

COAL FATAL

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

DISTRICT E

FINAL REPORT OF MINE EXPLOSION
BURNWELL NO. 1 MINE
OREN A. PILCHER, OPERATOR
HESPERUS, LA PLATA COUNTY, COLORADO

March 2, 1966

By

I. J. Ratliff
Federal Coal-Mine Inspector

T. C. Lukins
Mining Health and Safety Engineer

A. Z. Dimitroff
Supervising Mining Health and Safety Engineer

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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 Burnwell No. 1 mine, Oren A. Pilcher, operator, Hesperus, La Plata County, Colorado, between 7:55 and 7:58 a.m., Wednesday, March 2, 1966. Three men (all men in mine) were killed almost immediately from burns, possible carbon monoxide poisoning, and forces. The explosion originated near the face of room 11, or in the haulage entry in the vicinity of room 11 and was widespread, the forces emitting through the mine portals. An explosive mixture of methane and air was ignited by one of the following: a miner striking a match to light a cigarette; an electric arc or spark in the controller of the storage-battery locomotive; a bare spot in the battery cable contacting battery cell terminals of the locomotive; or an arc or spark from an unknown fault in a power conductor.

Names of victims, their ages, marital status, occupations, and number of dependents are listed in appendix A of this report.

The mine was on private land.

GENERAL INFORMATION

The Burnwell No. 1 mine is in Hay Gulch, about 6 miles southwest of Hesperus, La Plata County, Colorado, off State Highway No. 140, and is served by autotrucks.

The operator was Oren A. Pilcher, Route 2, Mancos, Colorado, and the owner was Columbus Wright, P. O. Box 204, Hesperus, Colorado.

Employment was provided for four men underground and one on the surface, one shift a day, 5 days a week. One underground workman was absent from work the day of the explosion. Average daily production of 40 tons of coal was loaded by hand onto shaking conveyors and then into mine cars.

Access to the mine is by two drift entries driven in the coalbed. Development was in an unnamed coalbed which averages 72 inches in thickness and dips about 2 degrees southwesterly. The deepest penetration was about 1,800 feet from the surface.

The immediate roof over the coalbed consisted of laminated shale and sandstone ranging from a few inches to 36 inches in thickness; main roof was sandstone. The floor was hard shale.

Analysis of a coal sample from the coalbed is as follows:

	<u>Percent</u>
Moisture	1.2
Volatile matter	32.1
Fixed carbon	60.1
Ash	<u>6.6</u>
	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 explosibility increases with increase in volatile ratio. The volatile ratio of coal in this mine as determined in the aforementioned analysis is 0.35, indicating that the dust from this coal is explosive.

The mine was opened in September, 1958. A gas ignition occurred in the mine April 13, 1961. Gas was ignited by a miner attempting to light a cigarette. The miner received first degree burns on the hands and face. There was no property damage.

The last Federal inspection of this mine was made November 15, 1965.

MINING METHODS, CONDITIONS, AND EQUIPMENT

Mining Methods: Mining was by room and pillar method. Entries were driven two abreast and rooms were driven to the left off the haulage entry. Entries were 15 to 18 feet wide on 40-foot centers. Rooms on 70-foot centers were driven 15 to 30 feet wide. Crosscuts, 10 to 12 feet wide, were from 50 to 100 feet apart. Pillars were not extracted. (See appendix C, map of entire mine.)

Roof support was by conventional timbering.

Coal was undercut by mining machines to a depth of eight feet. Permissible explosives were used for blasting coal on shift. Water in plastic bags was used for stemming. Owing to extensive roof falls and dangerous

roof conditions as a result of the explosion, explosives and detonators were not found.

Ventilation and Mine Gases: A continuous current of air was circulated through the mine by a blade-type fan driven electrically and operated exhausting. It was installed on the surface in a fireproof housing, properly offset, and equipped with pressure relief. An automatic warning device to give alarm when the fan slows or stops and a pressure-recording gage were not provided. The fan was inspected at the start of each shift and was operated only during working shifts.

Approximately 18,000 cubic feet of air a minute was reaching the last open crosscut and about 20,000 cubic feet of air a minute was returning from the mine during the last Federal inspection. Air was coursed by and through abandoned workings (rooms) before being used to ventilate active face areas. Preshift examinations for gas and other hazards were not made. Results of onshift examinations were recorded by the mine foreman in a book on the surface. Detection of methane was not recorded at any time. Weekly air measurements were made and recorded as "inby last x cut." Dates and initials posted in the abandoned rooms off the haulage entry indicated inspection intervals of more than 7 days. The mine was not liberating methane during the last inspection. Methane was not shown in the analyses of two air samples collected in the immediate return from the working section and in the main return from the mine.

Permanent stoppings between intake and return airways were constructed of cinder blocks. The last two crosscuts outby the faces between the main and back entries were open. A temporary stopping was installed in the third crosscut outby the faces of these entries. Reportedly, a line curtain was installed from the third inby crosscut between rooms 11 and 12 to conduct air to the face of room 12, and two temporary stoppings were installed in the first and second crosscuts between these rooms. The haulage entry between rooms 11 and 12 was open prior to the explosion. Auxiliary blower fans were not used in the mine.

The mine is classed gassy by the State and is a gassy mine under provisions of the Federal Mine Safety Code. Tests were made with a permissible flame safety lamp and a permissible electric methane tester throughout the mine during the investigation of the explosion; accumulations of methane or air deficient in oxygen was not indicated. Analyses of air samples collected in the mine more than 8 hours after the explosion and after ventilation was reestablished are listed in table 1. Three permissible flame safety lamps in the lamp room were in permissible condition. It is believed that the mine foreman had a permissible flame safety lamp in his possession at the time of the explosion, because a badly damaged lamp was found near his body. Damage to the lamp was a result of the explosion.

Gas and oil wells did not penetrate the coalbed in this mine.

Dust: The mine was dry. Dangerous accumulations of loose coal, coal dust, or float coal dust were not observed during the November, 1965, inspection. Dangerous quantities of float coal dust were present throughout the mine after the explosion. Means were not provided to allay coal dust at its source during normal mining operations, except water used to stem explosives in boreholes. The underground applications of rock dust was by hand. Rock dust applications or lack of applications inby room 10 prior to the explosion could not be determined because of falls of roof. A special coke sample was collected from a prop and cap piece in room 7 off the haulage entry, two float-dust samples were collected on top of falls in room 11 off the haulage entry, and 10 mine-dust samples were collected from the haulage and back entries after the explosion. Analyses for incombustible content and coke are listed in table 2. The analyses of these samples are not representative of mine dust conditions in the mine prior to the explosion.

A mine-dust survey was made in the track and back entries during the November, 1965, inspection. Of the six mine-dust samples collected, two contained less than 65 percent incombustible material. The mine was not rock-dusted adequately at that time.

Transportation: Coal was transported from the working places by shaking conveyors. Loaded and empty mine cars were handled by a storage-battery locomotive. Man trips were operated when the locomotive and mine cars were available.

Electricity: Electric power was received at a company-owned substation at 12,470 volts and reduced to 440 volts, by two transformers, for distribution on the surface and underground. Lightning arresters were provided on the high voltage line at the substation, but none were provided for the power circuits that entered the mine. A separate 440-volt feeder independent of the mine power feeder supplied power to the fan. A 440-to 110-volt transformer provided 110-volt power for lighting on the surface and 110-volt circuit underground.

The equipment underground was operated on 440-volts alternating current except for one hand-held electric drill, which was operated by 110-volt power. The locomotive was powered by storage batteries.

Switches with fuses were provided at the portal in the 440-volt and 110-volt power circuits to disconnect the power in the mine. These switches reportedly were thrown in the "off" position after the explosion. Three insulated single conductors installed on insulators in the haulage entry supplied 440-volt power to the working section. A sectionalizing switch was provided in this circuit at 1 right and a disconnecting switch was provided at a crosscut in the haulage entry outby room 11. The sectionalizing switch was reported to be in the "on" position after the explosion, and the switch at the working section was damaged, but found in the "on" position. The fuses from this switch were not found. Power for the cutting machines at the faces was supplied over fire-resistant three-conductor, type G, cables with Miller plugs. The face equipment

was not frame grounded. Power for the drill at 110-volts was supplied over two single conductors installed on insulators in the haulage entry. These conductors also had weatherproof sockets with incandescent light bulbs connected to them in the haulage entry. A two-conductor extension cord with a two-hole receptacle in room 11 supplied power for the drill. A sectionalizing switch in the 110-volt power line at 1 right was in the "on" position and had a blown fuse. The fuse probably was blown during or after the explosion. The power cables were buried in the caved area (see appendix C), and the power lines were tangled and piled near room 10 left. The charging station was located in the second crosscut off the main entry.

A Sullivan shortwall mining machine in room 11 had two holes drilled in the right explosion-proof compartment, several bolts missing from the left explosion-proof compartment, and openings in excess of 0.004 inch. The cable of this machine was not connected to the power supply. A nonpermissible hand-held electric drill in the last open crosscut between rooms 11 and 12 was not connected to the power supply. The power supply cables for the cutting machines and drill were tested and did not indicate a short circuit had occurred.

A shortwall mining machine, similar to that in room 11, was in room 12. Openings were not observed into the explosion-proof compartments of this machine. The end of the trailing cable was buried, and it could not be determined if it was connected to the power supply. This cable was tested and it did not indicate a short circuit had occurred.

A shortwall mining machine on a machinery-moving truck was stored in the main entry inby room 12. This machine was not examined because it was under dangerous roof.

La Dell Conveyor Manufacturing Company, model U-17, drives were used on the shaker conveyors in rooms 11 and 12. Open-type push button and magnetic starter in intake air were used with this equipment on the room 11 shaker conveyor drive.

A General Electric Type LSB, Class 2G5 storage-battery locomotive was in the haulage entry outby room 11. The battery cover had been blown off by the explosion, and the controller cover was damaged. There was a bare spot on one of the battery leads which could produce arcing or sparking when it came in contact with battery-cell terminals. This damage to the insulation could have occurred during the explosion. The controller was not of the explosion-proof type. Arcing or sparking occurs in the controller during normal operations.

A Joy loading machine approved as permissible was in room 4. This machine had several bolts missing from the controller compartment and was not in permissible condition. The trailing cable had been removed and reportedly the machine had not been used for several years.

Reportedly, tests for gas were made at the beginning of each shift in the face areas of the active workings before work started.

Illumination and Smoking: Permissible electric cap lamps were used for portable illumination underground. The haulage entry was illuminated at irregular intervals by incandescent light bulbs in weatherproof sockets. A searching program was not in effect to assure that smokers' articles were not carried into the mine. Underground employees had been warned previously by the operator not to smoke underground. Smokers' articles were found in the pocket of a jacket in the mine during the investigation and in the clothing of one of the victims at the mortuary.

Mine Rescue and Firefighting Equipment: Men employed in underground mines in the area were not trained in mine-rescue procedure and mine-rescue equipment was not available. Self-rescuers were not available.

A suitable escapeway was provided. A check-in and check-out system was in effect. Identification tags were found on each victim.

Approximately six tons of rock dust in bags were kept underground. Fire-fighting facilities and equipment other than rock dust were not provided underground.

STORY OF EXPLOSION AND RECOVERY OPERATIONS

Participating Organizations: These include the operator, a former employee, workmen from other nearby mines, Colorado Coal Mine Inspection Department, and the United States Bureau of Mines.

Activities of Bureau of Mines Personnel: I. J. Ratliff, Federal coal-mine inspector, and T. C. Lukins, mining health and safety engineer, were informed of the explosion by A. Z. Dimitroff, supervising mining health and safety engineer, Denver, Colorado, at 8:40 a.m., Wednesday, March 2, 1966. Donald Haske, State chief coal-mine inspector, had informed Dimitroff of the explosion. Ratliff and Lukins were instructed to proceed to the mine and arrived there about 7:40 p.m., the same day. Haske traveled with Ratliff, and Lukins followed in an automobile with Chemox breathing apparatus. Recovery work and investigation of the explosion continued until after 11 p.m.

The investigating party left the mine about midnight, and Bureau of Mines investigators returned to Durango, Colorado, arriving about 12:50 a.m., Thursday, March 3, 1966. The Denver office, Bureau of Mines, was informed of conditions at the mine up to that time.

Dimitroff arrived at the mine Friday, March 4, 1966, and assisted in the investigation until Sunday, March 6, 1966. James Westfield, assistant director--Health and Safety, arrived at the mine March 10, and, in company with the State chief coal-mine inspector and Ratliff, explored all areas of the mine except part of the return airway.

A coroner's inquest was held at Durango, La Plata County, Colorado, March 10, 1966. The following interrogated witnesses: Assistant District

Attorney, Sixth Judicial District, Colorado; Chief, Colorado Coal Mine Inspection Department; and the operator, Burnwell No. 1 mine.

Bureau of Mines personnel attending the inquest were James Westfield, assistant director--Health and Safety; A. Z. Dimitroff, supervising mining health and safety engineer; T. C. Lukins, mining health and safety engineer; and I. J. Ratliff, coal-mine inspector. Dimitroff participated in the inquest.

Mine Conditions Immediately Prior to the Explosion: The mine was idle from 4:30 p.m., Friday, February 25, 1966 to 7:45 a.m., Wednesday, March 2, 1966. The weather was cold and calm, and it was snowing on the morning of the explosion. Temperatures and barometric pressures from 5:30 a.m. to noon, March 2, 1966, as recorded at the City and County Airport, Durango, La Plata County, Colorado, are listed in appendix B. The barometric pressure dropped from 29.47 to 29.41 during this period, and temperature ranged from 22° to 27° F. Reportedly, barometric pressure of 29.41 on March 2, 1966, was the lowest ever recorded at the airport; this low pressure may have contributed to more than normal liberation of methane in the mine.

It was determined that normal mining operations were conducted Friday, February 25, 1966. Valdez, mine foreman, started the fan and he and the men entered the mine together shortly thereafter. Working places were examined by Valdez before the other men started work therein. Coal was produced from room 11, and room 12 was undercut at the face. Coal was blasted at the face of room 11, and tests for gas were made before and after firing each shot. Reportedly, a line curtain was erected in room 12 from the last crosscut between rooms 11 and 12, and temporary stoppings were installed in the first two crosscuts between these rooms. Evidence was not found during the investigation of this line curtain or these two temporary stoppings. Means were not provided between rooms 11 and 12 to direct the air current from the haulage entry into the rooms. Onshift examination of the mine, recorded by the mine foreman, indicated that the mine was in safe condition.

On Wednesday, March 2, 1966, Jose Ignacio Valdez, mine foreman, and Jose Remigio Garcia, and Jose Benito Lucero, miners, were about 15 minutes late reporting for work because of bad weather. Joe Ramirez, the other miner, did not report for work. Valdez informed Preston D. Daniels, caretaker at the mine, prior to leaving the mine office, that plans were to go underground, load a trip of mine cars with coal, pull the trip to the surface, and clear snow off surface-haulage tracks.

Evidence of Activities and Story of Explosion: Valdez, accompanied by Garcia and Lucero, left the mine office at 7:45 a.m., Wednesday, March 2, 1966, and proceeded directly to the mine. Reportedly, Valdez started the fan on the way to the haulage portal. The fan was not operated after 4:30 p.m., Friday, February 25, 1966. A preshift examination of the mine was not made for methane and other hazards before the men entered the mine; this was common practice at this mine as evidenced

by records kept in a book on the surface. It is not known whether the miners walked or rode into the mine, but it is believed Valdez took the battery locomotive and trip of cars into the vicinity of the carloading point outby room 11.

Evidently Garcia and Lucero proceeded to the face of room 11 and Valdez remained in the haulage entry to switch cars to the loading head. Because of the short interval between the time the men entered the mine and the occurrence of the explosion, and the locations where the victims were found, it was evident the active workings and adjacent areas were not examined for gases and other dangers. It also was evident that mining operations in the face areas had not yet been started when the explosion occurred.

Daniels, at his home near the mine office, heard the explosion and saw smoke and dust in the vicinity of the mine portals. He rushed to the mine portals and noted that the explosion had emitted with considerable force from both mine openings. Daniels immediately informed Donald Haske, State chief coal-mine inspector, of the explosion by telephone.

John Smith, employee at the adjacent King mine, stated that power failure occurred at 7:55 a.m. He and Pat Lindsey, employee of the Western Colorado Power Company, proceeded to the Burnwell mining property to determine the cause of power failure. Daniels informed them that "the mine was blown wrong side out" and that nothing could be done until inspectors arrived.

The explosion blew out roof supports causing extensive roof falls in active mine workings and passageways; conveyors were damaged; power conductors were torn from supports and piled along the haulage entry; mine cars were wrecked; the cover was blown off the battery locomotive; a belt was blown off the loading unit, room 11; the loading head unit for room 12 was turned on its side; temporary stoppings were destroyed; many permanent stoppings were demolished or damaged; and rock and debris were scattered throughout the main and back entries. Timbers and a bucket off a front-end loader in the mine yard were blown over the edge of a bank (see appendix C).

The estimated time of the explosion was determined by power failure in the area and a watch stopped at 7:58 a.m. on one of the victims.

Recovery Operations: John Smith, informed of the explosion, proceeded to the mine and disconnected power from conductors leading underground. John Daniels, a former employee at the Burnwell No. 1 mine, and Smith repaired pressure-relief doors damaged by the explosion, and replaced drive belts on the fan. (Belts were blown off by the explosion but were not damaged.) The fan was started at 10:25 a.m.

N. P. Parks, chief, Durango Fire Department; Evert Bixler, assistant chief, Voluntary Fire Department, Durango; Frank Adams, undersheriff, La Plata County; and others arrived at the mine between 9 a.m. and 10 a.m. P. Daniels informed these people that Haske's instructions were not to allow anyone to enter the mine except qualified persons with necessary equipment.

John Smith obtained a Scott Air Pack compressed-air-breathing apparatus from Parks and, accompanied by John Daniels and Oren A. Pilcher, operator, entered the mine. They traveled along the haulage entry to the battery-charging station in the second crosscut inby the mine portals. The stopping was damaged and air was short-circuiting back to the fan. Smith removed the Scott Air Pack and the stopping was repaired temporarily. These men proceeded along the haulage entry erecting temporary stoppings in place of permanent stoppings demolished or damaged by the explosion, and checked air movement with an anemometer. They were followed by Parks and others, including Wayne Moorehead, news editor, KIUP radio station, Durango. The body of Valdez was found opposite room 10 between the track rails in the haulage entry about 2:30 p.m. Moorehead, using a camera with flash bulb attachment, photographed Valdez' body. The body was then placed on a stretcher and removed from the mine. Clarence Rieke, chief, Voluntary Fire Department, Durango, transported the body in the department's rescue truck to the Park Lawn Mortuary, Durango, Colorado. Smith and Daniels explored further inby room 10, then decided to return to the surface after noting roof conditions, dust, and damage inby room 10.

Oscar T. Rice, State district coal-mine inspector, arrived at the mine about 3 p.m. and assumed charge of recovery operations. A notice was posted at the haulage portal by the State mine inspector debarring unauthorized persons from entering the mine. Rice, accompanied by J. Daniels, entered the mine traveling in intake air (haulage entry) and checking temporary stoppings and repairs to permanent stoppings. Upon arriving at the crosscut outby room 11 through which air was being short-circuited, they noted dangerous roof in the area and decided to return to the surface to obtain additional help, tools, and brattice material. Rice and a crew of six men, with tools and material, reentered the mine and resumed recovery work.

Shortly after the State chief coal-mine inspector and Bureau of Mines investigators arrived at the mine, they checked the mine fan, measured and tested return air, and collected an air sample. As progress was made underground, conditions and damages were observed along the haulage entry. Rice and the crew of six men were contacted and interviewed in the haulage entry near the entrance to room 11 at 8:50 p.m. Work of installing roof supports, erecting temporary stoppings (plastic material), and searching for the other two victims continued. Roof falls, caused by the explosion and ranging from 12 to 36 inches in thickness, were present in the mine workings and passageways inby room 10 (see appendix C). Movement of roof was discernible and an occasional fall occurred in the areas during recovery of the bodies.

The victims were located inby the rock falls and last crosscut, near the face of room 11, at 9:30 p.m. Their bodies were placed on stretchers, covered with blankets, and carried to the surface. Stretcher crews, with the bodies, and the investigators arrived on the surface at 11:05 p.m. The Mancos, Colorado, marshal transported the bodies by station wagon to the Park Lawn Mortuary, Durango, Colorado.

The investigation was resumed on the morning of March 3, 1966, and continued until Sunday, March 6, 1966.

6. Fine coal dust not allayed during mining operations accumulated underground and entered into the explosion.

Flame: Evidence of soot was present in varying degrees at faces of rooms 11 and 12 and in abandoned rooms off the haulage entry. Evidence of burned timbers extended into room 2 and at the second crosscut outby the face of the main haulage entry inby 1 right junction. Coke in varying quantities was present on props and coal ribs in some of the abandoned rooms off the haulage entry, and in the back entry where mine-dust sample A-4 was collected. Analyses of mine-dust samples collected after the explosion showed from traces to small and large amounts of coke particles present (see table 2 and appendix C). The coke content of dust samples collected in the mine after the explosion indicated that flame traveled from the faces of rooms 11 and 12, extended outby through passageways and abandoned rooms to within the vicinity of the parting outby 1 right junction (see appendix C).

Forces: There was no evidence of forces at the faces of rooms 11 and 12. Picks and shovels left upright against timbers and coal the last shift worked were not disturbed. Main forces of the explosion traveled outward from rooms 11 and 12, throughout the main and back entries including crosscuts between these entries, and dissipated on the surface (see appendix C).

Probable Point of Origin: Bureau of Mines investigators believe the explosion originated near the face of room 11, or in the haulage entry in the vicinity of room 11.

Factor Preventing Spread of Explosion: The explosion was widespread throughout the mine.

Summary of Evidence: Conditions in the mine during recovery operations and the investigation that followed, together with information made available during the last Federal inspection, interrogation of and discussions with the operator and employees of the mine, provided information as to conditions and practices prior to the occurrence and evidence as to the cause and origin of the explosion. This is summarized as follows:

1. Methane accumulated in active working areas because operation of the fan was stopped at the end of the shift February 25, when all men left the mine and was not started until a few minutes before men entered the mine at the start of the shift March 2, 1966.
2. Check curtains were not installed across the haulage entry between rooms 11 and 12 to conduct the air current from the haulage entry into the rooms. Apparently temporary stoppings were not installed in crosscuts in rooms and line curtains were not erected from the last crosscut to the faces of rooms.
3. Methane liberated in sufficient quantities from the undercut made at the face of room 12 and from the coal faces of rooms 11 and 12 (active working places) that when mixed with air in the mine formed an explosive mixture.

4. A preshift examination was not made for methane and other hazards before the men entered the mine.
5. Active face areas were not examined after men entered the mine.
6. Power conductors underground were energized when men entered the mine. A storage-battery locomotive equipped with a drum-type controller was used for transportation purposes.
7. The mine was dry and means were not provided to allay coal dust during mining operations.
8. The mine was not rock-dusted adequately at the time of the last two Federal inspections.
9. Employees had been warned previously by the operator not to smoke in the mine. Smokers' articles were found in the pocket of a jacket outby room 11 during the investigation and in the pockets of clothing of one of the victims at the mortuary.
10. An explosion involving methane and coal dust occurred between 7:55 and 7:58 a.m., March 2, 1966. The time was determined by a power failure in the area and a wristwatch that was stopped at 7:58 a.m., on one of the victims.
11. Victims died in a relatively short time from burns, possible carbon monoxide poisoning, and forces.
12. The flame extended from the faces of rooms 11 and 12 outby through the haulage entry and abandoned rooms off the haulage entry to the junction of 1 right entries and the main entries.
13. Analyses of mine-dust samples collected in the mine after the explosion showed from traces to small and large amounts of coked particles.
14. The explosion was widespread throughout the mine.

Cause of Explosion: The explosion resulted because methane accumulated from lack of adequate ventilation in the active face areas of the mine and was ignited by a lighted match, or electrical arc or spark. Failure to make preshift examinations, as a matter of course, so that the dangerous condition could have been detected and eliminated, aggravated the situation.

RECOMMENDATIONS

Compliance with the following recommendations may prevent similar disasters:

1. The main fan should be operated a sufficient length of time to ventilate adequately all open workings before any person is allowed underground. The fan should be operated continuously while men are underground.

2. The mine should be examined properly by a certified official before workmen are allowed in the mine. Dangerous conditions found should be corrected promptly before any other work is done.
3. A door, or a substantially constructed check curtain, should be installed in the haulage entry between active rooms so as to direct the air current into the rooms.
4. Substantially constructed line brattice should be used from the last open crosscut in rooms where necessary to provide adequate ventilation for the workmen and to remove gases.
5. Crosscuts between intake and return air courses should be closed except the one nearest the face.
6. Stoppings in crosscuts between main intake and return airways should be built of solid substantial incombustible material, such as concrete, concrete blocks, brick, or tile.
7. Air in sufficient quantity to prevent accumulation of explosive gases should be directed to the working faces at all times.
8. Smoking should be prohibited underground nor should anyone be permitted to carry smoking materials, matches, or lighters underground. Searches for smoking materials should be conducted at intervals sufficiently frequent to assure that smokers' articles are not carried underground.
9. The storage-battery locomotive should not be operated until the area in which it is to be used is examined for gases and found safe.
10. Abandoned workings should be ventilated adequately or sealed. If such abandoned areas are sealed, the sealing should be done in a substantial manner with incombustible material. One or more of the seals should be fitted with a pipe and cap, or valve to permit sampling of atmosphere behind the seals.
11. Air which has passed by or air that is used to ventilate abandoned workings should not be used to ventilate active face areas.
12. Water, or water with a wetting agent added to it, or other effective method should be used to allay coal dust raised into the air during underground mining operations.
13. Rock dust in adequate quantity should be applied to mine surfaces and maintained to within 40 feet of the faces of all places including open crosscuts.

14. Rock dust should be distributed upon the roof, floor, and ribs of all open places and maintained in such quantity that the incombustible content of the combined coal dust, rock dust, and other dust will not be less than 65 percent.

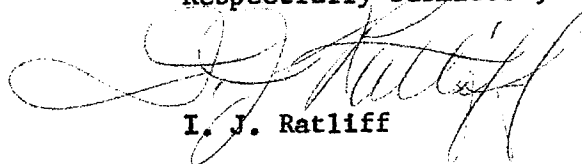
Although having no direct bearing on this explosion, the following recommendations should be complied with:

1. Unless constantly attended, the fan should be provided with an automatic device to give alarm when the fan slows or stops.
2. The fan should be equipped with a pressure-recording gage.
3. Weekly air measurements should include air entering the main intake and leaving the main return, and air measurements should be made weekly in ventilated abandoned workings to ascertain that such areas are ventilated effectively.
4. The interval between examinations of abandoned workings should not exceed 7 days.
5. Telephone service should be provided between the surface and working section.

ACKNOWLEDGMENT

The writers gratefully acknowledge the courtesies, cooperation, and assistance extended by the operator and employees of the mine, a former employee, and other persons in the area, and representatives of the Colorado Coal Mine Inspection Department.

Respectfully submitted,



I. J. Ratliff

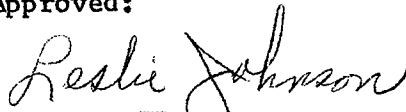


T. C. Lukins

/s/A. Z. Dimitroff

A. Z. Dimitroff

Approved:



Leslie Johnson
Acting District Manager

TABLE 1--ANALYSES OF AIR SAMPLES

MINE Burnwell No. 1 COMPANY Oren A. Pilcher, Operator COLLECTED BY I. J. Ratliff

DATE AND TIME	BOTTLE NO.	LOCATION IN MINE	CARBON DIOXIDE	OXYGEN	CARBON MONOXIDE	METHANE	NITROGEN	CUBIC FT. AIR PER MINUTE	CUBIC FT. METHANE IN 24 HRS.
3/2/66 8:50 p.m.	D-1814	Mine air, main haulage entry at room 11	0.05	20.86	.000	0.01	79.08	8,200	
3/2/66 8:20 p.m.	D-1810	Return air, 24 feet inby fan, main return airway	0.10	20.81	.021	0.05	79.02	22,000	16,000
3/3/66 2:45 p.m.	Z-9368	Mine air, immediate return main return airway - opposite room 10	0.05	20.88	.000	0.00	79.07	21,000	
3/2/66 9:30 p.m.	Z-9358	Mine air, room 11, 3rd crosscut	0.32	20.60	.005	0.07	79.00	Moving	
3/3/66 1:30 p.m.	D-1801	Mine air, face of room 11 off main entry	0.07	20.83	.000	0.00	79.10	Moving	
3/3/66 9:45 a.m.	D-1807	Return air, 15 feet inby pressure relief door at main fan main return	0.06	20.90	.000	0.01	79.03	26,000	

TABLE 2--ANALYSES OF DUST SAMPLES

DATE COLLECTED March 3, 1966

MINE Burnwell No. 1 COMPANY Oren A. Pilcher, Operator COLLECTED BY I. J. Ratliff and T. C. Lukins

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	AS-RECEIVED PERCENT INCOMBUSTIBLE
EXPLOSION SAMPLES				
Main entries 0 = mine portals				
<u>A = Main haulage entry</u>				
A-1	Band	0 + 300 feet	None	57.4
A-2	Band	0 + 600	Trace	40.3
A-3	Band	0 + 900	Trace	42.1
A-4	Band	0 + 1,200	Small	45.1
A-5	Band	0 + 1,425	Small	66.5
<u>B = Main back entry</u>				
B-1	Band	0 + 300 feet	None	47.8
B-2	Band	0 + 600	Trace	49.9
B-3	Band	0 + 900	Small	54.6
B-4	Band	0 + 1,200	Large	53.9
B-5	Band	0 + 1,425	Trace	45.7
7-A	--	Special coke sample from prop and cap piece, 95 feet off main haulage road in room 7	Very Large	36.8
R-11a	Floor	Float dust sample, room 11 off main haulage road, 65 feet inby loading unit (shaking conveyor)	Small	63.7
R-11b	Floor	Float dust sample, room 11 off main haulage road, 25 feet inby 1st crosscut	Small	69.9

APPENDIX A

Victims of explosion

Name	Age	Occupation	Years Employed in this mine	Marital Status	Dependents (Incl. children under 18)
Jose Ignacio Valdez	49	Mine foreman	3 years	Married	Wife and 1 child
Jose Benito Lucero	45	Miner	3 months	Married	3 children
Jose Remigo Garcia	50	Miner	2 years	Married	Wife and 1 child

APPENDIX B

BAROMETRIC PRESSURES AND TEMPERATURE READING AS
RECORDED AT DURANGO AIRPORT, LA PLATA COUNTY, COLORADO

Time	Wednesday, March 2, 1966 Temperature	Barometric Pressure
5:30 a.m.	25 ^o	29.46
6:00 a.m.	24 ^o	29.47
7:00 a.m.	23 ^o	29.46
8:00 a.m.	23 ^o	29.44
8:30 a.m.	Missing	29.43
9:00 a.m.	24 ^o	29.41
10:00 a.m.	22 ^o	29.44
11:00 a.m.	24 ^o	29.45
12:00 noon	27 ^o	29.46