COAL FATAL

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

District C

FINAL REPORT OF MAJOR MINE-EXPLOSION DISASTER
NO. 2-A MINE
C. L. KLINE COAL COMPANY
(NEAR) ROBBINS, SCOTT COUNTY, TENNESSEE

May 24, 1965

By

Eric H. Brown
Acting Subdistrict Manager

Carl F. Kahre
Supervising Inspector

Ralph B. Jones
Federal Coal Mine Inspector (Roof Control)

Jack E. Tisdale
Federal Coal Mine Inspector

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INTRODUCTION

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

A gas and coal-dust explosion occurred in the No. 2-A mine of the C. L. Kline Coal Company, Robbins, Scott County, Tennessee, sometime between 1:30 p.m. and 3:45 p.m., Monday, May 24, 1965. All 5 men underground were killed by the explosion and all died from burns and/or forces.

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

Bureau of Mines investigators believe that an explosive mixture of methane and air was ignited by a cigarette lighter at the face of the left air course which was driven 300 feet inby the last open crosscut. The explosion propagated therefrom by coal dust to other areas of the mine. Forces extended to the surface, but were dissipated by expansion in abandoned worked out rooms.

GENERAL INFORMATION

The No. 2-A mine is along the Huntsville Branch Road, 1/2-mile east of the Brimstone road junction, 5 miles southeast of Robbins, Scott County, Tennessee. The coal is transported 1/2-mile by autotrucks to a preparation plant on the Brimstone railroad near the road junction. The mine was

originally opened as No. 2 mine in 1959, temporarily abandoned on May 10, 1960, and reopened as No. 2-A by a new haulageway May 30, 1960. Mr. C. L. Kline, Robbins, Tennessee, is the owner and mine foreman.

During the last Federal inspection 12 men were employed underground on 2 shifts a day and an average of 65 tons of coal was being produced daily. Production in 1964 was 18,572 tons of coal. At the time of the explosion, 5 men, excluding the foreman, were working underground and 3 men reported for work on the second shift.

The mine is opened by 2 drifts in the Glenmary coalbed, which averages 36 inches in thickness in the area mined. The original haulageway was closed by caves and surface wash. The haulageway was virtually level with minor undulations throughout; however, when water accumulated sufficiently it flowed towards the carloading station near the active workings. The immediate roof was smooth shale that appeared solid in the working places, but had a tendency to disintegrate when exposed. The main roof contains sandstone beds. The floor was hard shale. Cover over the coalbed varied from 10 to 20 feet in thickness at the hillside portals to about 250 feet over the active face regions.

The analysis of a coal sample from the Glenmary bed in this mine is as follows:

Moisture	2.8
Volatile Matter	35.9
Fixed Carbon	54.0
Ash	7.3
	100.0

Numerous tests by the Bureau of Mines have shown that coal dust with a volatile ratio of 0.12 is explosive. The volatile ratio of the coal from the aforementioned analysis is 0.40, indicating this coal dust is explosive. The last Federal inspection was completed February 9, 1965.

MINING METHODS, CONDITIONS, AND EQUIPMENT

Mining Methods

A room-and-pillar method of mining was followed. Entries in pairs, 11 feet wide, were on 60-foot centers. The main entries had been driven a distance of 1,900 feet from the surface and stopped. The active left entries were started off the main entries at a 30-degree angle about 1,300 feet from the main portal and driven 1,400 feet. The left air course entry was extended an additional 300 feet beyond the last open crosscut. The ends of the stopped main entries had been connected to the left entries by a diagonal entry. A few places had been worked to the right off the

main entries. Rooms, starting near the portal, had been worked to the left off the main and left entries. (See Appendix B) Rooms in the active section were 30 feet wide on 40-foot centers and driven to a maximum depth of 300 feet. The normal practice is to work rooms in a group of 6. After No. 6 room has been completed the carloading station and chain conveyor equipment are moved forward for the next set-up. Entry crosscuts were on 60- and 80-foot centers. Room crosscuts generally were 60 feet apart, but some room faces were more than 60 feet ahead of the last room crosscut. Room pillars were 10 feet or less in thickness and were not extracted. The coal was undercut by shortwall mining machines, and holes for blasting were drilled with hand-held electric drills. The coal was loaded by hand onto shaker conveyors which discharged onto a chain conveyor system that conveyed the coal to a common carloading station. The active left entries are referred to as main entry and air course. (See Appendixes B and C).

Minimum standards for roof support had been adopted and a copy of the plan was posted in the car shop. Permanent timbers were set on 4-foot centers in the rooms and safety posts were kept near the working faces. Line posts, 4 feet apart along the conveyor line, were set in the entries. The main haulageway was supported by well installed timber sets where abnormal roof conditions had been encountered.

Explosives

Coal was blasted on shift with permissible explosives and electric detonators. Rubberized bags were used to carry explosives to the working faces and detonators were carried in wooden containers. Loose explosives and detonators were found lying on the mine floor near the face of No. 5 room. Normally, 3 shot holes were drilled in the faces of rooms and 2 in faces of entries. The explosives were in 1-1/8 x 6-inch cartridges. Rib and center holes were charged with 1-1/2 and 1 cartridge, respectively. Reportedly, incombustible stemming and wooden tamping bars were used. Shots were fired singly by a 6-volt dry cell battery with exposed terminals. A 2-conductor plastic insulated cable was used. The battery ends of the shooting cable were kept shorted when not in use.

Ventilation and Gases

A 4-foot disk-type fan was exhausting 9,000 cubic feet of air a minute from the mine. The fan was installed in a wooden air duct about 15 feet in length in line with the airway, and it was not attended nor provided with an alarm signal. The pulley was changed during recovery operations and the quantity of air increased to 10,800 cubic feet a minute. Later; however, it was necessary to install a second fan in the right side of the air duct to continue with recovery operations. With the second fan installed, the total air quantity was increased to 14,000 cubic feet a

minute as measured at the portal. After the recovery operations were completed, air measurements showed that very little air loss occurred between the portal and the left entries, but only 5,000 cubic feet of air a minute reached the outby end of the working section and only 4,000 cubic feet a minute was passing through the last open crosscut of the left entries. The stoppings in crosscuts between the main intake and return up to the left entries were built of concrete blocks. From there on the air current in the left entries was controlled by means of a wooden door and brattice cloth stoppings and curtains. An overcast about 400 feet inby the portal was used to divert the air to a right side airway driven several years ago after the left side airway had been blocked by caves. Line brattice was used to direct air to the working faces. (See Appendix C)

The mine was classed nongassy by the State. During the 12 Federal inspections of this mine three air samples taken at faces contained 0.03, 0.15, and 0.05 per centum methane on January 1962, January 1963, and January 1964 respectively. There was no other record of gas having been detected in the mine prior to the explosion. Preshift examinations were made by the owner who is certified as a mine foreman by the State of Tennessee. His record book was carried to and from the mine in his automobile or truck. No evidence was in the book to show that the mine was either idle or working between August 4, 1964, and January 4, 1965. All indications in the book showed the mine and fan to be "O.K." During the last two Federal mine inspections, the operator brought his examination records up to date. Weekly examinations for methane and other hazards were not made. There are no abandoned mines adjacent to the 2-A mine. There is no knowledge of gas or oil wells on the property.

Dust

The main haulageway through its entirety was generally wet. At least 24 inches of the bottom was brushed along all of the main haulageway. The air course and working places had been drained and were dry. Accumulations of coal dust and loose coal were observed in the left air course entry particularly along the 300-foot chain conveyor line, the 2 active and 9 adjoining abandoned rooms, crosscuts, and ledges near the carloading station. Rock dust had been applied to two working rooms during the previous Federal inspection at which time it was recommended that rock dust also be applied to the left air course entry. No traces of rock dust applications were apparent in accessible areas during the investigation. The incombustible content of 10 samples collected ranged from 17.6 to 26.6 percent.

Transportation

Mine cars were pulled in and out of the mine by a trolley locomotive. Side tracks were provided on the surface, near the left entry, and near

the conveyor carloading station. Regular wooden mine cars were used for transporting men. Coal was conveyed from the face by shaker and chain conveyors.

Electricity

Electric power was received at the mine at 2,300 volts alternating current. It was reduced to 220 volts for the 3-phase 7.5 horsepower fan motor, the shop equipment, and the 75 kilowatt motor-generator unit in the surface substation, which produced direct current at 230 volts for the locomotive and underground equipment. The mining machines and electric drills were permissible type but were not maintained in permissible condition. Motors to operate the conveyors were open-type. The 6/0 trolley wire also served as the powerline for all underground electric equipment. A lightning arrester and a cut-out switch were installed at the mine portal. Power wires at pumps and at the carloading station were supported by nails and switches were not provided. Mine rails were bonded and crossbonded. Starting boxes for the conveyors were poorly maintained. Trailing cables of drills and mining machines lacked short-circuit protection, and bare wires were exposed at a few of the temporary splices. The electric equipment was not frame-grounded. The knife blade cut-out switch for all equipment in Nos. 5 and 6 rooms was open, indicating none of the equipment was in operation at the time of the explosion. A nipping station at the end of the trolley line for power supply to the left air course equipment was destroyed by the explosion; however, the controller of the mining machine was off and the drill cable was not plugged into the machine cable. An individual remote conveyor-control switch was provided near each working face.

Telephone or other two-way communication system was not provided between the surface and underground working section.

Illumination and Smoking

Permissible electric cap lamps were used for illumination underground. Men carried matches, cigarettes, and cigarette lighters into the mine.

Mine Rescue

A state mine rescue team, recently trained, from Devonia, Tennessee, assisted with recovery operations. Fire-fighting equipment in form of fire extinguishers or rock dust was not kept at the mine. A limited amount of brattice cloth was available on the mine property. Two escapeways were available from the mine. Direction signs were not posted. A positive check-in and check-out system was not in effect and a daily record of men underground was not available at the mine.

STORY OF EXPLOSION AND RECOVERY OPERATIONS

Participating Organizations

The following organizations assisted during the recovery operations: Tennessee Division of Mines, Scott County Sheriff's Department, Tennessee State Highway Department, Scott County Rescue Squad, Highland Telephone Company, the mine rescue team of Morco Colliery, Pocahontas Fuel Company, and United States Bureau of Mines. Miners and officials from neighboring operations worked feverishly in recovery operations and deserve much credit for the untiring services they rendered until the last body was brought to the surface.

Activities of Bureau of Mines Personnel

C. F. Kahre, supervising inspector, was advised by a telephone call from James Sisson, assistant director, Tennessee Division of Mines, about 5:50 p.m., May 24, 1965, that an explosion had probably occurred in the No. 2-A mine. Kahre immediately called Eric H. Brown, acting subdistrict manager, and other Bureau personnel, including James Westfield, assistant director--health and safety, and J. S. Malesky, acting district manager. Kahre also immediately called the Sheriff's office of Scott County and confirmed that an explosion had occurred involving 5 men. Bureau of Mines personnel of the Jellico office by this time had gathered rescue equipment to proceed to the mine. E. L. Davis, driving the Bureau rescue truck, with Dee Zimmermann following arrived at the mine about 8:30 p.m. Kahre and Stephen J. Bukovitz arrived at the mine about 8:45 p.m. Zimmermann and Davis immediately on arrival checked the fan and assured that the underground mine power was disconnected. Considerable confusion was caused by the large group of persons gathered about the mine portal. About 10 minutes after his arrival, Kahre was able to contact James Sisson and Dean Stewart, of the Tennessee Division of Mines, who briefed him as to recovery operations in progress and the difficulties encountered. Ventilation was inadequate and a map of the mine was not available. About 9:00 p.m., Davis and Zimmermann made an exploratory trip underground and reported their findings.

The State Highway Patrol, Scott County Sheriff's Department, Scott County Rescue Squad and the Coroner roped off the area near the portal. The spectators were removed therefrom to make the area accessible for delivery of supplies.

Other Bureau of Mines personnel who aided in the exploratory and recovery operations arrived at the mine at various times from 9:00 p.m., May 24, to 12:10 p.m., May 25, 1965. J. S. Malesky, acting manager, District C, arrived at 12:15 a.m., May 25, Eric H. Brown, acting subdistrict manager, District C, arrived at 4:30 a.m., May 25, and James Westfield, assistant director--health and safety, arrived 12:10 p.m., May 25, 1965.

The following Bureau of Mines personnel also aided in the recovery operations: John D. Martin, Ralph B. Jones, Fred Jones, Hobart Jarvis, Jack E. Tisdale, W. R. Stewart, Brooks Blackwood, Ira Amburgey, H. D. Couk, J. A. Rejonis, and Charles E. Estep.

Mine Conditions Immediately Prior to Explosion

The weather on May 24, 1965, was fair. The temperature at Knoxville, Tennessee, about 40 air miles from the mine, ranged from a low of 56 to a high of 77 degrees Fahrenheit. Records of barometric pressure taken by U. S. Weather Bureau at Knoxville were as follows:

5:55 a.m.	May 24, 1965	30.23
8:58 a.m.	May 24, 1965	30.26
3:55 p.m.	May 24, 1965	30.15

It is believed the slight fluctuations in atmospheric pressures during the day had no bearing on the explosion.

The mine was operating normally on the day of the explosion, and the fan was running. An examination of the working places was reported to have been made before the day shift started work, and the examiner later said that dangerous conditions were not found. The examiner's record was not available at the mine during recovery operations, but on June 2, 1965, this record was available and indicated that the mine conditions on May 24, 1965, were "O.K."

Evidence of Activities and Story of Explosion

C. L. Kline, Owner and mine foreman, was in the mine the morning before the explosion, and his statements are the primary source of evidence in reconstructing the activities before the disaster.

Kline arrived at the mine about 7:00 a.m.; he checked the fan and shortly thereafter entered the mine to make a preshift examination. Kline reported he examined the faces of Nos. 5 and 6 rooms and left air course entry after which, about 8:00 a.m., he met the 5 workmen in the man trip near the left entry door. Methane or other dangerous conditions were not found during the examination.

The No. 6 room face had been stopped for several days because the coal had "pinched-out" to 22 inches, and Kline had decided to abandon this room. Kline believes that the mining in the left air course entry was stopped on Wednesday, May 19, because the shaker conveyor was "buckling." About 5 cars of loose coal remained to be loaded in No. 5 room.

At the start of the shift Russell Webb, motorman and carloading station operator, Arthur Norris and Lawrence Griffith were instructed to begin production from No. 5 room. Philip Davis and Clayton Griffith were assigned the job of delivering supplies to No. 5 room, and also to assist in loading the loose coal. Kline assisted the crew with their various duties making several trips into and out of the No. 5 room. He last visited the face of the No. 5 room about 11:30 a.m. Arthur Norris and Lawrence Griffith were cutting the place. The machine was sumped up and the cut across just started. Conditions appeared normal, and a gas test was not made. Philip Davis and Clayton Griffith were told to finish supplying No. 5 room and then start moving the equipment from No. 6 room. Kline went to the carloading station and had Webb haul him outside in a mine car attached to the locomotive. He estimated his arrival outside to be about 12:00 noon. Shorter timbers were needed for the No. 5 room so Kline helped Webb load the timbers into the mine car. Webb then immediately returned underground and Kline left the mine for lunch and to check on his other mine.

At least 1-1/2 hours was needed to finish cutting, and to drill and blast the face of No. 5 room. None of the equipment was removed from No. 6 room so that phase of the work had not been started. The half-hour lunch period was taken after Kline left; all the lunch buckets were empty.

So before the explosion at least 2 hours of time had elapsed since 11:30 a.m. because the face of No. 5 room was blasted. Probably blasting was done before lunch so that the fumes could dissipate while the men ate; however, the lunch period could have been taken at 12:00 noon. Anyway, Davis and Clayton Griffith had not accomplished other tasks besides unloading the timbers and supplying No. 5 room, unless it was to assist in preparing the coal in No. 5 room.

After the explosion, the bodies of Davis and Clayton Griffith were found at the face of the left air course entry; Lawrence Griffith and Norris were found in No. 5 and 6 rooms, respectively, and Webb was found at the loading station. (See Appendix C) It is assumed that the men in the rooms and Webb were going to load the cut of coal in No. 5 room; however, the conveyor had not yet been turned on.

The men in the left air course had apparently just reached that location because no sign of any productive work was found. The reason they went into this place is unknown; Kline thinks they may have misunderstood his instructions and were going to remove equipment, tools, or supplies from there instead of No. 6 room.

The explosion was not discovered until about 4:20 p.m. Kline returned to the mine about 3:45 p.m. followed by the 3-man second shift crew at 3:50 p.m. They waited for the day shift to come out at a location where

the portal could not be seen. About 4:15 p.m., Kline walked towards the portal and noticed a box from inside the mine lying in the track roadbed. Further investigation revealed that the explosion had occurred.

The underground mine ventilating system, such as stoppings, doors and curtains, was damaged extensively by the explosion. The conveyors were disjointed and roof supports on the haulageway were dislodged allowing the roof to fall at several locations.

Recovery Operations

Soon after the explosion was discovered, assistance was requested and rescue operations were started by the men at the mine. James Sisson and Dean Stewart of the Tennessee Division of Mines arrived shortly after being notified and took charge of recovery operations. A few workmen became ill during the early stages of recovery work. Work on restoring ventilation had to be started near the portal when the slight damage to the roof of the fan housing had been repaired.

The supplies to carry on the recovery operations had to be brought from various small mines in the area and suppliers. The equipment and material had to be carried or dragged and the low roof caused the work to be arduous and slow. Thin clear polyethylene plastic material was used to replace stoppings. Bureau personnel entered the mine at 9:00 p.m. and shared an active part in recovery operations. The task was to patch and replace stoppings. All work was done in intake air. Favorable progress was made for the first 1,000 feet when much carbon monoxide was encountered and ventilation had to be improved. Air entering the portal was increased by 1,500 cubic feet a minute by changing the pulley and speeding up the fan. The job required about 30 minutes. About 10:00 p.m. the rescue party reentered the mine. Stoppings were built and the abandoned rooms on the left side were blocked off. A stopping was built to replace the door on the main haulage road and the door in the left entry. A fresh air base was established on the haulage entry at the stopping about 2,000 feet from the portal. From this location the recovery operations were carried on under roof that varied from 28 to 40 inches in height for the next 1,300 feet to the face of the left air course entry. Exploration work was carried on by use of a self-contained oxygen breathing apparatus, Chemox and gas masks. About 4:45 a.m., May 25, the body of Russell Webb was found at the carloading station in the main haulage entry which was in return air.

Again ventilation became sluggish and the removal of noxious gases was very slow. Recovery operations were halted and all persons returned to the surface at 7:45 a.m., May 25. The ventilation was improved by the installation of an additional fan at the side of the wooden fan casing.

Both fans were operated in parallel and the air intake at the portal increased from 10,800 to 14,000 cubic feet a minute. Equipment or materials to further increase the ventilation were not available.

Crews reentered the mine about 10:30 a.m. and recovery operations resumed. About 2:00 p.m., May 25, the body of Lawrence Griffith was located in No. 5 room. Fresh air was directed into No. 5 room by use of check curtains. About 3:20 p.m., the body of Arthur Norris was located in No. 6 room. Both bodies were taken to the surface. Rescue operations were then concentrated toward the face of the left air course entry, but the high carbon monoxide content made progress extremely slow. It was decided by James Westfield of the Bureau and James Sisson of the State that a side trip down the main entry be taken to see if the other 2 bodies could possibly be near the carloading station, but they were not found there. Efforts were again directed to free the left air course of noxious gases, but progress was extremely slow. When about 100 feet of line brattice had been installed into this single entry, it was decided to explore the entry by men using Chemox who located the last 2 bodies at the face of the entry about 6:00 p.m. The body of Webb located at the carloading station was brought to the surface about 7:30 p.m. High concentrations of carbon monoxide hindered the removal of the last 2 bodies and providing sufficient air to the face was very slow and tedious as it had to be directed with brattice cloth for the last 200 feet. Plastic material had been used on the first 100 feet. The last body was brought to the surface about 3:00 a.m., May 26, 1965.

Recovery operations got a big assist from the Highland Telephone Company. By the time the first Bureau of Mines personnel arrived at the scene, this company had a surface mobile telephone unit in operation which aided in making local and long distant calls. About 3:00 a.m., May 25, telephone communication was established between the portal and the rescue crew. A battery powered phone supplied by the telephone company was installed at the portal and the other phone was carried forward by a member of the recovery party. The phone cable was extended as forward progress was made and the surface was kept advised of work being performed in the mine and the supplies, equipment, or men needed.

INVESTIGATION OF CAUSE OF EXPLOSION

Investigation Committee

A formal investigation of the explosion was made on June 1 and 2, 1965, by company officials, representatives of the Tennessee Division of Mines and by the United States Bureau of Mines. Further investigations by the United States Bureau of Mines and the Tennessee Division of Mines were continued on June 7 and 8, 1965, to obtain pertinent information.

The members of the investigating committee consisted of the following persons:

C. L. Kline Coal Company and Consultants

C. L. Kline	Operator and Mine Foreman
Ben Smith	Company mine foreman at another mine
Chester Honeycutt	Maintenance man, No. 2-A mine
Andrew West	President, W and W Coal Company, Inc.
Jack King	Former Superintendent, Laddie Coal & Mining Company

Tennessee Division of Mines and Consultants

J. R. Miller	Director
James Sisson	Assistant Director
Dean Stewart	District Inspector
J. H. Payne	District Inspector
William Davenport	District Inspector
I. W. Sampson	Superintendent, Pocahontas Fuel Company
Smith Williams	Superintendent, Tennessee Auger Co., Inc.

United States Bureau of Mines

James Westfield	Assistant Director--Health and Safety
J. S. Malesky	Acting District Manager, District C
Eric H. Brown	Acting Subdistrict Manager, District C
C. F. Kahre	Supervising Inspector
Ralph B. Jones	Federal Coal Mine Inspector (Roof Control)
Jack E. Tisdale	Federal Coal Mine Inspector

Methane and Dust as a Factor in the Explosion

The mine was classed nongassy by the Tennessee Division of Mines. Methane ranging from 0.03 to 0.15 per centum had been found in three air samples collected during 12 Federal inspections. Three gassy mines, in the Glenmary coalbed, one in which a methane explosion occurred on March 23, 1959, killing 9 men, are located in a 4-mile radius from the No. 2-A mine.

Records were not kept at the mine concerning gas testing or preshift examinations, and the owner carried the only flame safety lamp from his home each day.

The owner stated he made an examination for methane with his safety lamp in Nos. 5 and 6 rooms and the face of the left air course before 8:00 a.m. on the day of the explosion. This was the only such examination said to

be made that day, and initials and dates were not found in the active face areas. Records indicating the air quantity in circulation or examination of approaches to abandoned areas and air courses were not kept. The fan was kept running during the weekend of May 22-23.

Check curtains and line brattices were used to direct the air current near the room faces, and a line brattice was installed towards the face of the left air course. It was reported that this brattice was 25 feet from the face and evidence showed that this line brattice was in place but there was no way to determine its condition prior to the explosion because timbers supporting the line brattice were dislodged and the curtain itself was torn into shreds by the explosion. The left air course and No. 4 room were advanced 300 and 95 feet, respectively, without a crosscut. Apparently the inby eight stoppings between the main intake and return entries were constructed of brattice cloth material; there was no debris left indicating the use of other material.

Air measurements made during the investigation after all blown out stoppings were replaced with polyethylene plastic material showed 14,000 cubic feet a minute intake and 4,000 cubic feet a minute at the last open crosscut. Methane was detected during recovery operations. While locating the last two bodies a Federal inspector wearing Chemox collected an air sample about 15 feet outby the face of the left air course, and about 200 feet ahead of the line brattice which at the time was being extended by the recovery crews. The analysis of this sample No. D-1314 showed 6.5 percent of methane. However, the same sample contained also 3.4 percent hydrogen and 4.9 percent carbon monoxide; it is known from combustion tests that when methane is near or at the upper explosive limit much hydrogen and carbon monoxide are formed.

The products of this sample were referred to the Bureau Research Center at Pittsburgh for comment. The high percentage of carbon monoxide and hydrogen have been duplicated in the past by experiments with fuel-rich mixtures. The high percentages of methane and oxygen left were probably caused not by uniformly mixed pre-explosion gases but stratified with the layers near the roof higher than the upper explosion limit. Samples taken on June 7 that show stratified layers substantiate the above (see Table 1).

More air samples were taken throughout the mine during the investigation on June 2 to determine the source of the methane. Ventilation was only partially restored to the room faces at this time. To further probe the source of methane the ventilation was short-circuited at the last two crosscuts between the left entries from June 2 to 7. State and Bureau representatives entered the mine during the morning of June 7 to see the effect of the short circuited air and if there was a methane build-up.

Detectors and flame safety lamps were used. About 55 feet inby the last open crosscut in the left air course entry about 2.0 per centum methane was found. The methane content increased to more than 3 percent about 100 feet inby; air samples collected on June 7 showed 1.5 and 3.85 (see Table 1). State and Federal inspectors returned to the mine on June 8 and the gas was removed. A crack in the roof was present not far from the face area of the entry where high percentages of methane could be detected.

The coal, roof, and ribs in the face area of the left air course entry showed evidence of gas burning. The bodies of the victims in this area had 3rd degree burns.

Rock dust had not been applied in the working area. Dangerous accumulations of loose coal and coal dust were present. The amount of coke deposited, up to 1/4-inch thick on posts, and extent of the flame area indicate that the explosion was propagated by coal dust.

Flame

Coke deposits, from moderate to heavy, were found from the face of the air course entry to about 1,600 feet outby and in the rooms (see Table 2 and Appendix B). Soot deposits extended beyond this area. Heavy coke deposits up to 1/4-inch thick were on posts in Nos. 2, 3, 4, and 5 rooms outby the last open crosscut and the entry opposite these rooms. Visible coke deposits were slight in the entry opposite No. 6 room; however, soot deposits were heavy. Coke was formed at the face of the left air course entry, and the bodies therein were burned severly. Coke was not formed near the faces of the rooms. Explosives and detonators were found exposed in No. 5 room inby the last open crosscut; however, no evidence was found where explosives were detonated by the explosion.

Dust samples collected in the explosion area contained small to very large coke particles (see Table 2).

Forces

Evidence of forces radiating from the face of the left air course entry was: dislodged crossbars and chain conveyor at the carloading station in the track entry, deposits of debris on the outby rib of the last open crosscut between the entries, covers from the locomotive blown outby and the movement of the junction boxes in the left air course entry (see Appendix C).

Violence occurred throughout the working area as evidenced by the upturned chain conveyor, blown out stoppings, destruction of brattices, movement of light objects and brattice cloth. Swept places in the crosscuts to the abandoned areas show the forces dissipating in that direction.

The deposits of coke on the posts were generally thicker on the face and outby side in the rooms and crosscuts, respectively, indicating that the major forces moved through the rooms from the left air course face; however, some forces appeared to come from the rooms.

The forces reached the surface and did some damage to a portion of the fan duct roof, and material from the main haulageway was deposited on the fill about 20 feet from the drift opening.

Probable Point of Origin

Bureau of Mines and State investigators believe that the explosion originated at the face of the left air course entry.

Factors Preventing Spread of Explosion

The forces of the explosion reached the surface; however, the flame propagation was arrested primarily by pressure release while expanding into the worked out rooms. Also, wet areas along the haulage road and other wet to damp areas and rock falls in the worked out rooms probably retarded flame propagation.

Summary of Evidence

Evidence summarized below was obtained from: observations in the mine during recovery operations and investigation, discussion among members of the investigating committee, previous Federal Coal Mine inspection reports, and from the owner and workmen.

1. Methane and coal dust both were involved in the explosion.

2. The explosion occurred between 1:30 p.m. and 3:45 p.m., May 24, 1965.

3. All the victims died almost instantly.

4. The only gas test that had been made was before 8:00 a.m. on the day of the explosion. The examiner's initials and dates were not placed during this examination. The mine examination record books brought to the mine by the owner show the date and an "O.K." for that date. Flame safety lamps were not kept at the mine.

5. The fan was kept running during the weekend of May 22-23.

6. The inby eight stoppings were constructed of brattice cloth material. The left air course entry was advanced 300 feet without a crosscut and ventilated by means of a brattice cloth line curtain. Only 4,000 cubic

feet a minute of air was reaching the last open crosscut after all blown out stoppings had been replaced with polyethylene plastic material and the air quantity at the fan increased 5,000 cubic feet a minute.

7. Small percentages of methane were present throughout the active working area and 6.5 percent of methane was found near the face of the left air course entry during recovery operations. Air samples collected during the investigation on June 1 and 2 show 0.04 to 0.35 per centum methane. Air samples collected on June 7 in the face area of the left air course entry after the ventilation was short-circuited at the last two open crosscuts since June 2, 1965, showed 0.87 to 3.85 per centum methane. Methane was being liberated in that place.

8. A cigarette lighter opened as for lighting was found near the face of the left air course entry. Smoking materials were found on the body of one victim near the face of the left air course entry and on 2 others. Smoking was practiced regularly underground.

9. Blasting was not being done.

10. Electric face equipment was not being operated. The trailing cables to the equipment in Nos. 5 and 6 rooms were not energized, and the controls on the equipment at the face of the left air course were in the "off" position. The chain conveyors were not running; the controls were "off" at the carloading station. The shaker conveyors were not running, and coal was not being loaded.

11. Accumulations of loose coal and coal dust were present. Rock dust was not applied in the dry working area.

12. The coal dust is explosive.

Cause of Explosion

This explosion was caused by the ignition of a body of methane by sparks or flame from a cigarette lighter. The methane was liberated in the face area of the left air course entry and accumulated because of inadequate face ventilation.

RECOMMENDATIONS

The following recommendations are made to prevent similar disasters:

1. The mine should be considered a gassy mine and operated accordingly.

2. Smoking and the carrying of smoking materials, matches, or lighters underground should be prohibited.

3. Permissible explosives should be fired with permissible shot-firing units and examinations for gas should be made immediately before and after firing each shot.

4. The ventilating fan should have a capacity suitable for the mine.

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

6. At least 6,000 cubic feet a minute of air should always reach the last open crosscut in any pair of entries.

7. The volume of air entering the main intakes and leaving the main returns and the volume passing the last open crosscut in each active entry should be measured once a week. A record of the measurements should be kept on the surface.

8. Crosscuts should be made between entries and between rooms at intervals not exceeding 60 feet, according to State mining law. Entries should be driven in sets of two or more.

9. Room entry stoppings should be constructed of materials that will minimize air losses.

10. Air that has been used to ventilate abandoned areas that are inaccessible for inspection, or are not inspected should not be used to ventilate active underground working areas.

11. At least two permissible flame safety lamps in proper working condition should be kept available at the mine for the use by authorized persons.

12. Thorough preshift examinations should be made of the active underground area. Such examination should include a test with a permissible flame safety lamp for accumulations of methane in each active working place, active roadways, travelways, approaches to abandoned workings and accessible falls in active sections. The examiner should place his initial and date near the face of each place he examines. The preshift examination should be made within 3 hours before any coal producing shift and before any workmen enter the mine. The examiner should record the results of his examination in a book kept for that purpose on the surface at the mine.

13. Subsequent examinations should be made during each shift by certified persons as often as necessary for safety. Such examination should include a test with a permissible flame safety lamp.

14. Sufficient personnel should be trained in the use of a flame safety lamp to permit an examination for methane in any place immediately before electrically driven equipment is operated or taken into that place and frequently during such operation.

15. Weekly examinations should be made in at least one entry of the intake and return airway in its entirety, on pillar falls, in idle workings, and, insofar as conditions permit, abandoned workings. The examination should include tests with a permissible flame safety lamp. A record of these examinations and tests should be kept at the mine.

16. Coal dust and loose coal should not be permitted to accumulate in dangerous quantities in active underground workings.

17. The dry areas of the mine should be rock-dusted to within 40 feet of all faces, including all open crosscuts.

18. Where rock dust is applied it should be distributed upon the top, floor, and sides of all open places in such quantity that the incombustible content of the combined rock dust, coal dust and other dust will not be less than 65 per centum plus 1 per centum of incombustible for each 0.1 per centum of methane in the ventilating current.

19. The electric face equipment for use in this mine should be maintained in permissible condition.

The following additional recommendations, although not directly related to this mine explosion are good mining practices.

1. Explosives or detonators carried underground by persons should be in containers constructed substantially of nonconductive material and kept closed.

2. Explosives and detonators stored 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.

3. The main fan should be equipped 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. A pressure-recording gage should be provided on the fan.

4. The single door on the haulageway should be replaced with an air lock or the ventilation arranged so that doors are unnecessary.

5. Abandoned workings should be posted to warn unauthorized persons against entering the territory.

6. Underground power wires and cables, except ground wires, grounded power conductors and trailing cables, not encased in armor should be supported by well installed insulators and should not touch combustible material, roof, or ribs.

7. All electric equipment should be frame grounded.

8. Pumps should be provided with switches or other controls of safe design, construction, and installation. Trailing cables on the drills and mining machines should be provided with suitable short-circuit protection.

9. Temporary splices in trailing cables should be well-insulated.

10. Electric equipment and wiring should be inspected at least once a month and defects should be corrected.

11. Suitable fire-fighting equipment, adequate for the size of the mine, should be provided.

12. Telephone service or equivalent two-way communication facilities should be provided between the surface and the underground working section.

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

14. A check-in and check-out system that provides positive identification upon the person of every individual underground should be provided. A written record should be kept of the men in the mine.

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

ACKNOWLEDGMENT

The writers acknowledge gratefully the courtesies extended and help given by officials, employees and other representatives of the operating company and representatives of the Tennessee Division of Mines and the United States Bureau of Mines.

Respectfully submitted,

Eric H. Brown

Carl F. Kahre

Ralph B. Jones

Jack E. Tisdale

Approved by:

/s/ James Westfield

James Westfield
Assistant Director--Health and Safety

/s/ Frank C. Memmott

Frank C. Memmott
Acting Director

ANALYSES OF AIR SAMPLES

TABLE 1

MINE No. 2-A COMPANY C. L. Kline Coal Company COLLECTED BY: H. D. Couk, Dee Zimmermann, R. B. Jones, Jack E. Tisdale, John D. Martin, E. L. Davis

DATE	TIME	LOCATION IN MINE	BOTTLE NO.	Percent in Volume					
				CARBON DIOXIDE	OXYGEN	HYDROGEN	CARBON MONOXIDE	METHANE	NITROGEN
5/24/65	11:05 p.m.	Return at fan	F-1489	0.36	20.07	-	0.29	0.18	79.10
5/25/65	3:10 a.m.	Return at fan	E-8606	0.60	19.84	0.19	0.41	0.15	78.81
5/25/65	3:35 a.m.	Return at fan	F-97	0.53	19.86	0.18	0.34	0.11	78.98
5/25/65	1:30 p.m.	Return at fan	F-96	0.23	20.61	-	0.11	0.05	79.00
5/25/65	3:30 p.m.	Near face No. 6 room	F-1500	0.63	20.08	0.12	0.39	0.15	78.63
5/25/65	3:30 p.m.	Near face No. 5 room	F-1874	0.79	19.33	0.12	0.43	0.23	79.10
5/25/65	3:40 p.m.	Near face No. 6 room	D-1315	0.51	19.21	0.10	0.39	0.16	79.63
5/25/65	6:06 p.m.	Face left air course entry	D-1314	5.5	6.8	3.4	4.9	6.5	72.9
6/2/65	10:25 a.m.	Face No. 6 room	F-1487	0.22	20.65	-	-	0.13	79.00
6/2/65	10:45 a.m.	Face No. 5 room	E-1345	0.32	20.43	-	Trace	0.21	79.04
6/2/65	11:00 a.m.	Face left air course entry	F-1499	0.14	20.79	-	-	0.35	78.72

ANALYSES OF AIR SAMPLES

TABLE 1

MINE No. 2-A COMPANY C. L. Kline Coal Company COLLECTED BY: H. D. Couk, Dee Zimmermann, R. B. Jones, Jack E. Tisdale, John D. Martin, E. L. Davis

DATE	TIME	LOCATION IN MINE	BOTTLE NO.	Percent in Volume					
				CARBON DIOXIDE	OXYGEN	HYDROGEN	CARBON MONOXIDE	METHANE	NITROGEN
6/2/65	11:00 a.m.	Face No. 4 room	F-1491	0.20	20.71	-	-	0.06	79.03
6/2/65	11:45 a.m.	1st room outby No. 1 room over rock fall	E-1823	0.23	20.63	-	-	0.04	79.10
6/2/65	11:53 a.m.	3rd room outby No. 1 room over rock fall	E-4499	0.15	20.77	-	-	0.05	79.03
6/7/65	10:15 a.m.	Left air course entry, 100 feet inby last open crosscut	D-6321	0.34	19.87	-	-	3.85	75.94
6/7/65	10:18 a.m.	Left air course entry, 54 feet inby the last open crosscut (taken near roof)	F-1476	0.34	20.20	-	-	1.51	77.95
6/7/65	10:20 a.m.	Left air course entry, 54 feet inby the last open crosscut (taken near floor)	D-5420	0.19	20.45	-	-	0.87	78.49

ANALYSES OF DUST SAMPLES

TABLE 2

DATE COLLECTED: May 28 and June 2, 1965

MINE No. 2-A COMPANY C. L. Kline Coal Company COLLECTED BY: Charles E. Estep, John D. Martin

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE	ALOCHOL COKE TEST	AS-RECEIVED PERCENT INCOMBUSTIBLE
1	band	Haulage entry - 60 feet inby carloading station	very large	22.9
2	band	Haulage entry - 120 feet inby carloading station	very large	26.6
3	band	Left air course at last open crosscut	small	19.6
4	band	Left air course 100 feet inby last crosscut	small	17.6
5	band	Left air course 200 feet inby last crosscut	large	19.6
6	band	Left air course at face	large	20.3
7	band	Left air course inby No. 6 room	large	23.4
8	band	Left air course inby No. 5 room	large	21.4
9	band	Left air course inby No. 3 room	large	21.1
10	band	Left air course 30 feet outby No. 1 room	large	24.8

APPENDIX A

VICTIMS OF EXPLOSION, NO. 2-A MINE

C. L. KLINE COAL COMPANY

May 24, 1965

Names of Persons Killed	Age	Number of Dependents	Occupation	Exp. This Occupation	Total Experience in Mines
Russell Webb	45	5	Motorman and Loading head opr.	6 yrs.	20 yrs.
Arthur Norris	49	9	Cutter - loader	6 yrs.	20 yrs.
Lawrence Griffith	57	3	Cutter - loader	1 yr.	20 yrs.
Philip Davis	52	1	Cutter - loader	6 yrs.	20 yrs.
Clayton Griffith	20	0	Loader	1/2 yr.	1 yr.

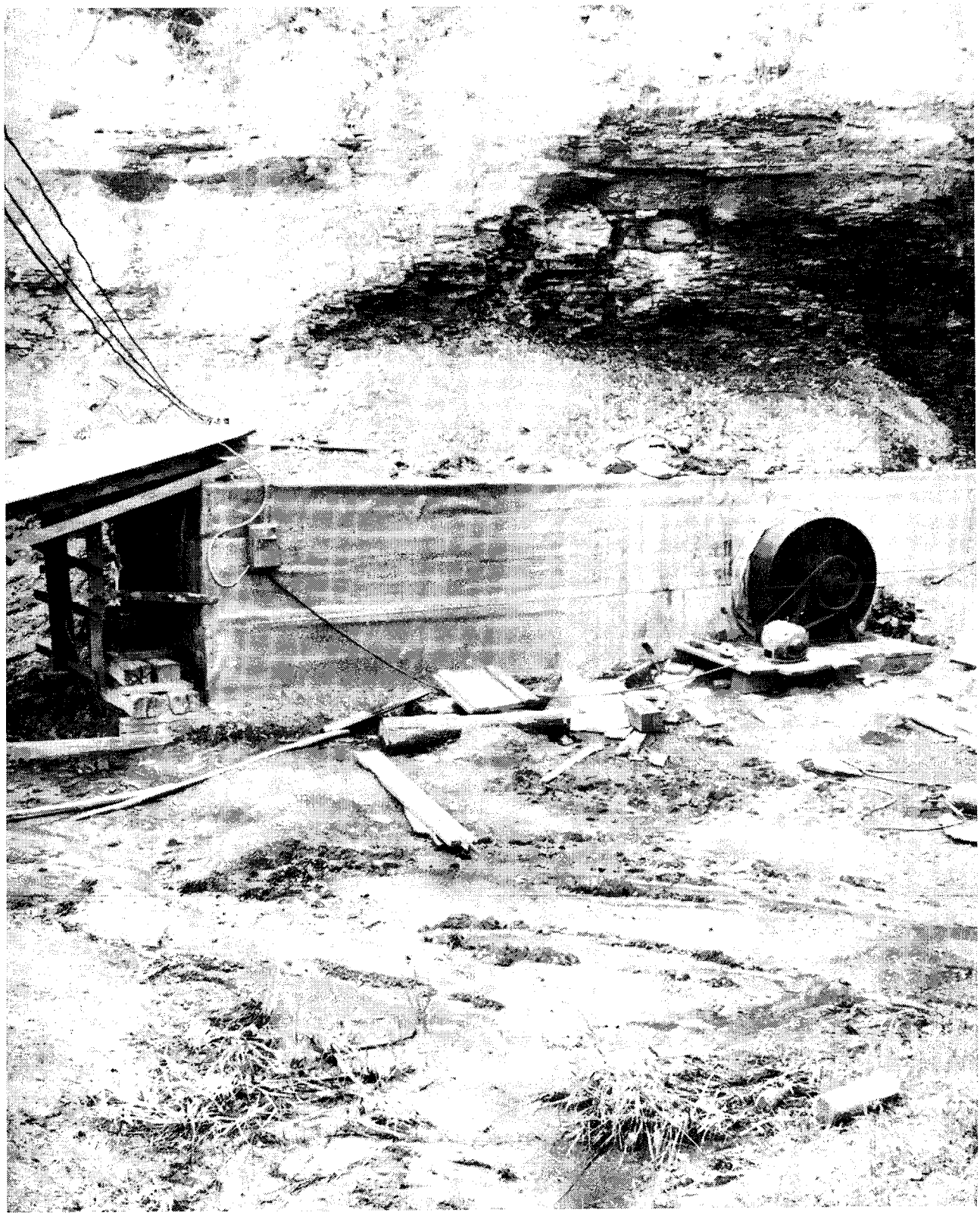


FIGURE 2. - Main Fan Housing Showing Fan at Right Installed During Recovery Operations.

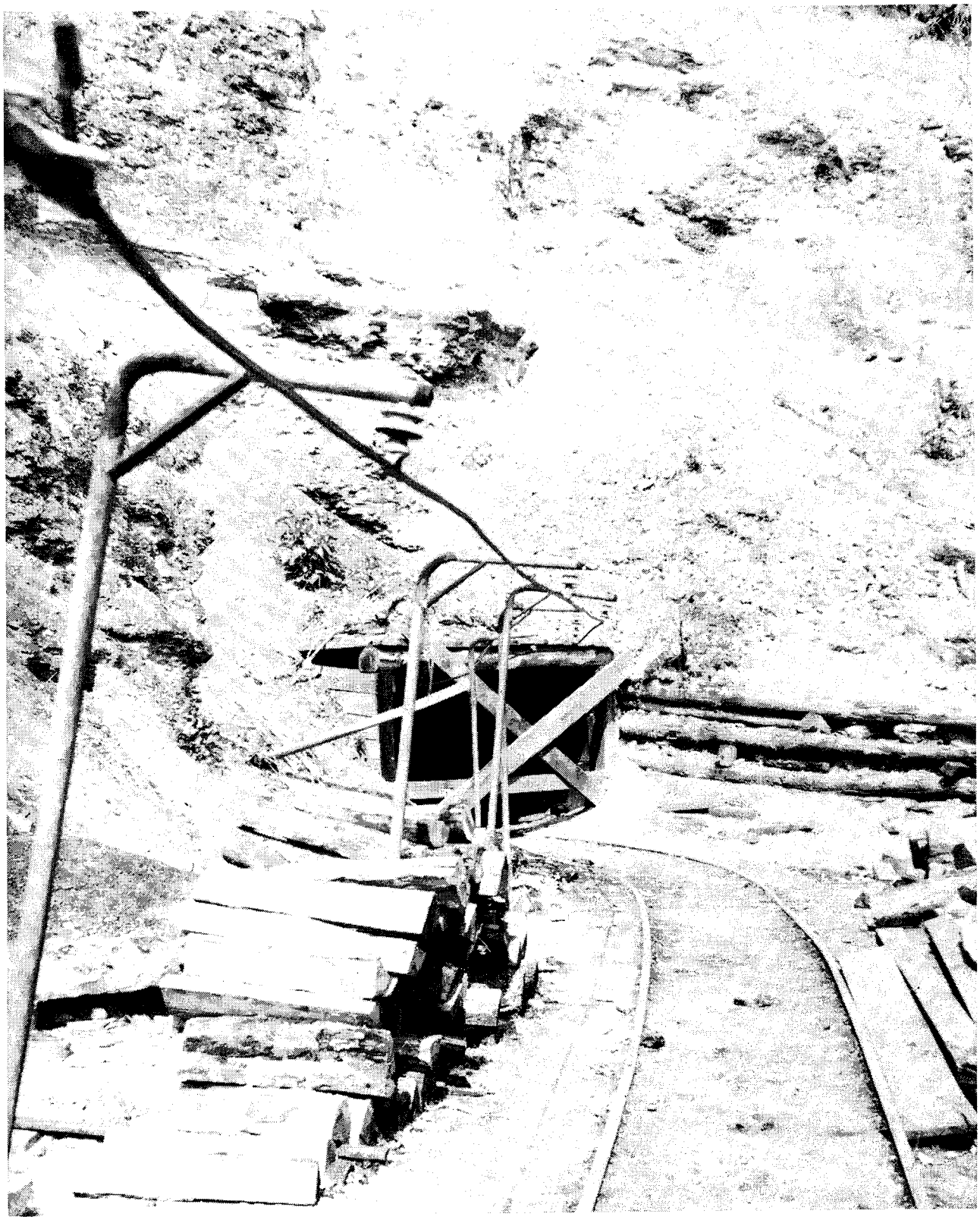
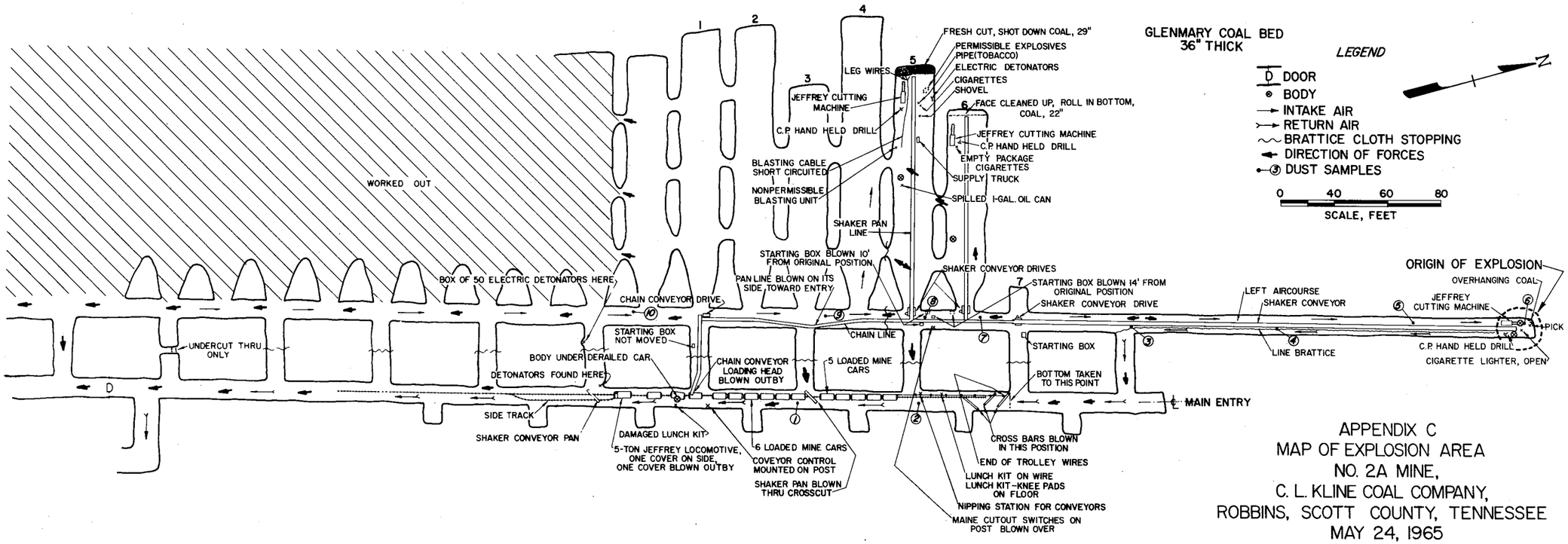
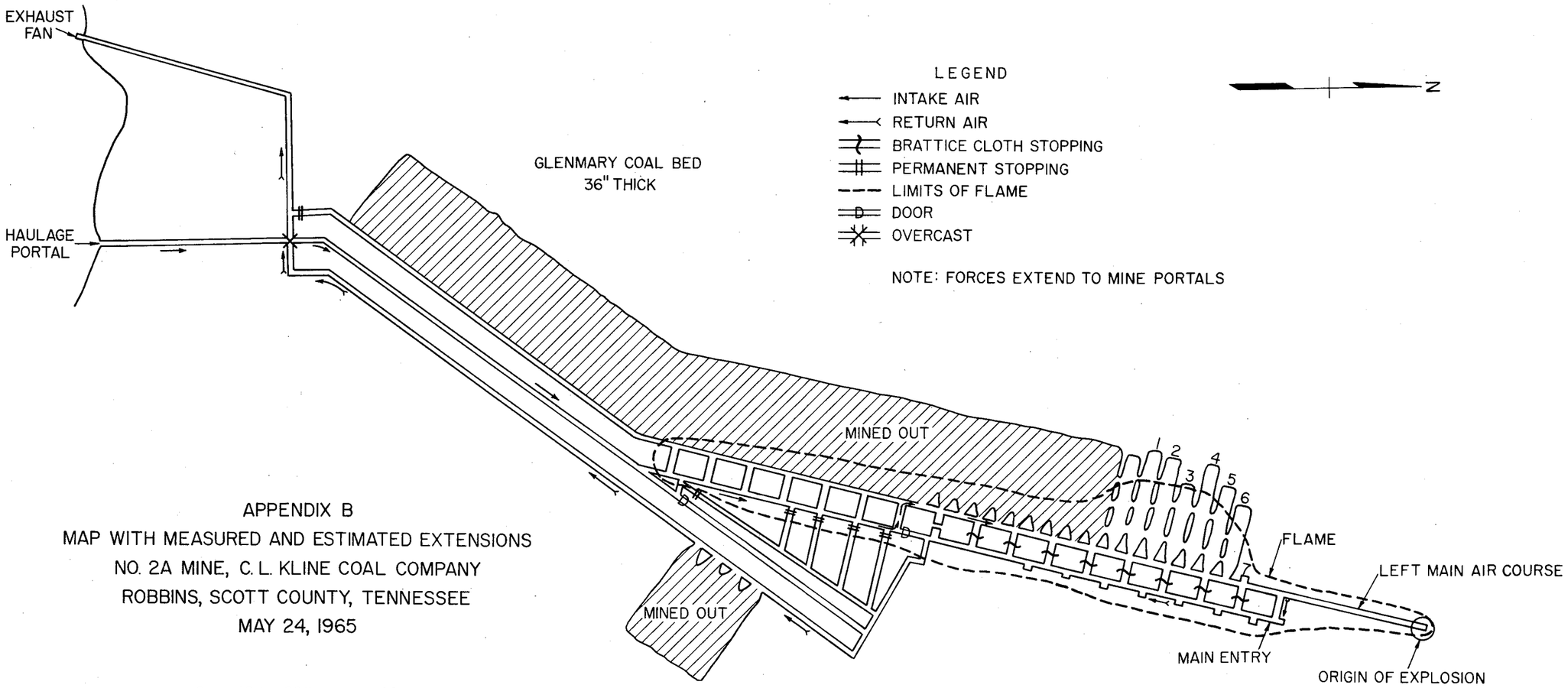


FIGURE 1. - Main Haulage Portal.



APPENDIX C
MAP OF EXPLOSION AREA
NO. 2A MINE,
C. L. KLINE COAL COMPANY,
ROBBINS, SCOTT COUNTY, TENNESSEE
MAY 24, 1965

S-939



APPENDIX B

MAP WITH MEASURED AND ESTIMATED EXTENSIONS

NO. 2A MINE, C. L. KLINE COAL COMPANY

ROBBINS, SCOTT COUNTY, TENNESSEE

MAY 24, 1965

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