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Coal Mine Safety and Health

Report of Investigation
Underground Coal Mine Explosion
No. 21 Mine - I.D. No. 40-00524
Grundy Mining Company, Incorporated
Whitwell, Marion County, Tennessee
December 8, 1981

by

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ABSTRACT

This report is the result of an investigation by the Mine Safety and Health Administration (MSHA) made pursuant to Section 103(a) of the Federal Mine Safety and Health Act of 1977 ("Mine Act"), Public Law 91-173, as amended by Public Law 95-164, 30 U.S.C. 813(a) (Supp. IV, 1980).

At approximately 12 noon (CST) on December 8, 1981, an explosion occurred in 003 Section of the No. 21 Mine of Grundy Mining Company, Incorporated. There were 56 men in the mine when the explosion occurred, 13 of whom were killed by or died from the results of the explosion. The other 43 men survived the explosion and, except for 6 men who remained underground and participated in the recovery operations, escaped to the surface; 12 men were working in the adjacent 007 section; 18 men were working in the 008 section and 13 men were working at various locations along the belt conveyor and track entries. The explosion occurred when one of the victims used a cigarette lighter in an explosive methane-air mixture that accumulated as a result of inadequate ventilation in 003 section.

The names of the victims, their ages, occupations, mining experience and training are listed in Appendix A. Autopsies were not performed.

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GENERAL INFORMATION

The No. 21 Mine, Grundy Mining Company, Incorporated, owned by Tennessee Consolidated Coal Company was opened during 1966, and is located approximately 15 miles northwest of Whitwell, Marion County, Tennessee. At the time of the explosion, the President, Vice President and Chief Engineer of Tennessee Consolidated Coal Company also held the same positions in Grundy Mining Company, Incorporated. Other operating supervisory officials served Grundy Mining Company, Incorporated only. Among the supervisory officials with responsibility for the No. 21 Mine were:

William B. Allison	President
Ronald C. Calhoun	Executive Vice President
Ed Presley	Chief Engineer
James Saynes	Superintendent
* Jimmy Wayne Rogers	Assistant Superintendent
Buddy Gene Layne	Assistant Superintendent
Wade Shadrick	Maintenance Superintendent
Jewell Shadrick	Assistant Maintenance Superintendent
Jerry R. Morrison	Assistant Maintenance Superintendent
* Roy White	General Mine Foreman
Hollis Rogers	Safety Director
Dan Basham	General Mine Foreman/Second Shift
* Jackie Tate	Section Foreman/003 Section
Don Bivens	Second Shift Section Foreman
Ladue Bouldin	Electrician Foreman
Leonard Sutherland	Preshift Examiner

* Rogers, White and Tate were victims of the explosion.

The No. 21 Mine was opened by nine drift openings into the medium volatile Sewanee coalbed which averages 39 inches in thickness in the present mining areas. A total of 127 men were employed; 123 worked underground on two production and one maintenance shifts a day. Production during the last Federal inspection of the entire mine completed October 30, 1981, was approximately 900 tons of coal per day. The floor is firm shale. The immediate roof is fragile shale. The main roof is sandstone and the maximum overburden is approximately 450 feet. The mine map did not indicate any gas or oil wells penetrating the mine area (Appendix B-1).

The analysis of a raw coal sample taken in the Sewanee coalbed in the No. 21 Mine is as follows:

	<u>Percent</u>
Moisture	1.9
Volatile matter	27.8
Fixed carbon	61.6
Ash	8.7

Numerous tests by the Bureau of Mines have shown that coal dust having a volatile ratio of 0.12 and higher is explosive. The volatile ratio of the coal dust in the mine is 0.31 indicating the coal dust is explosive. The volatile ratio is the ratio of volatile matter to fixed carbon plus volatile matter:

$$VR = \frac{v}{fc + v}$$

MINING METHODS, CONDITIONS AND EQUIPMENT

Mining Methods

A block system of mining was employed. Multiple entries were developed, 20-22 feet wide. Entries and crosscuts were approximately 60 feet apart. The main headings were developed approximately 13,000 feet in a southeasterly direction. Panels were developed right and left off the main headings at irregular intervals due to irregular conditions of the coalbed. In December 1981, mining consisted of developing three panels using conventional mechanical equipment.

The 003 section was developed off 6 right toward the abandoned 2 left off 5 right section, a distance of approximately 3,800 feet. According to management, the 003 section was to be mined into the abandoned gob area to develop a bleeder system for second mining. On approaching the abandoned area test boreholes were drilled in advance of the faces. Test boreholes, penetrating the gob area prior to mining through, indicated air from the abandoned gob area was flowing into the active 003 section. According to an entry in the preshift examiners book dated December 7, 1981, 5.2 percent methane was detected flowing from the boreholes. The gob area was directly connected to the main return aircourses and air from the active area should have been flowing through the test boreholes, across the gob and to the fan. The reverse flow in the boreholes indicated the gob ventilation was ineffective.

Ventilation and Gases

Ventilation was induced by a continuously operated Model 8 HU-72, Aerodyne fan manufactured by Jeffrey Manufacturing Company, belt driven at 1195 rpm by a 300 horsepower alternating-current motor. During the investigation, measurements by personnel from the MSHA Ventilation Section, Pittsburgh Health Technology Center, Pittsburgh, Pennsylvania, indicated the fan was exhausting 176,000 cubic feet of air a minute at 5.8 inches water gauge pressure. The methane content of the return air was 0.01 percent. Approximately 152,000 cubic feet of air a minute was measured at the six intake openings. Total methane liberation from the mine as calculated from the analysis of samples collected during the last inspection was 17,000 cubic feet in 24 hours. Air flow was controlled by permanent stoppings, overcasts, and regulators constructed of incombustible

materials. Plastic flame-resistant brattice material was used for check curtains and line brattice. The last ventilation system and methane and dust control plan for the mine was approved October 1, 1981.

003 Section Ventilation

A split system of ventilation was used for ventilating the three active sections. However, during the investigation it was discovered that air lock doors or a stopping was missing in a cut-through developed during November 1981, between the return aircourses of 007 section and the intake aircourses in 003 section. The belt conveyor entries were to be separated from the intake and return aircourses; however, in the 003 section the belt conveyor entry was not separated from the return aircourse outby the belt tailpiece for a distance of about 200 feet. A permanent stopping, as required by the approved ventilation plan, had not been constructed between the intake and return aircourses, in the third open crosscut outby the working faces. Also, it could not be determined if a permanent stopping had been constructed in the crosscut between the intake entry and the belt conveyor entry just outby the tailpiece, due to a large roof fall in the area. Plastic check curtains were installed between the intake and return aircourses in the first, second and fourth crosscuts inby the tailpiece. The third crosscut, shuttle car roadway, was open and the air was short circuited and was not effectively ventilating the working faces.

Bleeders

The 5 right gob area was developed after the effective date of the Federal Coal Mine Health and Safety Act of 1969. Section 303(z)(2) of the provisions of the Act states in part:

"...All areas from which pillars have been wholly or partially extracted and abandoned areas, as determined by the Secretary or his authorized representative, shall be ventilated by bleeder entries or bleeder systems or equivalent means, or be sealed, as determined by the Secretary or his authorized representative...."

Section 303(z)(3) states in part:

"In the case of mines opened on or after the operative date of the title, or in the case of working sections opened on or after such date in mines opened prior to such date, the mining system shall be designed in accordance with a plan and revision thereof approved by the Secretary and adopted by such operator so that, as each working section of the mine is abandoned, it can be isolated from the active workings of the mine...."

Blocks of coal were left around the perimeter of second mined (pillared) 5 right areas to serve as bleeder entries. Such "bleeder entries" were not travelable and, as was indicated by the direction of air flow from the gob area into the active areas of 003 section, were ineffective. During the mine recovery and investigation, it was determined that the extensive pillared areas from 1 right to 5 right were not sealed and were not effectively ventilated.

According to records of the preshift and onshift examinations and tests, methane had been detected on shifts immediately preceding the 7 a.m. - 3 p.m. shift of December 8, 1981. During the investigation 0.3 percent methane was detected from test boreholes leading into the abandoned area from the No. 3 entry, 003 section. Although preshift and onshift examinations and tests were conducted by certified persons, a preshift examination was not made for the 11 p.m. - 7 a.m. shift on December 7 and 8, 1981. Also, records of the preshift examinations and tests for maintenance shifts were not in the preshift examiner's book.

Rock Dust and Coal Dust

A clean-up program was in effect at the mine. Rock dust was applied to the roof, floor and ribs of the mine surfaces. During inspections of the entire mine made during 1980 and 1981, 132 dust samples were collected; 86 were substandard. A total of 58 of the samples were collected in the 003 section; 30 of which were substandard. The 003 working section was rerockdusted on the shift from 11 p.m. December 7, 1981, to 7 a.m. December 8, 1981.

Electricity

Three-phase power was purchased from the Sequatchie Valley Cooperative at 13,200 volts and transmitted to a surface substation near the mine portal. At the surface substation the electric power was reduced to 4,160 volt, 3-phase power for underground distribution by a bank of three 333-kVA transformers connected delta-wye. The secondary neutral was properly grounded through a 25-ampere, current-limiting resistor. A grounding circuit, originating at the grounded side of the resistor, was used to ground the metallic frames of all electric equipment supplied from the underground high-voltage distribution system.

A 600-ampere, oil filled circuit breaker in the surface substation was equipped with a ground check circuit and relays designed to provide overload, short-circuit, grounded-phase, and undervoltage protection for the underground high-voltage distribution system. Three, single-pole fuse cutouts were provided in the surface substation to open the phase conductors of the underground high-voltage distribution system.

The underground high-voltage distribution system consisted of approximately 18,200 feet of shielded, No. 2/0 AWG, 3-conductor, 15 KV mine power cable. Nine sets of three, single-pole fuse cutouts were installed at or near the beginning of the branch circuits in the underground high-voltage distribution system. The fuse cutouts were equipped with either 100-ampere or 125-ampere K-rated fuse links to provide additional overcurrent protection for the transformers and branch circuit conductors. A one-line diagram of the underground high-voltage distribution system is contained in Appendix C-1.

Nine portable power centers, 6 rated at 300 kVA and 3 rated at 150 kVA, reduced the 4,160-volt, 3-phase power to 480-volt, 3-phase power for the operation of 6 belt conveyor drive units and 3 battery charging stations. Three 750-kVA portable power centers reduced the 4,160-volt, 3-phase power to 480-volt, 3-phase power and 300-volt, direct-current power for the operation of the electric equipment on the three coal-producing sections. However, the direct-current portions of the portable power centers in the 007 and 008 sections were not in use at the time of the explosion.

The portable power center in the 003 section was used to supply 480-volt, 3-phase power to a cutting machine, face drill, loading machine, roof-bolting machine, belt feeder-breaker and battery charger and 300-volt, direct-current power to two shuttle cars. The primary windings of the power transformer in the portable power center were connected delta. The 480-volt secondary windings of the power transformer were connected wye with the secondary neutral properly grounded through a 15-ampere current limiting resistor. The 222-volt secondary windings of the power transformer were connected ungrounded delta. The negative polarity of the rectifier bridge in the portable power center was solidly grounded to the power center frame. The portable power center contained 7 molded-case circuit breakers which were equipped with devices to provide short-circuit, grounded-phase and undervoltage protection for the 480-volt, 3-phase circuits originating at the power center. Ground check circuits were provided to monitor the continuity of the grounding circuits for the 480-volt, 3-phase circuits originating at the power center. The portable power center contained 3 molded-case circuit breakers which were equipped with devices to provide short-circuit and undervoltage protection for the 300-volt, direct-current circuits originating at the power center. A cable coupler was provided in conjunction with each 3-phase, alternating-current and each direct-current circuit breaker to provide visual evidence that the power is disconnected when the cable plug is withdrawn from the receptacle.

The electric face equipment was of a permissible type and, according to the mine record books, was examined weekly. A record of these examinations was kept in a book in the mine office on the surface.

Blasting and Explosives

The coal was undercut, drilled and blasted onshift. Permissible-type explosives, fired by permissible-type shot firing units were used. The shot firers were certified. Explosives were stored in separate storage-magazines on the surface. A special container was used for transporting explosives underground. The container was transported on a rubber-tired car pulled by a rubber-tired battery tractor. Explosive storage-magazines were used for underground storage. It was observed that supplies of explosives and detonators in excess of that which can be stored in the section magazines were stored on the 003 section. Explosives and detonators in their original containers were transported on the section equipment in the face areas of 003 section.

Transportation and Communications

The coal was hauled in shuttle cars or rubber-tired mine cars and battery tractors from the face regions to belt conveyors which transported the coal to the surface. Battery-powered track haulage equipment was used to transport supplies to the section supply areas. Men were transported underground in battery-powered covered mantrip vehicles and in open-type, rubber-tired, battery-powered vehicles. A two-way telephone paging system was provided between the surface and the underground areas of the mine in compliance with Sections 75.1600 through 75.1600-2, 30 CFR 75.

Mine Rescue

Two trained mine rescue teams, equipped with oxygen breathing apparatus, were maintained at the company's mines. The two teams performed the underground recovery operations in the 003 section. Information obtained during the investigation indicates one-hour filter-type self-rescuers were carried by all underground employees and each employee had been trained in the use of the self-rescuers. Self-contained self-rescuers were not available to the miners at the mine. However, these rescuers had been ordered on June 18, 1981.

Fire Protection

The underground firefighting facilities included water lines installed along belt conveyors to near the faces. Water outlets were provided at 300-foot intervals along the lines and firehose and fittings were available at strategic locations. Fire extinguishers were provided on mobile equipment, and at stationary electric equipment. The electric face equipment was equipped with dry chemical fire suppression systems or used fire resistant hydraulic fluid. A portable-type rock dusting machine was available underground. An automatic, deluge-type water spray system was installed at each belt drive. According to the mine records, fire

According to Charles Cooley, Belt Maintenance Man, White tried for about an hour to contact 003 section by telephone, but could not. White then called Joe Ray Layman, Belt Maintenance Man, at 003 Section beltdrive and told Joe to contact Jackie Tate, Section Foreman, and tell him to get the telephone line fixed. White further told Layman that he would be in after a while because they would be shooting a ventilation hole through into the gob from 003 section. Not long after this conversation, Jackie Tate called outside and talked to White and Jimmy Rogers, Assistant Superintendent. J. Tate told White and Rogers they had cut through with the cutting machine and he had detected five percent methane. He further explained he did not know how much gas was in the gob into which they had cut. After this was reported, Rogers told Tate to use a low flame on his safety lamp, recheck the place for methane and call this information outside. About twenty minutes later, Jackie Tate called back and stated there was no black damp but there was methane because when he checked the face the flame in the safety lamp came to a peak like a christmas tree. At this point, Rogers told J. Tate to hold everything and ventilate, and said that he and White were coming in the mine to 003 section. Rayburn Tate, Electrician Repairman, Robert Roddy, Belt Maintenance Man, and Charles W. Cooley, overheard Jackie Tate telephone the mine office and discuss 003 section conditions with White and Rogers. Rayburn Tate, Roddy and Cooley were at telephones in 007 section, at No. 4 beltdrive and at the No. 2 beltdrive, respectively, when they overheard the conversation between Tate and Rogers.

About 10:10 a.m., the mantrip carrying White and Rogers reportedly passed the No. 4 beltdrive on its way to the end of the track in 003 section. While White and Rogers were enroute to 003 section, Buddy Gene Layne, another Assistant Superintendent, called 003 section beltdrive and asked Layman to stop Rogers and have him call outside because Layne wanted some information about a spad which was 120 feet from the 003 section beltdrive. When Rogers arrived at the 003 section beltdrive at about 10:45 a.m., he called Layne and stated he would get the spad information when he returned from 003 section. The last account of White and Rogers was when Stanley Scissom, Section Supervisor, traded battery-powered covered mantrip vehicles (rail runner) with them on 003 section track about 12 crosscuts inby the 003 section beltdrive.

Between 8 a.m. and 8:30 a.m., Ray Brown, a Company Belt Inspector, arrived at the end of 003 section track. Before going into the 003 section belt entry, he stopped 3 to 4 minutes and helped the scoop operator who was loading supplies. After supplies were loaded, he observed the scoop operator traveling toward the face of the 003 section. At this time Brown left the track entry and traveled in the 003 section belt entry, aligning the belt and making repairs. According to Brown, he made three trips up and down the belt during the morning, and on his last trip to the section dumping point he asked Lee Grimes, Shuttle Car Operator (victim) to help repair the belt to prevent coal from being spilled. Once the repair was made, Grimes told Brown they were getting ready to shoot in the face area. As near as Brown remembered he heard the report of

the shots 30 to 40 minutes before the explosion while traveling to the 003 section belt drive. He arrived at the 003 section belt drive about 11:55 a.m.

About 12:00 noon on December 8, 1981, an explosion occurred in the 003 section. Evidence that there had been an explosion was witnessed by Layman, Brown and James Meeks, who were working at the beltdrive and were preparing to eat lunch at this location when they felt a blast of hot air followed by high concentrations of airborne dust. They reported that airborne dust was in such high concentrations that they could not see for 3 to 4 minutes until the dust either settled or ventilation in the area carried the dust away. Robert Roddy and Charles Cooley stated that all electric power to the belt conveyors went off at about the same time as the explosion.

After observing evidence of the explosion, Layman began making telephone contacts to various locations in the mine and to the mine office. He first tried to contact the 003 section face crew but received no response. While Layman was on the telephone to 003 section, Jerry Fultz, Section Foreman on 007 section, tried to call about the power being off. At this time, Layman told Fultz there was a lot of dust at 003 section beltdrive. Next, Louis Nunley, Belt Maintenance Man at 6 right beltdrive, called on the telephone and stated there was a lot of dust coming down the belt-line. Fultz then called outside to Ladue Bouldin, Electrician Foreman, saying there might have been an explosion in 003 section. Bouldin told Fultz to go check 003 section. Next, Layman contacted Jimmy Frizzell, Slate Picker, on the surface and told Frizzell to have Bouldin disconnect all electrical power going into the mine. Bouldin disconnected the underground mine power. While this was taking place, Charles Morrison, Utility Man on 008 section, called Bouldin telling him to get the men out of the mine. Bouldin then ordered the men to leave the mine. Most of the miners began to leave either by riding a mantrip or walking.

Recovery

Fultz told his crew, except Jack Foshee, Section Electrician on 007 section, to leave the mine. In transit to 003 section, Fultz and Foshee stopped at 003 section beltdrive, where Fultz called Bouldin at the mine office and told him to Call James Saynes, General Superintendent. While Fultz and Foshee were traveling from 007 to 003 section on a battery-powered personnel carrier (3-wheeler), Scissom, picked up Brown and Mark Bivens, Utility Man, at the 003 section beltdrive and proceeded to the end of the 003 section track. Layman also traveled from the beltdrive to the end of the track in 003 section. After the six men arrived at the end of the track, Fultz took the telephone he had brought from 007 section and hooked it to the telephone line. The receiver on the telephone that was at the end of the 003 track was missing. According to Fultz, Scissom and Brown explored about 11 crosscuts

According to testimony of Don E. Bivens, 3 p.m. - 11 p.m. Section Foreman, 003 section, test boreholes were drilled into the abandoned area at 8:15 p.m., Monday, December 7, 1981, at the face of No. 3 entry (Appendix F, Photograph No. 4). The air was flowing from the abandoned area into the active working area. Tests were made using a methane detector and 5.2 percent methane was detected. The hole was plugged. The results of the tests were reported to Dan Basham, Second Shift General Mine Foreman. The onshift record book of December 7, 1981, shows this entry. On Monday night, prior to Leonard Sutherland entering the mine, Basham instructed Sutherland, Preshift Examiner for the day shift, to remove the plug installed by Bivens and to let the effluent from the gob bleed into the return. James R. Lyle, Electrician, accompanied Sutherland on an examination of the faces in the 003 section and Lyle detected 3.3 percent methane. Sutherland had all the equipment, except the shuttle cars, moved to the intake side of the working section and the working section was rerockdusted. On completion of the rock dusting, Sutherland painted the word "stop" on the faces where test boreholes penetrated the gob in Nos. 2 and 3 faces and removed the plug from the test boreholes in No. 3 face as instructed by Basham. Lyle informed Roy White, General Mine Foreman, on completion of his shift, that he had detected 3.3 percent methane in the 003 section.

The weather on December 8, 1981, was cold and cloudy. The barometric pressures for the period of time from December 6 to 10, 1981, recorded at the U.S. Department of Commerce, National Weather Service in Chattanooga, Tennessee, which is approximately 30 air miles from the No. 21 Mine, are as follows:

<u>Date</u>	<u>Time</u>	<u>Barometric Pressure</u>
December 6	12 Noon	29.5
December 7	12 Noon	29.4
December 8	12 Noon	29.42
December 9	12 Noon	29.3

MSHA investigators believe the slight change in the atmospheric pressure did not contribute to the explosion.

Explosion

Prior to entering the mine at 7 a.m. (CST) on December 8, 1981, Jimmy Holtzclaw, 008 Section Foreman, overheard Leonard Sutherland report to Roy White that there was 5 percent methane in the 003 section. The eleven man production crew assigned to 003 section entered the No. 21 Mine about 7 a.m. on December 8, 1981. They traveled in the track entry of the mains, through 6 right and then to the end of the track in 003 section. Although it was normal for 003 section miners to ride the scoop from the end of the track to the working place, it could not be determined during the investigation how this crew traveled to the working places from the end of the track on the day of the accident.

