mine fan was started at 6:40 a.m. (CST) and that the underground crew of nine men followed the usual daily practice of starting the shift at 7:00 a.m., and each man getting his own timbers and other needed supplies and loading them into mine cars before walking into the mine. Prior to this, no one had entered the mine that morning, so a preshift examination was not made. Mr. West estimated the time to be about 7:10 a.m. (CST), when the men started into the mine. The motorman, after oiling his locomotive, entered the mine with a trip of 6 mine cars a few minutes later. It was general practice for the mine foreman to ride into the mine, but it could not be determined definitely if he walked or rode on March 23, 1959. At 7:30 a.m. (CST) Mr. West, on the surface, heard a noise and seeing dust coming from the mine portal thought at first it was caused by a roof fall or a "windy" shot, but when he looked into the mine portal he realized an explosion had occurred. He shut the electric power off the mine, but left the fan running before telephoning the Laddie Coal & Mining Company for help. Jack King, electrician, Laddie Coal & Mining Company, and other persons proceeded to the mine. It was suggested that Mr. West shut down the fan, which he did, but not being sure that this was the right action under the circumstances, he told L. E. Gazay to call the Bureau of Mines at Jellico and ask them what should be done about the fan. When Eric H. Brown advised that the fan should be kept running, it was immediately started again. It is estimated that the fan was idle about

30 minutes. Mr. West drove to where he could see the fan from a distance to make sure it was operating; however, he failed to see that the explosion doors were open and these were not closed until the arrival of George Lewis, a few minutes later.

The noise of the explosion was heard also by 2 children who lived near the fan. They ran a short distance to the top of a hill from where they could see the fan. They stated it looked like sand and dust were coming through the explosion doors.

Examination of the mine after the disaster revealed that none of the face equipment was being operated, or that any of the nips had been connected to the power source. The discharge valve of the pump near the brushed face of the haulage entry was closed, so it could not have been operating at the time of the explosion.

The location of the four bodies in the right conveyor room showed that the men had not reached the face and that no work had been done. The room had penetrated into a faulted or "pinched" zone in the coal bed. The cutter bar had been "sumped in" at two places, but was forced to stop when the body of the machine encountered low roof; on the third attempt, a continuous "cut" of undetermined depth was completed to the left rib. After the partial "cut" had been completed, it had been drilled and fired by one or perhaps two shots, and 2 or 3 cars of coal had been loaded by quitting time on Friday, March 20, 1959.

State inspectors stated that they removed part of a cigarette from the flat part of the conveyor near the face and a burned match nearby.

Two men had stopped inby the mouth of the active conveyor room where a new loading point was being prepared on the left. There was no evidence that any work had been done by these men.

The inby end of the pushed cars was 210 feet from the brushed face of the haulageway entry, or about 94 feet from the conveyor loading head. One body was found 12 feet inby the cars face down in the middle of the track and headed towards the face. It appeared as if he were running from the source of ignition, at or near the locomotive, and that he was shielding his face with his arms.

The motorman's body was found face down 8 feet outby the locomotive on the right side of the track. His posture indicated he was shielding his face. The position of the controller on the locomotive was off, the reverse-lever was in the direction of travel toward the face of the entry, the light switch was on and the brake wheel wound tight. The trolley pole was just off the wire. An oil can was found 36 feet outby the locomotive. The mine foreman's body was 137 feet outby the locomotive on the left side of the track, and he was apparently shielding his face.

Timbers, a glass jar of water, and 2 lunch kits were still in the mine cars. The mine foreman also operated the conveyor loading head, so it was obvious that he had not reached his place of work. Cigarettes and a box of burned matches were lying on the left side of the track outby the locomotive.

Property damage caused by the explosion was negligible.

Recovery Operations: Jack King and 4 miners entered the mine after the fan had been started, and reached the end of the side track about 8:15 a.m. (CST); however, the smoke was too bad so they returned to the surface. In the meantime, Audie Acres had sent his truck to the Lassie mine of the Laddie Coal & Mining Company, about 3 miles distant, to obtain some brattice cloth, as none was available at the mine.

When the brattice cloth was received, Acres, King, and others proceeded underground. They closed a manhole in the first permanent stopping and the open crosscuts on the entry with brattice cloth as they advanced. Five bodies were recovered in the entry, and a curtain was installed across the entry outby the mouth of the active conveyor room and a line curtain was extended towards the face of the room. The rescue workers had reached the first of 4 bodies in the conveyor room when the Bureau personnel arrived and located the last 3 bodies.

INVESTIGATION OF CAUSE OF EXPLOSION

Investigation Committee: Concurrent, but separate, formal investigations of the explosion were started on March 24, 1959, by representatives of the Tennessee Division of Mines and by the United States Bureau of Mines. The United States Bureau of Mines' investigation, concluded on March 31, 1959, consisted of a careful examination

of visible evidence, sampling and analysis of the mine atmosphere and residual dust at various places underground, a study of the mine ventilating system, and interviews with several persons who participated in recovery operations, a co-partner, the mortician who prepared the bodies for burial, and the firm's accountant.

The separate investigating committees were comprised as follows:

Tennessee Division of Mines

J. R. Miller	Chief Inspector
James Sisson	Assistant Chief Inspector
John Gouger	District Mine Inspector
Burgess Turner	District Mine Inspector
Dean Stewart	District Mine Inspector

United States Bureau of Mines

James Westfield	Assistant Director--Health and Safety
Milton C. McCall	Supervisor, District D
William R. Park	Supervisor, District C
Eric H. Brown	Subdistrict Supervisor
Harry A. Schrecengost	Technical Assistant
Fornie A. Jordan	Coal Mine Inspector
Stephen J. Bukovitz	Coal Mine Inspector

Other representatives of the Bureau of Mines who participated in various phases of the investigation were Federal Inspectors Ira Amburgey, Brooks Blackwood, H. D. Couk, Charles E. Estep, John D. Martin, Joseph Neal, Jack Reese, and Dee Zimmermann. Zimmermann prepared all maps and sketches in this report.

Methane as a Factor in the Explosion: The mine was classed nongassy by the Tennessee Division of Mines. Eleven Federal inspections have been made of the mine, but the most methane in any sample taken was 0.05 percent. It is known, however, that methane has been found and ignited in nearby mines being operated in the Glen Mary coal bed. Mine record books were not kept, flame safety lamps were not available at the mine, and preshift examinations were not made. Three flame safety lamps were at the operator's home, but had no fuel, and apparently had not been

used for some time. Available information and evidence observed indicated further that the on-shift examinations, made without the benefit of a flame safety lamp, consisted primarily of routine observations made during normal day-to-day work performance by a certified person who served in the dual capacity of mine foreman and loader at the conveyor loading head.

Air measurements made during the investigation, after curtains of brattice cloth had been installed in 9 of the last crosscuts between the intake and return airways, showed that 13,000 cubic feet of air a minute was entering the main portal, but that the main fan was exhausting 23,000 cubic feet a minute. About 10,000 cubic feet of air a minute was entering through inaccessible openings. About 9,400 cubic feet of air a minute, or 41 percent of the total air volume, was delivered to within 600 feet of the face of the main entry, 4,600 cubic feet a minute to within 400 feet of the face, but beyond this point the air current was not sufficient to turn an anemometer.

Permanent stoppings of concrete blocks had been erected to conduct the air along the main entry to the twelfth crosscut outby the entry face. Eight of the intervening 11 crosscuts were, reportedly, closed with cloth curtains and the last 3 crosscuts were open prior to the explosion. However, it could not be determined, during the investigation, which of these eight crosscuts had been closed. A head-board remained in place in one of these crosscuts, and brattice cloth was wedged, by a post, among some large rocks in another of the crosscuts.

A 32- by 32-inch opening had been left in the center of one of the concrete block stoppings about 550 feet from the face of the main entry (see Appendix E). A careful examination of this stopping revealed that it had not been equipped with a door nor a doorframe, and nail holes could not be found in the concrete blocks. Moreover, brattice cloth, which could have been supported across this opening by braces, could not be found in the area.

Methane in the amount of approximately 0.2 percent persisted in the general air of the explosion area during the investigation. The analytical report on an air sample, bottle No. V-2725, collected at 12:30 p.m. (5 hours after the explosion), March 23, 1959, about 150 feet from the face, 24 inches from the roof, and 6 feet from the ribs in the main entry, showed the air at that point contained 0.90 percent carbon dioxide, 19.46 percent oxygen, 0.23 percent methane, 0.34 percent carbon monoxide, and 79.07 percent nitrogen.

As part of the investigation, and to determine definitely that methane was accumulating in quantity, it was decided with the consent of the mine operator to shut down the mine fan on Friday evening, March 27, 1959, and let it remain idle until Monday morning, March 30, 1959, when the Federal inspectors would enter to sample the mine atmosphere. It was realized fully that conditions would not be exactly as on the previous week end, nevertheless, they would be comparable. The fan was shut down at 4:55 p.m. (CST) on March 27, 1959, and started again at 9:05 a.m. (CST), on March 30, 1959. Federal inspectors entered the mine at 9:15 a.m. (CST) and walked directly to the explosion area. Two inspectors entered the return airway and proceeded to check for methane. Two inspectors sampled the air at the face of the entry and examined the faces of the abandoned rooms on the left. Two inspectors entered the conveyor room on the right and went towards the face where an explosive mixture of methane and air was found 30 feet from the face. The results of analyses of the air samples are given in Table 1.

Undoubtedly, the disaster resulted from ignition of methane. The ignition occurred in the main entry when an arc was produced by the removal of a locomotive trolley wheel from the trolley wire, or perhaps as the result of smoking in the same vicinity. Gas, accumulated in the right hand rooms, had probably been drawn by the action of the exhausting main fan toward the leaky brattice cloth curtains, or, perhaps, through open crosscuts, to the vicinity of the locomotive and into the left parallel entry and into some of the left hand rooms.

Flame: Evidence of heat and flame, in the form of coke and soot, extended from the face of the right parallel entry outward for a distance of 400 feet, from the face of the main entry for a distance of 800 feet, from the face of the left parallel entry into an entry going towards the fan, a distance of 200 feet, and to near the faces of the right and left hand rooms. The bodies of the victims, four of which were found in the inby right room and five found along the main entry, were burned badly.

Evidence of explosives having been discharged by forces or flame was not found, although 12 cartridges of permissible explosives in a wooden box and 17 detonators in a similar box were found in a crosscut about 100 feet inby the point where the explosion originated. Another cartridge of permissible explosives and 6 detonators were found in a cardboard container about 50 feet from the face of the inby right hand room. The probable extent of flame is shown in Appendix E.

Forces: Evidence of slow-burning gas, in the form of soot streamers, was found in the vicinity of the locomotive on the haulage entry. Forces radiated from this point in 4 directions. Brattice cloth and other debris was blown into the left entry through the crosscut at the locomotive. This force spread inby and outby in the left entry from this crosscut. A cover from the locomotive was carried outby 121 feet from the locomotive. Another locomotive cover was blown into a crosscut to the right entry at the locomotive. An oil can from the locomotive was found 36 feet outby the locomotive. An electric cap lamp, with a leather strap from a miner's safety hat attached to the lamp cord, was blown inward to a room-neck inby all of the bodies. Forces entered the right entry through a crosscut at the locomotive and traveled inby and outby from this crosscut.

Coke on timbers and places swept on the floor in the abandoned rooms on the right show that forces entered these rooms from the entry and proceeded toward the faces. The direction of forces into the active conveyor place was shown by coke deposits on the outby sides of cap-pieces over the jacks holding the conveyor loading head, and more clearly defined in a crosscut between the active room and the outby abandoned room. Canvas had been blown around the base of a post in this crosscut, and coke had been deposited on the canvas on the outby side. That part of the post not covered by the canvas was covered by dust and some coke, while the base of the post protected by the canvas was clean. A small heap of dust and coke was deposited in a pocket formed by the canvas on the inby side of the post. Forces entered the rooms on the left side from the left entry. Some conflict of forces was evident in these rooms and was probably due to the numerous crosscuts and the width of the rooms. Coke was deposited on the right rib of the haulage entry opposite the crosscuts to the left entry, because the explosion originating in the haulageway passed the crosscuts before forces from the left entry reached them. This difference was due to the lengths of paths traveled by the explosion.

The direction and extent of the forces are shown on Appendix E.

Probable Point of Origin: Because of the forces radiating from the vicinity of the locomotive and the positions of bodies on the haulageway, it is the consensus of Bureau of Mines investigators that the explosion originated at the locomotive.

Factors Preventing Spread of Explosion: The concussion wave forced the explosion doors open at the main fan and projected soot and other fine debris to the surface through the main and the fan drifts. A more widespread explosion was prevented by an adequate area for expansion, probable complete combustion of the methane, wet areas, large falls of rock which absorbed the major forces in the return airway, and the preponderance of exposed rock surfaces along the main haulageway.

Summary of Evidence: Evidence observed in the mine during recovery of the bodies of those killed and during the investigation together with information furnished by a co-partner and gathered from the reports on 11 previous Federal inspections provide knowledge upon which the investigators' conclusions are based. The evidence and information are summarized as follows:

1. The mine was considered to be nongassy.
2. The general practice of stopping the main fan at the end of each shift was followed on Friday preceding the explosion and the fan remained idle until 6:40 a.m. (CST), Monday, just 50 minutes prior to the explosion.
3. Preshift, on-shift, and weekly examinations, including tests for gas and oxygen deficiency, were not made.
4. Tests with an M-6 Methane Tester and analysis of an air sample disclosed that about 0.2 percent methane persisted throughout the explosion area during the underground investigation. Tests with permissible flame safety lamps and analyses of air samples collected after a 63-hour test period of fan stoppage showed that methane had accumulated in explosive proportions in the last right hand room and in lesser amounts in adjoining rooms.
5. The last right hand room and accessible adjoining outby rooms had penetrated into a faulted or "pinched" zone in the coal bed, which the investigators believe to be the principal area of gas liberation.

6. Attempts had been made to undercut the face of the last right hand room presumably on Friday, March 20, 1959, 3 days prior to the explosion. The cutting bar had been "sumped in" at least at 2 places, but was forced to stop when the body of the machine encountered low roof; on the third attempt, a continuous cut of undetermined depth had been completed to the left rib. After completing the partial cut, one or perhaps 2 shots were fired and about 2 cars of coal were loaded before the workmen went to the surface at quitting time.

7. Records of air measurements and other mine records were not made.

8. Entries were developed excessive distances (up to 400 feet or more) beyond the last permanent stoppings, and temporary stoppings, if used, were poorly constructed without frames or other supports.

9. A blower fan without tubing and installed in a manner that would permit recirculation of air was situated on the intake side of a line brattice 30 feet inby the last open crosscut in the inby right hand room.

10. The coal is highly volatile, the mine surfaces were dry except at a few locations, and rock dust was not observed in any part of the mine during the investigation.

11. Matches, cigarettes, and smoking tobacco and cigarette papers found at several places showed that smoking underground was common practice.

12. Seven of the workmen entered the mine afoot about 7:10 a.m. and apparently had arrived at points near where their bodies were found at 7:30 a.m., the time of the explosion.

13. The motorman lubricated the locomotive on the surface, and probably accompanied by the mine foreman riding on top of the locomotive, pushed 6 empty mine cars into the mine about 7:20 a.m. The locomotive and the trip of cars had stopped just outby the loading point at or about the time of the explosion.

14. The positions of the 4 terminals or "nips" of cables that supplied power to electrical equipment in the explosion area and the deposition of dust, soot, and coke particles indicated that all of the "nips" were disconnected at the time of the explosion.

15. Forces originated at and radiated from the vicinity of the locomotive.

16. The trolley pole of the locomotive was off the trolley wire and, although soot and dust were deposited heavily in the surrounding area, the spots where the rims of the trolley wheel contacted the roof and the tops of the wheel rims were clean, thus indicating that the trolley wheel contacted the roof before soot and dust were deposited.

17. Two boxes of matches were found in the cab of the locomotive, and a closed box of burned matches and 5 unsmoked cigarettes were found on the floor 6 feet outby and to the right of the locomotive. Other smoker's articles were found at places indicated on Appendix E.

18. A representative of the State Division of Mines stated that he found a burned match and a half-smoked cigarette, one end of which was wet, near one of the bodies in the last right hand room. He stated further that this matchstick and the partially consumed cigarette were taken from the mine and placed in the finder's automobile.

19. Heavy coatings of coke (up to 1-1/2 inches in thickness) were plastered on the inby sides of nearly all the posts in the left hand rooms, against the right rib of the main entry, and on the outby sides of posts in the right hand rooms, particularly in the last room on the right side. These deposits showed that coal dust in the left rooms entered into the explosion and marked the direction of travel of the major explosion forces.

Cause of Explosion: The Federal investigators concur in the opinion that the explosion was caused by the ignition of methane that had been drawn by the main fan to the vicinity of the locomotive. The source of ignition was an arc produced when the trolley wheel was removed from the trolley wire, or smoking in the same vicinity. Coal dust aided in propagating the explosion.

RECOMMENDATIONS

The following recommendations are made to prevent similar disasters:

1. The mine should be classed as gassy and operated as such.

2. The main fan should be provided with an automatic device to give alarm when the fan slows down or stops. This device should be placed so that it will be seen or heard by a responsible person.

3. The main fan should be provided with a pressure-recording gage.

4. When a main fan has been stopped, with all men out of the mine, and started again, the mine should be examined for gas and other hazards and made safe before men, other than the examiners, are permitted in the mine. This examination should be completed before underground electric circuits are energized.

5. Not less than two permissible flame safety lamps in proper working condition should be kept at the mine for the use of authorized persons.

6. Preshift examinations for methane and other hazards should be made within 3 hours preceding the beginning of a coal-producing shift and before any men are permitted to enter the mine. The examinations should include all the active workings and the abandoned areas which are ventilated with air used to ventilate the active workings.

7. The on-shift examinations should include tests with a permissible flame safety lamp for methane, and oxygen deficiency. Such tests should be made before electrically-driven equipment is taken into or operated in the face regions, and frequent examinations for methane should be made during such operations.

8. Tests for methane with a permissible flame safety lamp or a permissible methane detector should be made at least once each week, by the mine foreman or other competent persons designated by him, in the return and in abandoned workings and entrances thereto; he should also make examinations for other dangerous conditions.

9. Records should be made of preshift, on shift and weekly examinations. These records should be kept at the mine and should be open for inspection by interested persons.

10. The volume and velocity of the air current at the working faces should be sufficient to readily dilute so as to render harmless, and to carry away, flammable or harmful gases.

11. The quantity of air reaching the last open crosscut in any pair or set of entries should not be less than 6,000 cubic feet a minute.

12. Crosscuts, between intakes and return air courses, should be closed with incombustible stoppings except the one nearest the face.

13. Crosscuts between entries and between rooms should be at intervals not exceeding 60 feet, in accordance with Tennessee State Law.

14. When line curtain is used it should be fastened securely at the top and bottom so as to conduct a sufficient quantity of air to the working faces.

15. A continuous current of air should be coursed through abandoned worked-out areas, sufficient to remove flammable or harmful gases.

16. The blower fan should be removed from the mine.

17. The practice of smoking underground should be prohibited and the carrying of smoking materials, matches, or other flame-making devices into the mine should not be permitted.

18. The mine should be thoroughly rock dusted in dry areas in the haulageway, the parallel entries connected to the haulageway by open crosscuts, and to within 40 feet of all faces, including the last open crosscuts. Rock dust should likewise be applied in the return airway, preferably to the main fan, but at least for a distance not less than 1,000 feet outby the active workings.

19. The rock dust should be applied and maintained in such quantity that the incombustible content of the combined rock dust, coal dust, and other dusts will be not less than 65 percent, plus 1 percent of rock dust for each 0.1 percent methane present in the ventilating current.

The following additional recommendations are made to minimize the possibilities of having gas and dust explosions in this mine:

1. At least once each week, a properly certified or competent person should measure the volume of air entering the main intakes and leaving the main returns, and the volume passing through the last open crosscut in each active entry. A record of such measurements should be kept in a book on the surface, and the record should be open for inspection by interested persons.
2. The ventilation should be arranged so that the passage of trips or persons along entries will not cause interruptions of the air current.
3. Abandoned workings should be posted to warn unauthorized persons against entering the territory.
4. Explosives and detonators kept near the working faces should be in separate closed containers, and should be in a location out of line of blast not less than 50 feet from the face and 15 feet from any pipeline, powerline, rail or conveyor; except that if kept in niches in the rib, the distance from pipeline, powerline, rail or conveyor should be at least 5 feet. Such explosives and detonators, when stored, should be separated by a distance of at least 5 feet.
5. Permissible shot-firing units should be used for firing explosives.
6. Examinations for gas should be made immediately before and after firing each shot or group of multiple shots.
7. The permissible-type undercutting machines should be restored to and maintained in permissible condition.
8. Splices in trailing cables should be well insulated, and a program should be established to require that trailing cables containing a fixed number of temporary splices will be removed from the equipment and service until such splices have been vulcanized.

9. Both rails of the main haulage track should be bonded or welded at every joint and crossbonds should be installed at intervals not greater than 200 feet.

10. The cables of the electric drills should be provided with overload protective devices.

11. The trolley wire circuit should be equipped with a disconnecting switch at intervals of not more than 2,000 feet underground.

12. All electrical equipment should be frame-grounded.

13. The mine should be provided with suitable fire-fighting equipment, adequate for the size of the mine.

14. An accurate map of the mine should be prepared and be brought up-to-date at least annually.

15. Direction signs should be posted conspicuously at all points of intersections with other passageways to indicate manways and designated escapeways.

16. The check-in and check-out system should include keeping a written record of all persons in the mine.

ACKNOWLEDGMENT

The undersigned investigators gratefully acknowledge the courtesies extended and the information furnished willingly by W. O. West, a co-partner; Charles V. West, mortician; Clifton Sexton, accountant; representatives of the Tennessee Division of Mines, United States Bureau of Mines and others.

The authors extend commendation to all of those who participated in the initial recovery, and special commendation is extended to Audie Acres, Jack King, and George C. Lewis, who first entered the mine and who performed the tedious and arduous work of recovering the bodies,

which was accomplished with forethought relative to safety and with little disturbance of evidence.

Respectfully submitted,

/s/ Milton C. McCall

Milton C. McCall
District Supervisor, District D

/s/ Eric H. Brown

Eric H. Brown
Subdistrict Supervisor

/s/ Harry A. Schrecengost

Harry A. Schrecengost
Technical Assistant

/s/ Fornie A. Jordan

Fornie A. Jordan
Federal Coal-Mine Inspector

Approved by:

/s/ James Westfield

James Westfield
Assistant Director--Health and Safety

/s/ Marling J. Ankeny

Marling J. Ankeny
Director

Sheet No. 1

TABLE 1 ANALYSES OF AIR SAMPLES

COLLECTED: March 23-30, 1959

MINE No. 1 COMPANY Phillips and West Coal Company COLLECTED BY: Blackwood, Bukovitz, Neal,
Reese, and Zimmermann

Bottle No.	Laboratory No.	Location in Mine	Percent in Volume					Cubic Feet Air Per Minute	Cubic Feet Methane in 24 hours
			Carbon Dioxide	Oxygen	Methane	Carbon Monoxide	Nitrogen		
V-2725	338474	Taken in Explosion Area, Main entry, inby con- veyor discharge point, 3/23/59, 12:30 p.m. (On day of explosion)	0.90	19.46	0.23	0.34	79.07		
Q-3825	338834	Working place, at brushed face of Main entry 3/24/59, 11:00 a.m. (Day after explosion)	0.11	20.88	0.00		79.01		
R-4932	338838	Working place, right side conveyor room off Main entry	0.34	19.29	3.83		76.54		

TABLE 1 ANALYSES OF AIR SAMPLES

COLLECTED: March 23-30, 1959

MINE No. 1 COMPANY Phillips and West Coal Company

Blackwood, Bukovitz, Neal,
Reese, and Zimmerman

Bottle No.	Laboratory No.	Location in Mine	Percent in Volume				Cubic Feet Air Per Minute	Cubic Feet Methane in 24 hours
			Carbon Dioxide	Oxygen	Methane	Carbon Monoxide		
S-27	338839	Working place, Main head- ing at end of brushed top	0.40	20.32	0.04		79.24	
S-53	338840	Abandoned room, right side, No. 3 room outby conveyor room	0.22	20.43	0.71		78.64	
S-59	338841	Abandoned room, right side, No. 2 room outby conveyor room	0.22	20.05	2.20		77.53	
Q-4938	338835	Main return inby fan	0.06	20.87	0.00		79.07	23,800
Q-4944	338836	Main return inby fan	0.12	20.81	0.03		79.04	(Natural Ventila- tion 3,000)
R-4929	338837	Working place, right side conveyor room (4 inches from roof)	0.29	18.79	5.94		74.98	

LAB. NOS. G-26897 to G-26922

Sheet No. 1

TABLE 2 ANALYSES OF DUST SAMPLESCOLLECTED March 1959John D. Martin, Ira Amburgey,
Brooks Blackwood,MINE No. 1 COMPANY Phillips and West Coal CompanyCOLLECTED BY: S. J. Bukovitz, C. E. Estep

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE SPECIAL SURVEY AFTER EXPLOSION	Alcohol Coke Test Amount of Particles	As Received Percent Incombustible
24		Main and Air Course Entries in Explosion Area. First sample collected 200 feet outby brushed top on main entry, then		
	A-1 Roof & Rib	2 + 00	Small	26.3
	A-1 Floor	2 + 00	Small	13.9
	A-2 Roof & Rib	4 + 00	Small	23.4
	A-2 Floor	4 + 00	Small	17.1
	A-3 Roof & Rib	6 + 00	Trace	17.5
	A-3 Floor	6 + 00	None	15.9
	A-4 Roof & Rib	8 + 00 Caved - No sample collected		
	A-4 Floor	8 + 00 do.		
	A-5 Roof & Rib	10 + 00 No signs of coke or dust - sample not collected		
	A-5 Floor	do.		

LAB. NOS. G-26897 to G-26922

Sheet No. 2

TABLE 2 ANALYSES OF DUST SAMPLES

COLLECTED March 1959

MINE No. 1 COMPANY Phillips and West Coal Company

John D. Martin, Ira Amburgey,
Brooks Blackwood,
COLLECTED BY: S. J. Bukovitz, C. E. Estep

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE SPECIAL SURVEY AFTER EXPLOSION	Alcohol Coke Test Amount of Particles	As Received Percent Incombustible
B-1	Roof & Rib		Very large	20.8
B-1	Floor		Very large	15.9
B-2	Roof & Rib		Very large	36.0
B-2	Floor		Small	31.1
B-3	Roof & Rib		Small	28.1
B-3	Floor		Small	28.7
B-4	Roof & Rib		Small	37.9
B-4	Floor		Small	43.8
B-5	Roof & Rib	Very little coke or dust - Sample collected	Trace	49.4
B-5	Floor	do. do.	Trace	36.9

LAB. NOS. G-26897 to G-26922

Sheet No. 3

TABLE 2 ANALYSES OF DUST SAMPLES

COLLECTED March 1959

MINE No. 1 COMPANY Phillips and West Coal Company

COLLECTED BY: John D. Martin, Ira Amburgey,
Brooks Blackwood,
S. J. Bukovitz, C. E. Estep

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE SPECIAL SURVEY AFTER EXPLOSION	Alcohol Coke Test Amount of Particles	As Received Percent Incombustible
C-1	Roof & Rib		Small	15.8
C-1	Floor		Very large	14.4
26	C-2	Roof & Rib	Trace	31.3
	C-2	Floor	None	24.8
	C-3	Roof & Rib	None	42.9
	C-3	Floor	None	16.0
	C-4	Roof & Rib	Trace	18.9
	C-4	Floor	None	20.4
	C-5	Caved out by fan entry - No sample collected		
	C-5	do.	do.	

LAB. NOS. G-26897 to G-26922

Sheet No. 4

TABLE 2 ANALYSES OF DUST SAMPLES

COLLECTED March 1959

MINE No. 1 COMPANY Phillips and West Coal Company

COLLECTED BY: S. J. Bukovitz, C. E. Estep

John D. Martin, Ira Amburgey,
Brooks Blackwood,

S. J. Bukovitz, C. E. Estep

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE SPECIAL SURVEY AFTER EXPLOSION	Alcohol Coke Test Amount of Particles	As Received Percent Incombustible
1	Spot	Inby end of concrete air duct at fan	None	48.5
2	Band	Main fan blades, bearing support and fan ring	None	33.0

APPENDIX A

COPY OF CORONER'S VERDICT

STATE OF TENNESSEE, SCOTT COUNTY

An inquisition held at HUNTSVILLE, in the county and State aforesaid on the 28 day of March 1959, before NORMAN C. ACRES, Coroner of said County, upon the body of OSCAR WEST and, lying dead, by the jurors whose names are hereto subscribed, who upon oath do say that the dead body is that of OSCAR WEST who lived at and prior to his death, at ONEIDA in the State of TENNESSEE; that he was about 45 years of age, a WHITE MARRIED man; they find that he had been Fatally injured due to an accidental gas explosion at the Phillips and West Coal Co. mine at Robbins, Tennessee in the Brimstone community.

The evidence disclosed that Gas had accumulated due to the mine being down. There has been no evidence submitted to indicate any foul play. said Not Applicable was arrested and Not Applicable

The jury therefore, find that the deceased came to his death at the hands of the said Not Applicable who perpetrated the homicide while laying in wait and is therefore guilty of murder in the first degree.

In testimony whereof the said jurors have hereunto set their hands the day and date above.

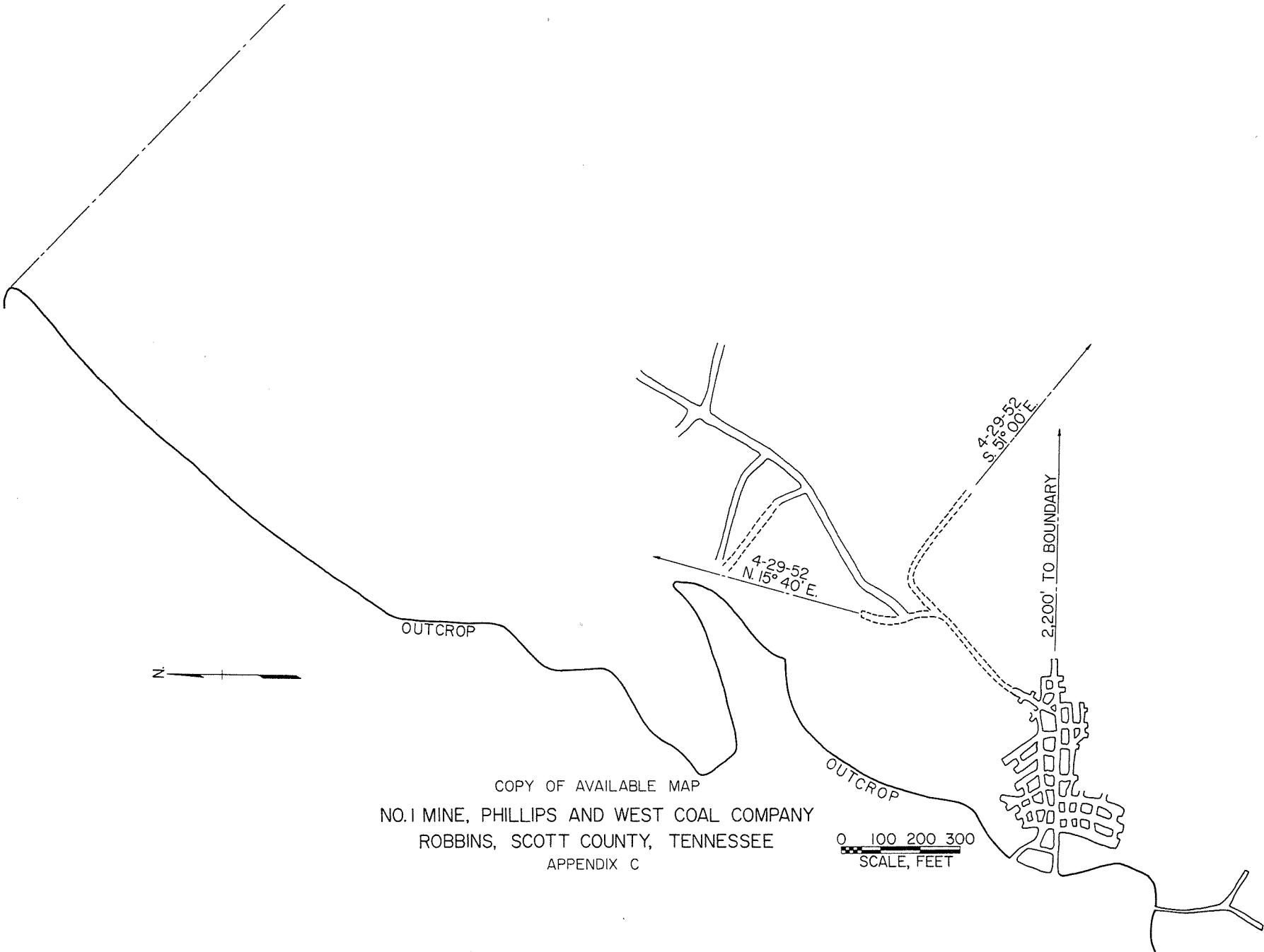
/s/ Norman C. Acres
Coroner

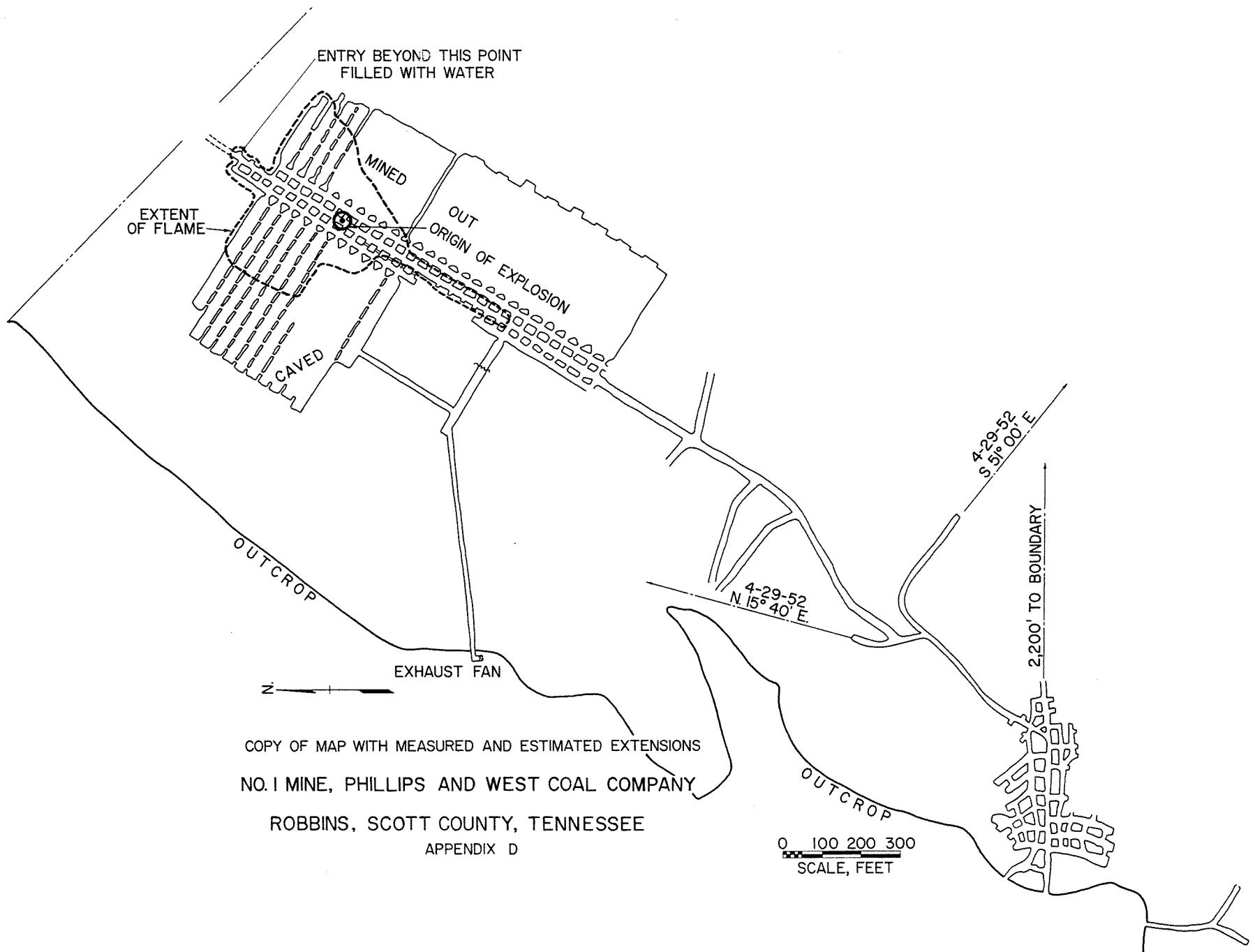
/s/ Eugene McDonald
/s/ Clendon Blakley
/s/ Walford Jeffers
/s/ Vernon Jeffers
/s/ R. G. Yancey
/s/ M. H. Phillips
/s/ Boyd Reed
/s/ Elmer Sexton
/s/ Clyde Phillips
/s/ Maynard Adkins
/s/ Bedford Hatfield
/s/ Kelly Newport

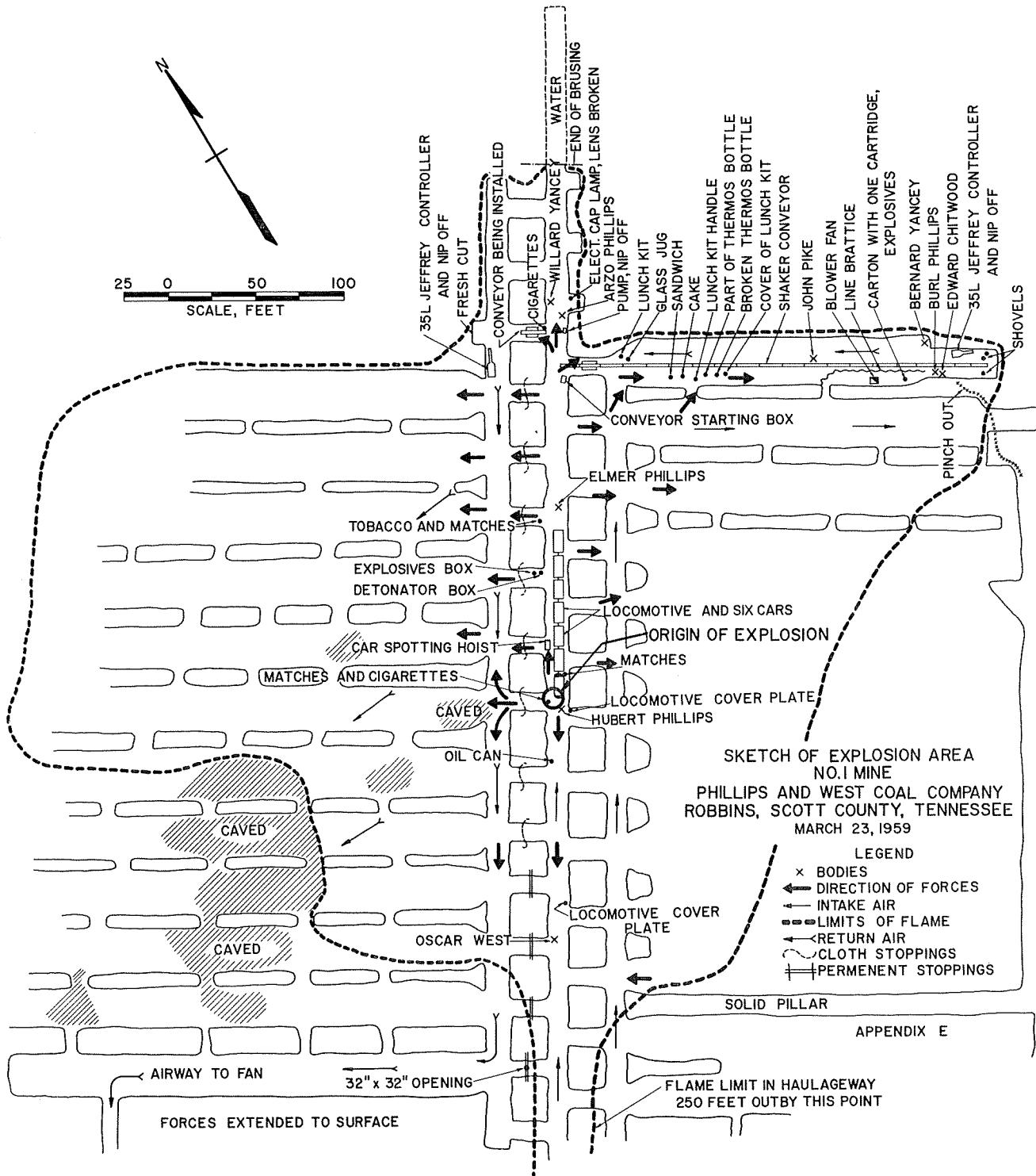
NOTE: An identical report was submitted on each victim.

APPENDIX B
 VICTIMS OF EXPLOSION, NO. 1 MINE
 PHILLIPS AND WEST COAL COMPANY
 March 23, 1959

<u>Names of Persons Killed</u>	<u>Age</u>	<u>Number of Dependents</u>	<u>Occupation</u>	<u>Exp. This Occupation</u>	<u>Total Experience in Mines</u>
Oscar West	45	3	Mine foreman - Loading head opr.	10 yrs.	20 yrs.
Hubert D. Phillips	29	5	Motorman - Electrician	1 yr.	15 yrs.
Burl Phillips	53	1	Cutter - loader	7 yrs.	35 yrs.
Elmer Phillips	38	6	Loader	6 mos.	10 yrs.
Arzo Phillips	17	0	Loader	1 yr.	1 yr.
Edward Chitwood	44	8	Loader and General work	4 days	15 yrs.
John L. Pike	40	3	Loader	1 yr.	8 yrs.
Lemuel W. Yancey	36	5	Loader	1 yr.	15 yrs.
Bernard Yancey	34	4	Cutter-loader	1 yr.	15 yrs.







APPENDIX F

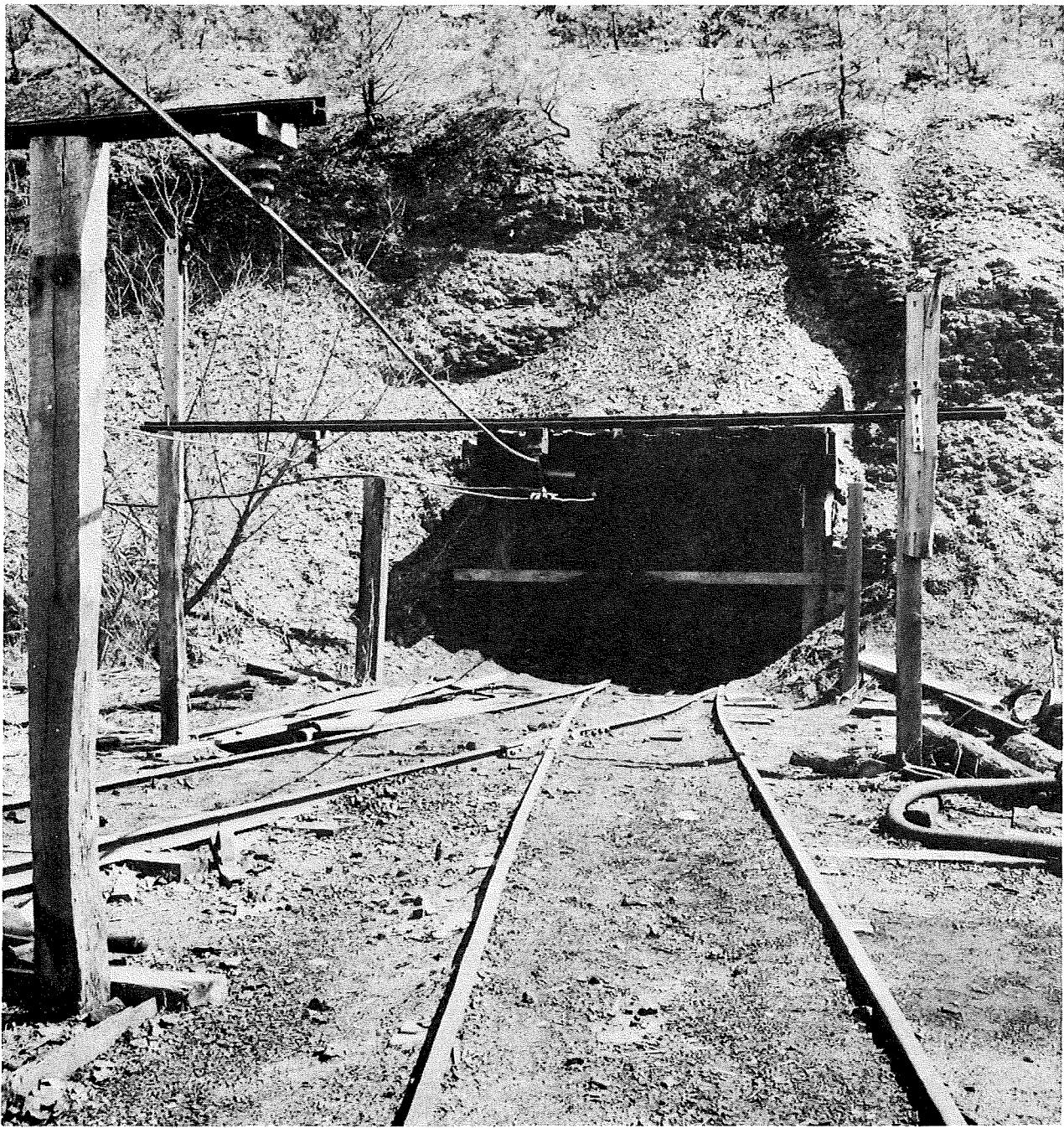


FIGURE 1. - Mine Portal.

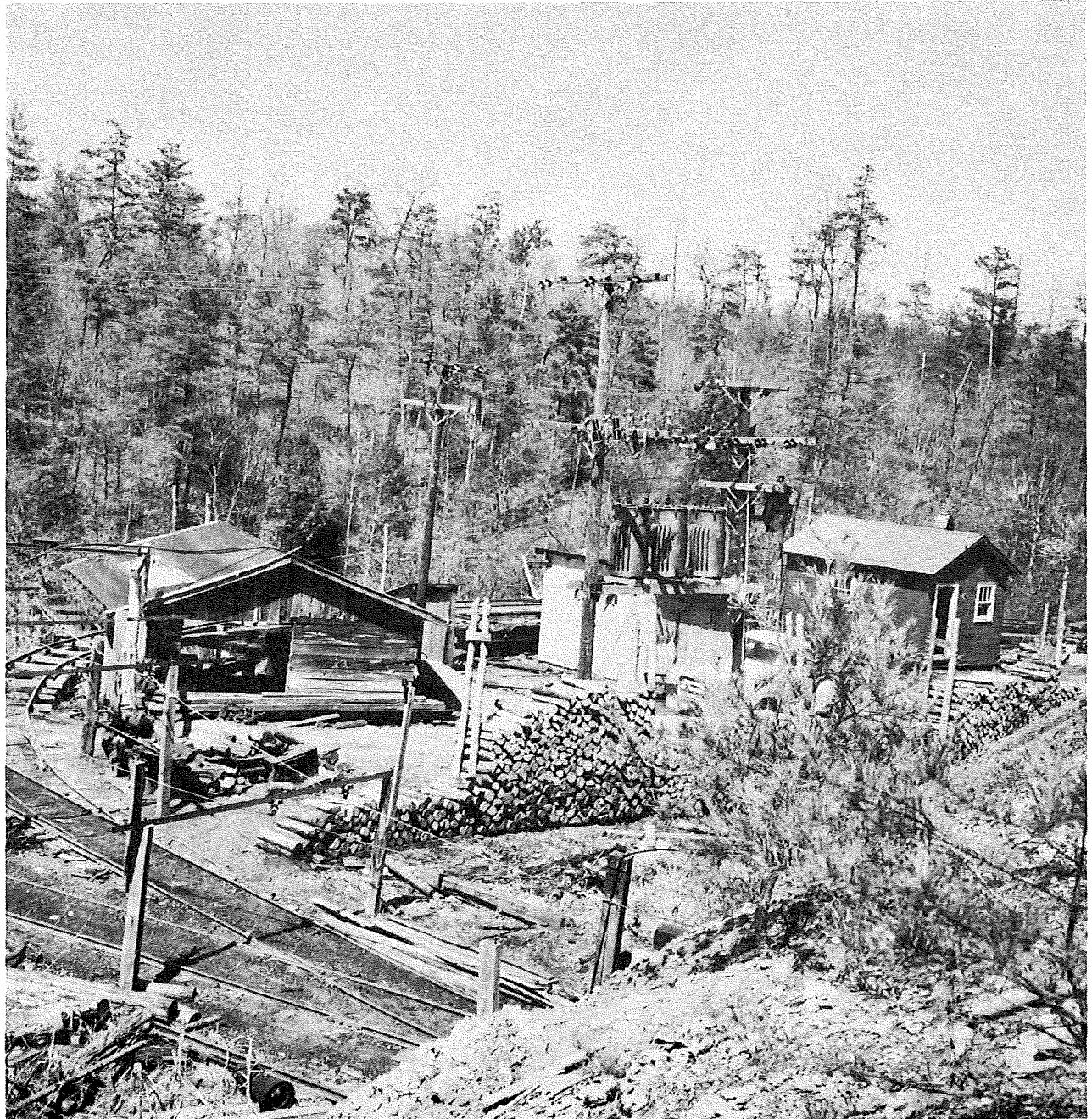


FIGURE 2. - Surface Plant.

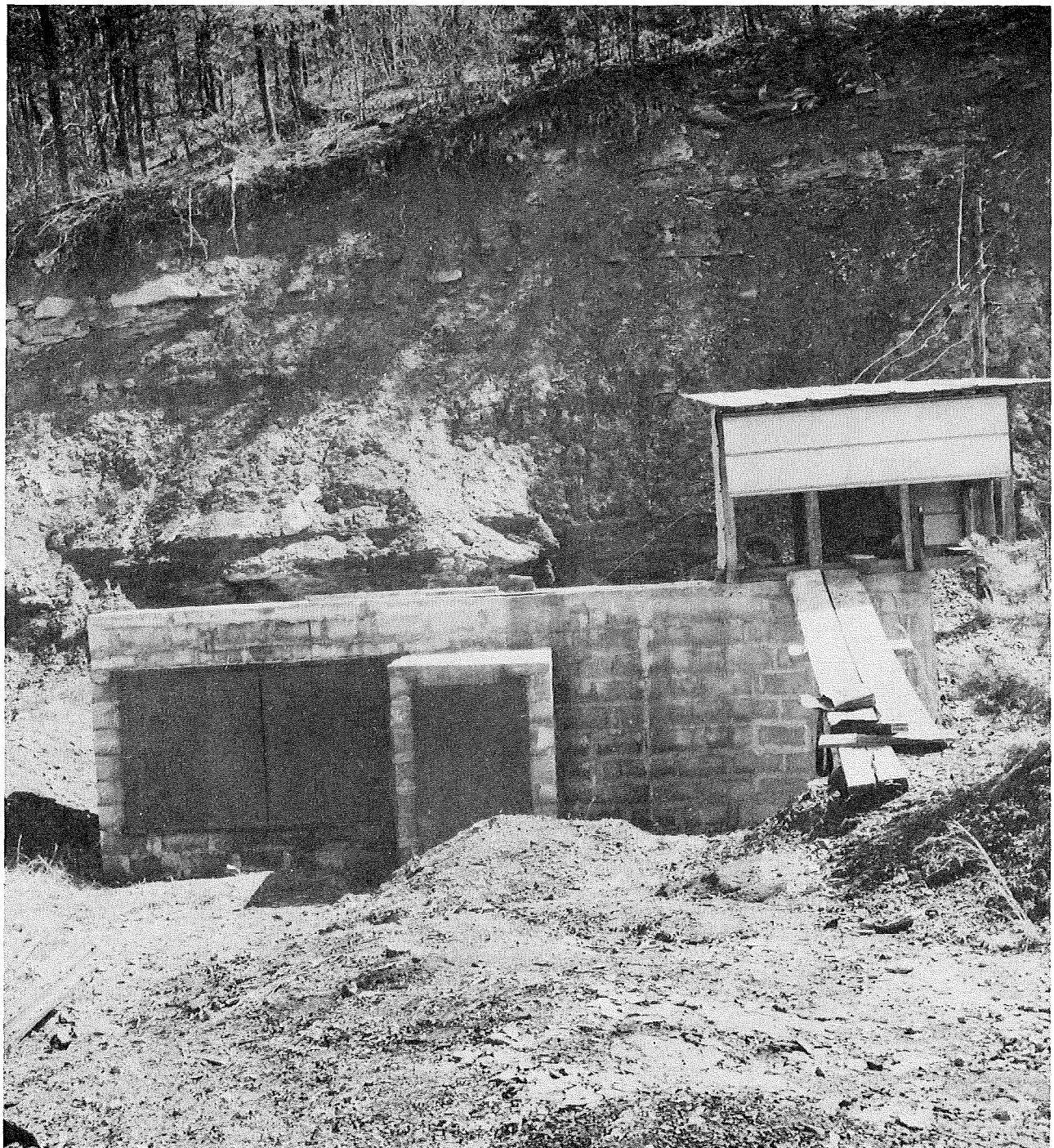


FIGURE 3. - Fan and Fan Duct Showing Explosion and Man Doors.



FIGURE 4. - End View of Fan.