UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

DISTRICT E

FINAL REPORT OF MAJOR MINE-EXPLOSION DISASTER
DUTCH CREEK MINE
MID-CONTINENT COAL AND COKE COMPANY
REDSTONE, PITKIN COUNTY, COLORADO

December 28, 1965

By

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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 Dutch Creek mine, Mid-Continent Coal and Coke Company, near Redstone, Pitkin County, Colorado, about 11:45 p.m., Tuesday, December 28, 1965. A total of 30 men was in the mine at the time of occurrence; 9 perished almost immediately from forces, burns, and possible carbon monoxide poisoning, and 21 escaped uninjured.

The Director, Bureau of Mines, Washington, D. C., instructed the Assistant Director--Health and Safety, to render all assistance possible and to undertake full investigation of this explosion (see appendix A).

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

Bureau of Mines investigators believe that the explosion originated near the face of room 6 off 4 south entries where an explosive mixture of methane and air was ignited by an electric arc from a blown-out temporary splice in a trailing cable to a mobile loading machine, or by sparks from a poorly insulated splice in the trailing cable of a shuttle car. The main forces of the explosion traveled outwardly from the face of room 6 throughout room 5 and dissipated as they moved along the 4 south entries and main slopes.

The area where the explosion originated was on Federal land.

GENERAL INFORMATION

The Dutch Creek mine, Mid-Continent Coal and Coke Company, is about 9 miles northwest of Redstone, Pitkin County, Colorado, off State Highway No. 133. Coal was hauled by autotrucks from the storage bins at the mine to the preparation plant near Redstone, then by semi-trailer trucks to Carbondale, Garfield County, Colorado, where it was loaded into railroad cars on the Denver and Rio Grande Western Railroad.

Operating officials of the company were:

J. A. Harker, chairman of board, P. O. Box 450, Boise, Idaho
William Gibbs, president, 105 West Adams, Chicago, Illinois
J. A. Reeves, vice president and general manager, Carbondale, Colorado
Robert Delaney, vice president and general counsel, Glenwood Springs, Colorado
Edward Selan, superintendent, Glenwood Springs, Colorado
Max Wareham, general mine foreman, Carbondale, Colorado

A total of 82 men was employed, of which number 60 worked underground on one maintenance and two coal-producing shifts a day, 5 and 6 days a week. Average daily production was 1,800 tons of coal.

The mine was opened by seven parallel slopes developed to a depth of about 3,950 feet. The 2 north entry and a raise off the 2 south entry were driven to the surface, but this latter opening was not accessible because pillars had been extracted and caving had occurred. Development was in the Coal Basin "B" bituminous coalbed, which averages 84 inches in thickness and dips 13 degrees southwesterly.

Roof over the coalbed was a hard laminated shale and sandstone of undetermined thickness. The floor was soft shale ranging from 3 inches to 22 feet in thickness, underlain by 11 feet of coal known as the Upper "A" and Lower "A" beds. Shale between the Coal Basin "B" and the Upper "A" bed was about 3 inches thick in room 6, 4 south.

The analysis of a coal sample from the Coal Basin "B" coalbed in the Dutch Creek mine is as follows:

	Percent
Moisture	5.3
Volatile matter	23.4
Fixed carbon	63.3
Ash	8.0
	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 the volatile ratio. The volatile ratio of the coal in this mine as determined from the aforementioned analysis is 0.27, indicating that the dust from this coal is explosive.

The following ignitions and explosions, investigated by the Bureau of Mines, occurred in this mine since its opening in 1956:

Date	Ignition Source	No. Injured
7-29-57	Coal dust was ignited by an electric arc which occurred when the frame of a defectively wired shuttle car contacted the frame of a loading machine.	2
8-15-59	Explosion (entire mine). No persons in the mine. Methane ignited in the fan house on the surface by the flame from an oxygen-acetylene torch.	3 (surface)
10-27-60	Methane ignited by an electric arc in an open contactor compartment for the head motor of a permissible-type continuous-mining machine while repairs were underway. Gas feeders issuing from the floor also were ignited.	0
1-13-61	Loose end of broken drive shaft, twirling around torn electric wires from gathering-head motor caused an electric arc which ignited gas feeders issuing from the floor underneath a continuous-mining machine.	0
11-11-63	Explosion (slope section). Methane ignited by friction sparks when continuous miner cutter-head was used to break up fallen cap rock.	9

The last Federal inspection of this mine was made October 19-22, 1965.

MINING METHODS, CONDITIONS, AND EQUIPMENT

Mining Methods: A room-and-pillar method of mining was practiced and pillars were extracted by a splitting-and-fender method. Main slopes were developed seven abreast, and room entries, in sets of four, were turned north and south off the slopes. Slopes, entries, and slope and entry crosscuts were driven 20 feet wide on 100-foot centers. Rooms

20 feet wide were turned on 67-foot centers and developed down the pitch to a depth of about 400 feet. Room crosscuts 20 feet wide were on 80-foot centers and a crosscut was provided at each face when development was completed. The 4 south and 5 north entries were the only active coal-producing entries at the time of this explosion. Occasionally, a crew was employed in 3 south entries developing the entries through a rock fault, but on the day of the explosion this section was idle. The 6 north entries were developed and the bleeder slopes connected prior to developing rooms off 5 north entries. This was done in an attempt to release gas from the block of coal before rooms were developed. Management believes that opening the area around this block of coal did help in bleeding off some of the gas. The 4 south entries were on retreat and rooms 1 to 4, starting at the inby end, were worked out and the area caved. Room 5 was developed and a crosscut connecting to room 4 was provided at the face. Work was in progress driving the No. 3 crosscut off room 6 toward room 5 the full height of the coalbed when the explosion occurred.

The coalbed in the 4 south section was approximately 7 feet thick and was overlain by approximately 1,000 feet of burden. Rock faults were encountered at various places in the mine, and pressure bumps occurred frequently, liberating large quantities of methane into the atmosphere.

Roof support was accomplished by conventional timbering and by roof bolts installed in accordance with a plan approved by the Bureau of Mines. Coal was mined by ripper-type continuous mining machines, dumped on the floor, and then loaded by crawler-type loading machines into cable-reel shuttle cars. Management stated that company rules permitted not more than 1/2 to 2/3 of a shuttle-car load (3 to 4 tons) to be piled on the floor behind the continuous miner at one time.

Explosives: Explosives were not stored underground and were taken in the mine only when needed for driving through rock faults. Then blasting was done off shift with permissible explosives and instantaneous electric detonators fired with a permissible 10-shot blasting unit by certified personnel who were the only persons underground at the time. Clay and rock dust were used for stemming.

Ventilation and Mine Gases: Ventilation was induced into the mine by the No. 2, 5-foot axial flow fan, and by the No. 3, 7-foot axial flow fan. The fans were driven electrically by 150-horsepower and by 250-horsepower motors, respectively, and operated exhausting. The No. 1, 4-foot axial flow fan powered by a 100-horsepower electric motor, was maintained as a standby. A manually controlled gasoline-powered engine was provided as a standby drive unit for No. 2 fan. The fans were installed on the surface in fireproof housings equipped with fireproof air ducts, and offset a safe distance from the mine openings. Pressure-recording gages and automatic signaling devices were provided. The fans

were operated continuously and inspected daily; records were kept of the inspections.

A split system of ventilation was employed (see appendix C). Bleeder slopes were provided for the north entries but, because of the irregular property line, bleeder slopes were not provided for the south entries. In future development, the company contemplates providing bleeder slopes for the south entries.

Permanent stoppings between intake and return airways in the slopes were constructed of solid cinder blocks, and overcasts were built of solid cinder blocks and corrugated metal. Because of heaving floor and heavy ground, cinder-block stoppings along the slopes in many instances were damaged and were difficult to maintain. When this occurred, the cinder-block stoppings were backed up by installing metal telescopic stoppings to prevent undue loss of air. In the past 3 years when solid cinder-block stoppings were erected in slope crosscuts, metal telescopic stoppings were installed at the same time to assure normal ventilation in event the cinder-block stoppings crushed out. Because of similar heaving and heavy ground conditions, metal telescopic stoppings were used to separate the airways along room entries. Brattice cloth and plastic stoppings were used in room crosscuts. Line curtains were constructed of brattice cloth and plastic materials.

The face ventilation system was so arranged that it was not necessary for moving equipment to pass under check curtains. Company officials and machine operators stated that the inby end of line brattices were to be kept within 8 to 15 feet of the faces. Line brattice was erected on the return side by setting a row of props 3 to 4 feet from the left rib. Wooden framing was provided along the top of the line brattice and wooden cleats were used to tighten the curtain against the roof. Although the line brattice in room 6 off 4 south entries was destroyed by the explosion, evidence indicated that the inby end of the curtain had been within 17 feet of the face of the crosscut. Company records at the mine showed 95,000 cubic feet of air a minute reaching the last open crosscut in 4 south entries immediately prior to the explosion, and it was estimated by company officials that approximately 40,000 cubic feet of air a minute was reaching the inby end of the line curtain in room 6. This indicates a loss of about 55,000 cubic feet of air a minute through five brattice cloth and plastic stoppings and the line curtain.

The mine is classed gassy in accordance with the laws of the State and is a gassy mine under the provisions of the Federal Coal Mine Safety Act. Methane feeders frequently are encountered in the floor and, when bumps occur, large amounts of methane are liberated into the mine atmosphere. During the October 1965 Federal inspection, approximately 400,000

cubic feet of air a minute was returning from the mine and a minimum of 65,000 cubic feet of air a minute was passing through the last open crosscut of active entries and reaching the intake end of pillar lines. The analyses of air samples collected during that inspection indicated that 4,630,000 cubic feet of methane was liberated from the mine in a 24-hour period, of which 520,000 cubic feet was liberated from the 4 south section. Air samples collected in the explosion area by a Federal coalmine inspector more than 12 hours after the explosion contained from 0.23 to 1.75 percent methane (see table 1).

Preshift examinations for gas and other hazards were made by certified officials before the first operating shift each day, and preshift examinations for succeeding shifts were made by the onshift officials during their regular tours of duty. Onshift examinations for gas and other hazards were made with permissible flame safety lamps at not more than 15-minute intervals during mining operations by the unit foreman and continuous-miner operator. Company officials and continuous-miner operators stated that these tests for gas were made alternately so that the tests would be made at not more than 8-minute intervals. Results of preshift, onshift, and weekly examinations were recorded in books on the surface. The foreman and fire-boss reports show that methane had been detected frequently and was removed by an approved method, that is, by extending line brattices and increasing airflow as required.

It is believed that the mine foreman and the continuous-miner operator had permissible flame safety lamps in their possession at the time of explosion, because a lamp was found in the vicinity of each body. The lamps were sent to the laboratories of the Bureau of Mines in Pittsburgh, Pennsylvania, for testing and examination, and were found to be in permissible condition. The examinations disclosed that the mine foreman's flame was at a capping or gas detection height, and the continuous-miner operator's flame was slightly below walking height (see appendix D). The unit foreman had taken a permissible flame safety lamp underground, but sometime during the shift the lamp was damaged and taken out of service. This was determined by the unit foreman's telephone call to the surface about 11:35 p.m. asking for another lamp and stating his lamp had been run over by a shuttle car.

As a result of this telephone call, the outside man, who is certified as a mine foreman, serviced a lamp and gave it to a workman with instructions to carry it to the unit foreman in 4 south section. This workman was walking down the slope with the lamp when the explosion occurred. The unit foreman's original flame safety lamp was found in No. 3 entry, 4 south between rooms 5 and 6, the location where the unit foreman usually ate his lunch. The bonnet was crushed, the globe broken, and the complete igniter assembly was missing. The igniter was found in a pocket of the victim's clothing at the mortuary. It is believed that the igniter was removed from the damaged lamp by the unit foreman as a safety precaution.

Gas or oil wells do not penetrate the coalbed in this area.

Dust: Generally, the mine was dry. Dangerous accumulations of float coal dust, coal dust, or loose coal was not observed during the October 1965 inspection. Several days after the explosion, examination of the belt-conveyor entries and shuttle-car roadways in sections not affected by the explosion revealed that the belt-conveyor entries were reasonably clean and well rock-dusted, but the shuttle-car roadways had dried out and were not rock-dusted, and that there were dangerous accumulations of loose fine coal and coal dust on these roadways. Water with a wetting agent was delivered at 500 psi through 1-1/4-inch pipes to the face areas and was used to sprinkle shuttle-car roadways and allay coal dust formed during mining operations. Management stated that shuttle-car roadways were kept wetted down during working shifts. Each continuous miner was equipped with 13 water sprays. Other than the shuttle-car roadways, the mine was rock-dusted throughout, including the back slopes and back entries. Active sections were rock-dusted by hand during the coal-producing shifts and generalized rock dusting of the face areas and other sections was done on the second and third shifts. A permissible slow-feed rock-dusting machine was installed in the return airway at the inby end of No. 1 entry, 4 south (see appendix E). Reportedly this machine was operated continuously during the coal-producing shifts to help counteract the float-coal-dust danger. However, investigation revealed that the cable to the slow-feed rock-dusting machine had been taken apart at a splice and the machine is not believed to have been in operation. Company records show that 22-1/2 pounds of rock dust per ton of coal mined was applied to the mine surfaces during 1965. During the October 1965 Federal inspection, 12 survey dust samples were collected in the 4 south section and 8 representative spot-location samples were collected in other areas. The incombustible content of the 20 samples ranged from 74 to 100 percent.

A total of 45 mine-dust samples was collected from the mine after the explosion (see table 2 and appendix F). Of the 18 band samples collected from the explosion area, 17 were substandard, ranging from 10.1 to 43.3 percent incombustible material. The analyses of dust samples collected in the explosion area are not necessarily representative of mine-dust conditions in this area prior to the explosion. Of the 27 mine-dust samples collected in the 4 south entries and main slopes outby the explosion area, 9 were substandard, ranging from 13 to 61.5 percent incombustible material. A mixture of rock dust and coal dust at least 4 inches deep was observed on the floor the entire length of the No. 2 material-haulage entry. All the dust samples collected in No. 2 entry were substandard, ranging from 51.4 to 61.2 percent incombustible material. The roof and ribs in this entry were well rock dusted. The excessive dust on the floor was due to heavy applications of rock dust and to rubber-tired equipment operated in this entry breaking the floor and pulverizing the coal and rock. The floor

in rooms 5 and 6 in the explosion area was coal, and rock dust was not evident on the floor, but it was apparent that the roof and ribs had been rock dusted. Company practice was to keep shuttle-car roadways wet between the faces and belt-conveyor tailpieces. Shuttle-car roadways were cleaned frequently but accumulations of coal and coal dust were observed on the shuttle-car roadway in room 6 after the explosion.

Transportation: Coal was hauled in shuttle cars from the face regions to well-installed 36-inch-wide belt conveyors, which transported the coal to the surface. Beltmen were employed to maintain the conveyor belt lines. Track was installed in No. 6 slope and was used for transporting men and material. Men were transported on the slope in special man-trip cars and walked from the man-trip stations in the slope to their respective working places. Permissible battery-operated utility trucks were used to transport material along the intake entries parallel to the belt entries.

Electricity: Three-phase 60-cycle electric power was received at 69,000 volts and reduced to 23,000 volts for distribution to the surface substations. On the surface, 440- and 110-volt power was used to operate equipment and for lighting. A 2,000 kv-a, delta/delta-connected transformer with a 300 kv-a grounding transformer reduced 23,000-volt power to 7,200 volts for delivery underground at Dutch Creek mine. Separate feeders independent of the mine power feeder supplied power to the fans. An exceptionally long span in No. 3 fan feeder, which crossed an avalanche area, was responsible for disrupting at times the power supply to that fan during periods of high winds. An attempt had been made to correct this by increasing the spacing of the conductors on one side of the span, but this did not correct the condition.

The 7,200-volt primary feeders underground were shielded nonmetallic-sheathed cables suspended on insulated hooks. Disconnecting switches were provided in the primary feeders to the working sections. Proper short-circuit, ground-fault, and ground-monitoring protection were provided.

All equipment underground was operated by 440-volt alternating current except the permissible battery-powered utility trucks. These batteries were charged at two locations by standard battery-charging equipment. Various electric power centers reduced the 7,200-volt power to 440 volts.

A 400 kv-a power center connected delta/wye supplied 440-volt alternating-current power to the equipment in 4 south section. This center provided individual disconnecting switches, overload protection, and ground-fault protection for trailing cables of equipment connected to it. All trailing cables were type G and fire resistant.

Electrical face equipment underground was examined after the explosion and found to be as follows:

4 south section (explosion area)

The permissible Joy continuous miner, type 6CM-3AH, had several lock washers missing from bolts on explosion-proof compartments but no openings into explosion-proof compartments were found. An extension cable was used to connect the trailing cable of this machine to the power center. The plug of this extension at the power center was damaged and the power conductors were grounded. This plug was damaged by the explosion.

The permissible Joy loading machine, type 14 BU 10-11 DH, had one lock washer missing from a bolt in the controller compartment but no openings in explosion-proof compartments were found. This machine used an extension cable to connect the trailing cable to the power center. Five temporary splices were found in the trailing cable and three in the extension cable of this machine. One of the temporary splices in the trailing cable, located 31 feet from the cable anchor at the machine, indicated a short between the power conductors and had blown out. Examination of this splice indicated that considerable heavy arcing had occurred between the power conductors at the time of a phase-to-phase fault (see photographs, appendix G). In making up this splice, the connectors on the power conductors were not staggered properly to minimize damage to the insulation. The three grounding conductors had been grouped and placed on one side of the splice, and this did not provide proper ground-fault tripping when the short occurred in the splice.

The permissible Joy right-hand-drive shuttle car, type 10 SC 6 PXH-11, had no openings in excess of .004 inch into explosion-proof compartments. The headlight on the receiving end had a cracked lens, apparently broken by the explosion. This car used an extension cable. Three temporary splices were found in the extension cable and two in the trailing cable. One of the splices in the trailing cable had damaged insulation and a bare power conductor. The insulation damage was such that an intermittent fault to ground could have resulted in arcing when the bare power conductor contacted the metal surface of the shuttle car.

The permissible Joy left-hand-drive shuttle car, type 10 SC 6 PH-11, had the trailing cable connected to the power center without an extension. Two temporary splices were found in the trailing cable of this car. Permissibility defects were not found on this car.

The power center in 4 south had the back cover, on the primary side, blown off and damaged. The front covers also were open and partly damaged. The covers of Nos. 1, 5, and 6 circuit breakers were blown off and the lower right corner of the cover of No. 3 circuit breaker was broken off. The continuous miner was served by an 800-ampere circuit breaker and the loading machine and shuttle cars were served by 225-ampere circuit breakers.

The ground-trip relay of No. 1 circuit breaker, serving the miner, and the ground-trip relay of No. 3 circuit breaker, serving the loading machine, were not in operating condition. Damage to this power center was a result of the explosion. The ground-trip relays of Nos. 2 and 4 circuit breakers serving the shuttle cars were in operating condition. Circuit breakers Nos. 5, 6, and 7 were not in use.

A permissible T1-3PM Joy truck equipped with a permissible Mine Safety Appliances rock-dust distributor, type 77806, was in 4 south section and its cable was extended to but not connected to the power center.

A permissible Mine Safety Appliances type A92916 rock-dust distributor was in No. 1 entry, which is the return of 4 south section. This duster was in permissible condition but the cable to it had been taken apart at a splice and it apparently had not been in use.

Permissible face equipment in 3 south and 5 north sections also was examined during the investigation. The examination revealed only minor defects, such as missing lock washers and missing strain clamps. Face equipment in general was in good condition and reflected a good maintenance program and permissibility inspection. Face equipment was examined periodically for permissibility and grounding-conductor continuity in the trailing cables. A maintenance foreman was assigned full time to this work and conducted these examinations on each piece of equipment once each week or oftener. Results of these examinations were entered in a log book by the maintenance foreman and were checked by the master mechanic.

After the explosion, the 4 south and 5 north continuous-mining machines were equipped with Bureau of Mines continuous-methane monitors. These monitors were installed so that in addition to providing warning of methane build-up, a red-light alarm will come on and operation of the machine will be stopped automatically at a predetermined percentage of methane.

Illumination and Smoking: Permissible electric cap lamps were used for portable illumination underground, and mobile equipment was equipped with headlights. A searching program was in effect to assure that smokers' articles were not carried into the mine. Evidence of smoking never was found during the many inspections and investigations made in the mine. Smoking material was not found in the mine or on the victims following the disaster.

Mine Rescue: Mine rescue teams were not maintained, but four Chemox self-generating oxygen-breathing apparatus were kept at the mine. Some men at the mine were trained in mine rescue work. Self-rescuers for each man in the mine were provided near the belt tailpiece in each section. The company

has ordered five McCaa 2-hour self-contained oxygen-breathing apparatus, and plans to establish a mobile mine rescue station. The company plans to purchase five additional apparatus at some future date.

Escapeways were provided and maintained in good condition. A positive check-in and check-out system was in effect.

Fire-fighting equipment consisted of water at 500 psi piped to all sections of the mine, with outlets and hoses provided at strategic places. A 2-inch pipeline with outlets at suitable intervals was installed along the main belt line. A supply of rock dust, 50-gallon barrels filled with water, and buckets were provided at 300-foot intervals along secondary belt lines. Dry-chemical fire extinguishers and bagged rock dust were provided at electrical stations and on electrical equipment, and at other locations. A foam generating machine, high-pressure rock-dusting machines, and a supply of nails, boards, and brattice also were provided. Telephone service was provided from each section of the mine to the surface.

STORY OF EXPLOSION AND RECOVERY OPERATIONS

Participating Organizations: These include officials and employees of the Mid-Continent Coal and Coke Company, officials of the Redstone Workers Association, the Colorado Coal Mine Inspection Department, and the United States Bureau of Mines.

Activities of Bureau of Mines Personnel: About 12:50 a.m., Wednesday, December 29, 1965, Robert Delaney, vice president and general counsel, Mid-Continent Coal and Coke Company, telephoned R. T. Reay, Federal coal-mine inspector, at his home in Denver, Colorado, that an explosion had occurred in the company's Dutch Creek mine at Redstone, Colorado. Meanwhile Donald Haske, State chief coal-mine inspector, reported the explosion to A. Z. Dimitroff, supervising mining health and safety engineer, United States Bureau of Mines. R. T. Reay, accompanied by Donald Haske, arrived at the mine about 9:30 a.m., December 29. At 3:50 a.m., December 29, Dimitroff telephoned J. Freeman, Federal coal-mine inspector, Price, Utah, that he and T. T. Reay, Jr., Federal coal-mine inspector, Price, Utah, should proceed to the mine. Freeman and T. T. Reay, Jr. arrived at the mine about 12 noon.

When R. T. Reay and Haske arrived at the mine, they learned that ventilation had been restored in the explosion area, that all victims had been located, and that recovery of bodies was about completed.

On December 29, 1965, a withdrawal order was issued under Section 203(a)(1) of the Federal Coal Mine Safety Act, debarring all persons from the Dutch Creek mine, except those needed for exploratory and recovery work. Management had withdrawn all men, except those mentioned above, from the mine before the order was issued.

James Westfield, assistant director--Health and Safety, A. C. Moschetti, technical assistant, and A. Z. Dimitroff arrived in Glenwood Springs shortly before midnight, December 29, 1965, and proceeded to the mine early the next morning.

The following Bureau of Mines personnel assisted in the underground investigation:

James Westfield	
A. C. Moschetti	T. C. Lukins
A. Z. Dimitroff	R. T. Reay
J. Freeman	T. T. Reay, Jr.

A coroner's inquest was held at Aspen, Pitkin County, Colorado, January 4, 1966, and the following organizations were permitted to interrogate witnesses: Assistant District Attorney, Ninth Judicial District, Colorado; Colorado Coal Mine Inspection Department; Mid-Continent Coal and Coke Company; Redstone Workers Association (union representing mine workers); U. S. Bureau of Mines.

Bureau of Mines personnel participating in the inquest were Frank C. Memmott, deputy director, James Westfield, assistant director--Health and Safety, and A. Z. Dimitroff, supervising mining health and safety engineer.

Mine Conditions Immediately Prior to the Explosion: The weather was cold and clear on the day of the explosion. Temperatures and barometric pressures from 6:30 a.m. to 4 p.m., December 28, as recorded at the Aspen airport, Aspen, Pitkin County, Colorado, are listed in appendix H. The barometric pressure dropped from 30.24 to 30.08 during this period and the temperature ranged from 16° to 28° F. Temperatures and barometric pressures were not recorded at the airport between the hours of 4 p.m., December 28, and 6:30 a.m., December 29. It is the opinion of the Bureau of Mines investigators that the change in atmospheric pressure had no bearing on the explosion.

Normal mining operations were in progress when the explosion occurred. The Nos. 2 and 3 main fans were operating. Fire-boss records indicate that the day-shift unit foreman preshift-examined the 4 south section for the afternoon shift and found it reasonably safe and no accumulations of methane. An air reading taken on December 27 and recorded in a book provided for that purpose indicated that 95,000 cubic feet of air a minute was passing through the last open crosscut in 4 south entries.

Evidence of Activities and Story of Explosion: The day-shift crew entered the mine Tuesday, December 28, 1965, at 6:45 a.m., and proceeded to the

working places. After the crew in the 4 south section had examined the working places for gas and other hazards, they began mining operations. Mining in this section was accomplished with a Joy 6CM continuous miner, which discharged the coal onto the floor. A Joy 14BU loading machine gathered the coal from the floor and loaded it into two 10SC cable-reel shuttle cars. The shuttle cars hauled the coal to the inby end of the belt conveyor in 3 entry. Mining was confined to developing room 6 down the pitch and connecting crosscuts to room 5 for ventilation purposes. As the crosscuts were completed the one outby was closed with plastic or brattice cloth curtains. A line brattice supported by timbers with a board nailed along the top was maintained 8 to 15 feet from the face, and when necessary a wing curtain was used at the face.

Mining operations progressed normally and the equipment operated trouble free, including the trailing cables. Excessive amounts of methane were not detected. The crew advanced approximately 130 feet and at the end of the shift they had holed No. 2 crosscut through to room 5, but the connection was not completed. Before departing for the surface, they pulled the equipment back from the face area, which is normal procedure.

Robert Henderson, unit foreman, examined the working section for methane and other hazards for the oncoming afternoon shift. Results of this examination, recorded in a book on the surface, indicated that excessive amounts of methane were not detected and that the section was in a reasonably safe condition. When Henderson arrived on the surface, he contacted James Amiday who was unit foreman in 4 south section on the afternoon shift. Henderson briefed Amiday on progress and conditions in the 4 south section.

The second shift entered the mine at 3 p.m., prepared to work a full shift and 4 hours overtime toward making up a shift so that the men could be idle New Years Eve. It was planned to work overtime again Thursday night, December 30. George Dunlap, mechanic, telephoned the 5 north section about 7 p.m., and contacted Lee Seeley, maintenance foreman. Dunlap informed Seeley that he was having trouble with the left-hand-drive shuttle car in 4 south section because the power circuit breaker kept tripping. Seeley suggested that Dunlap examine the cable on the reel. When Seeley contacted Dunlap a short time later, Seeley learned that the trouble had been eliminated.

About 8 p.m., James Amiday interrupted a telephone conversation between Raymond Wardlaw, outside man, and Magnus Abelin, mine foreman, who was in 5 north. Amiday informed Abelin that operations in 4 south were stopped because of gas. Sometime between 10 p.m. and 10:20 p.m., Amiday telephoned Abelin and reported that operations in 4 south had been stopped for about 1-1/2 hours because of gas and he requested Abelin's assistance. Willis

Davis, third-shift mine foreman, reported that when he arrived at the lamp room on the surface, Abelin telephoned from 4 south and gave him work orders for the third shift. About 11:35 p.m., Amiday telephoned to the surface and requested a flame safety lamp because his had been run over by a shuttle car.

The third shift entered the mine at 11:30 p.m., and about 11:45 p.m. as they were walking down the slopes to their assigned working places they felt a concussion that filled the atmosphere with rock dust. Paul Burbridge, belt tender, was in the belt slope near 5 north and was forced to hold onto a prop to keep from being blown over. The crew in 5 north felt the concussion and saw dust in suspension. The 5 north working section is approximately 4,800 feet from 4 south working section (see appendix C). The 5 north section foreman, Frank Gabossi, immediately tried to contact someone in the 4 south section by telephone but received no reply. Dee Smith, fireboss, who had duties on the maintenance shift prior to starting his preshift examination for the day coal-producing shift, was a short distance inside the mine when the explosion occurred. He saw rock dust thrown into suspension, and he returned to the surface and informed Wardlaw that something was wrong. Wardlaw checked the near-by No. 2 fan and noted that the chart indicated a disturbance in the ventilation system (see appendix I). He immediately telephoned Edward Selan, superintendent, at his home and reported that an explosion or large cave-in had occurred in the mine. Selan directed Wardlaw to disconnect the mine power and instruct all men in the mine to proceed to the foreman's shack on the slope and await further instructions. En route to the mine, Selan, John Reeves, vice president and general manager, and Max Wareham, general mine foreman, contacted personnel at the mine via two-way radio and instructed that all uncertified men be removed from the mine.

The investigation revealed that when the explosion occurred, work was in progress driving No. 3 crosscut off room 6 toward room 5, and that the crosscut had been advanced 30 feet. The continuous miner was back 2 feet from the face, with the cutterhead on the floor and the operating controls in "off" position. From 20 to 25 tons of mined coal on the floor in back of the continuous miner extended from the line curtain on the left to the right rib and was piled to within 4 inches of the roof at the apex (see appendix E). A methane feeder was present on the floor 9 feet outby the face on the left side of the continuous miner, and sloughed coal along the right rib near the face indicated that a bump had occurred. The gathering head of the loading machine was in the pile of coal, the conveyor was loaded with coal, and the controls were: pump "off", conveyor "off", tram "off", master switch "on". The right-hand-drive shuttle car was parked under the boom of the loading machine; the shuttle car was about half loaded with coal and the brakes were set. The controls were: lights

"off", conveyor "on", pump "on". It is believed that at the time of the explosion the left-hand-drive shuttle car was parked at 4 entry intersection, which was used as a passby, and that it later ran down room 6 (see appendix E). The controls on this shuttle car were: pump "on", lights "off", brakes "on".

The body of Glen Anderson, continuous miner operator, was found on the left side of room 6, 37 feet outby the bumper of the continuous miner, and his flame safety lamp was 43 feet away on the floor near the left side of the continuous miner. Magnus Abelin was in return air at No. 2 crosscut in 5 room, and his flame safety lamp was 17 feet inby. Edward Smith, loading-machine operator, was found in room 6, 111 feet outby the controls of the loading machine. Location of all victims is shown in appendix E.

The explosion forces demolished or damaged 10 telescopic metal stoppings along the inby end of 4 south entries, ripped out the line brattice and curtains in the section, and moved the tailpiece of the belt conveyor about 10 feet, which caused the conveyor belt to bind and pull apart. The ventilating fans were not damaged by the explosion and ventilation was not interrupted, except in the 4 south section.

The pressure-recording-gage charts for Nos. 2 and 3 fans indicated a disturbance in the ventilation system at the time of the explosion (see appendices I and J). The time of the explosion was determined by statements from workmen who were in the mine and felt the concussion. Reportedly, some men looked at their watches at the time and determined it was 11:45 p.m. The pressure-recording charts were not timed accurately when installed; therefore, the time of disturbance shown on the charts does not coincide with the time reported by the workmen.

Recovery Operations: Immediately after the explosion, Wardlaw called by telephone and reported the occurrence to Selan at his home in Glenwood Springs, Colorado. Selan contacted Reeves, and accompanied by Wareham they proceeded to the mine, using a two-way radio to convey instructions to personnel at the mine. Meanwhile a crew of eight men, later joined by others, carried a telephone and a roll of wire and proceeded in intake air along the 4 south entries, examining stoppings between Nos. 1 and 2 entries as they advanced. They used a carbon monoxide indicator and permissible flame safety lamps to test for gases. About 12:40 a.m., December 29, they found the bodies of Dunlap and Marvin Cattoor, tailpiece man, lying on the floor directly below the power center. An explosive mixture of methane and a high concentration of carbon monoxide were detected at the intersection of room 6 and No. 4 entry.

Reeves, Selan, and Wareham arrived at the mine about 1 a.m. Reeves assumed duties on the surface, and Selan and Wareham went underground and arrived in

the section about 1:30 a.m. and joined the men already there. When an orange glow resembling a fire was detected in room 6 about 112 feet from 4 entry, everyone was removed from the mine except Selan, Wareham, and Jack Moser, mine foreman, No. 2 mine. Moser remained in fresh air while Selan and Wareham put on Chemox breathing apparatus and explored room 6. They located six more bodies and found the orange glow to be a lighted cap lamp on one of the victims. All eight men in room 6 had moved outward from where they were believed to have been immediately before the explosion. The body of the mine foreman was found about 8 a.m. in No. 2 crosscut near room 5. After exploring room 6, they decided to return to the surface. En route they meet Reeves and Harold Mortensen, master mechanic, walking in the 4 south entries. After a short discussion they all decided to return to the surface. About 5:30 a.m., Reeves and three section foremen left the surface en route to the explosion area. Temporary repairs to damaged stoppings were made and line curtains were installed as they advanced.

Oscar T. Rice, district mine inspector, Colorado Coal Mine Inspection Department, arrived at the mine at 6:30 a.m. Rice, accompanied by Selan and a number of employees who were to effect repairs to damaged stoppings and to act as stretcher bearers, entered the mine a few minutes later. By tests made with a permissible flame safety lamp, Rice detected 1-1/2 to 2 percent methane in the No. 1 entry return near crosscut No. 20. Carbon monoxide up to 0.025 percent also was detected.

Stretcher crews began recovering the bodies about 7 a.m., and recovery operations were completed at 10:10 a.m., Wednesday, December 29.

R. T. Reay, Federal coal-mine inspector, and Donald Haske, State chief mine inspector, arrived at the mine about 9:30 a.m. and were informed that temporary ventilation had been established and that recovery operations were about completed. The two inspectors entered the mine immediately and examined the explosion area. Reay collected six samples of the atmosphere in the explosion area; the analyses are listed in table 1. Sample No. Z-9122 collected in No. 4 south return contained 1.75 percent methane and indicated that the rate of methane liberation for a 24-hour period was 1,400,000 cubic feet at that time.

Following the explosion, ventilation was reestablished in the explosion area by the installation of brattice cloth and plastic stoppings in place of damaged stoppings. A new line curtain was installed from the last open crosscut in room 6 to within 10 feet of the face in No. 3 crosscut off room 6. With the No. 1 and No. 2 fans operating, approximately 54,000 cubic feet of air a minute was reaching the last open crosscut in 4 south entries. With the coal pile still in place, only 15,000 cubic feet of air a minute was reaching the inby end of the line curtain. After the coal pile was removed, 21,000 cubic feet of air a minute was reaching the inby end of the line curtain.

INVESTIGATION OF CAUSE OF EXPLOSION

Investigating Committee:

Mid-Continent Coal and Coke Company

J. A. Reeves	General Manager and Vice President
Edward Selan	Superintendent
Max Wareham	General Mine Foreman
Jack Moser	Mine Foreman, No. 2 Dutch Creek mine
Harold Mortensen	Master Mechanic
Val Jensen	Maintenance Foreman
Joe Ruden	Unit Foreman
Robert Henderson	Unit Foreman
Raymond Wardlaw	Outside Man

Redstone Workers Association

John Vidakovich	President and Safety Committeeman
Matthew Biondich	Vice President and Safety Committeeman
James Diamanti	Recording Secretary and Safety Committeeman

Colorado Coal-Mine Inspection Department

Donald Haske	Chief Inspector
Arthur Haske	District Inspector
Oscar T. Rice	District Inspector

United States Bureau of Mines

James Westfield	Assistant Director--Health and Safety
A. C. Moschetti	Technical Assistant
A. Z. Dimitroff	Supervising Mining Health and Safety Engineer
J. Freeman	Coal-Mine Inspector
T. C. Lukins	Mining Health and Safety Engineer
T. T. Reay, Jr.	Coal-Mine Inspector
R. T. Reay	Coal-Mine Inspector

A detailed examination of the explosion area was made by the entire committee. Examinations also were made of the 5 north and 3 south sections. To expedite the work, the committee was divided into two groups, each composed of representatives of each agency. Each group was provided with a mine map properly inscribed so that when the examination was completed, each group might have a complete record of findings. Electrical

equipment in the explosion area was examined by a Bureau of Mines electrical engineer, the company master mechanic, and a mine safety committeeman whose regular occupation is as a mechanic. The findings were recorded heretofore in this report.

The coroner's inquest was held January 4, 1966. A copy of the Coroner's Jury verdict is shown in appendix K.

Methane and Dust as Factors in the Explosion: The following evidence indicates that methane was liberated rather freely in this mine:

1. Official record books kept at the mine show that gas had been found frequently.

2. Air samples collected during the October 1965 Federal inspection showed the rate of methane liberation from the mine to be 4,630,000 cubic feet in 24 hours. The rate of methane liberation from the 4 south section was 520,000 cubic feet in 24 hours at that time.

3. Following the explosion, an explosive mixture of methane and air was detected with a permissible flame safety lamp at the intersection of room 6 and No. 4 entry, 4 south.

4. Air samples collected in the explosion area more than 12 hours after the explosion contained from 0.23 to 1.75 percent methane (see table 1).

5. James Amiday reported that production in 4 south was stopped because of gas at about 8 p.m., Tuesday, December 28, 1965.

6. Indications of a bump were present along the face of room 6 and, reportedly, when a bump occurs large quantities of methane are liberated.

7. A gas feeder was present on the floor in the crosscut on the left side of the continuous miner 9 feet outby the face.

The ventilation in the face area was obstructed by a pile of mined coal discharged on the floor behind the continuous miner. The pile extended from the line curtain to the right rib and was within 4 inches of the roof at the apex.

Coal dust from the shuttle-car roadway, from the coal pile behind the miner, and from the coal on the face equipment entered into the explosion.

Flame: Evidence of soot was present throughout rooms 5 and 6, and in 4 south as far as 300 feet outby room 6. Charred pieces of paper and brattice cloth were found at various places in rooms 5 and 6, and in 4 south as far as 500 feet outby room 6. Large quantities of coke were

present on the props and cap pieces in rooms 5 and 6, and in the 4 south entries from the belt tailpiece inby. Analyses of dust samples collected after the explosion showed from traces to small amounts of coke particles present (see table 2 and appendix F). The coke content of the dust samples collected in the explosion area indicated that the flame traveled throughout rooms 5 and 6 into 4 south entries and extended out No. 1 return entry about 950 feet from room 6 (see appendix L).

Forces: The main forces of the explosion traveled outwardly from the face area of room 6 throughout room 5 and dissipated as they moved along the rock-dusted 4 south entries and main slopes. The forces moved the tailpiece of the belt conveyor in 2 entry about 10 feet, ripped out the line brattice and curtains in the section, and demolished or damaged 10 telescopic metal stoppings (see appendix L).

Probable Point of Origin: Bureau of Mines investigators believe the explosion originated in the vicinity of the loading machine in the face area of room 6 off 4 south entries.

Factors Preventing Spread of Explosion: Applications of rock dust in the 4 south entries prevented further spread of the explosion.

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 and interrogation of and discussions with officials and employees of the Mid-Continent Coal and Coke Company, provided evidence as to the cause and origin of the explosion. The evidence from which the conclusions of the Bureau of Mines investigators are drawn is summarized as follows:

1. An explosion involving methane and coal dust occurred at 11:45 p.m., December 28, 1965. The time was determined by workmen in the mine who checked their watches when they felt the concussion.

2. The victims died in a relatively short time from forces, burns, and possible carbon monoxide poisoning.

3. Methane was liberated in the face areas and was found frequently with permissible flame safety lamps in the 4 south section. About 8 p.m. on the night of the explosion, the unit foreman in 4 south section reported they were having trouble with gas, and between 10 p.m. and 10:20 p.m. the unit foreman requested the assistance of the mine foreman and stated in a telephone message that the working section in 4 south had been shut down from 1 to 1-1/2 hours because of gas.

4. During recovery operations methane was detected with a permissible flame safety lamp near the junction of room 6 and 4 south entries.

5. A methane feeder was present in the floor about 9 feet from the face of the No. 3 crosscut being driven between rooms 6 and 5. This feeder was evident from gas bubbling violently through water collected on the floor.

6. The presence of loose coal in the right rib of the No. 3 crosscut of room 6 indicated that a bump had occurred. Reportedly, large amounts of methane are liberated into the mine atmosphere when such bumps occur.

7. From 20 to 25 tons of coal were piled on the floor by the continuous miner at the intersection of room 6 and No. 3 crosscut. This coal pile obstructed the ventilation to the working face. The airflow at the end of the line brattice in No. 3 crosscut, room 6, increased from 15,000 cubic feet a minute to 21,000 cubic feet a minute after the coal pile was removed.

8. Five brattice cloth stoppings and a line curtain were used to direct the air current to the face of No. 3 crosscut, room 6. The condition of these stoppings before the explosion could not be determined because they were destroyed by the explosion.

9. A temporary splice in the trailing cable to the loading machine had shorted and blown out. This splice was 31 feet along the cable from the anchor at the loading machine, and was near the right inby wheel of the shuttle car and about 18 feet from the coal pile.

10. A power conductor was exposed at a temporary splice in the trailing cable of the shuttle car that was at the discharge end of the loading machine. An electric arc or spark could have occurred when the bare power conductor contacted the metal surface of the shuttle car.

11. The operating controls of the continuous miner were in the "off" position, and the cutting head was about 2 feet back from the face and on the floor.

12. The gathering head of the loading machine was in the pile of coal and the conveyor was loaded with coal. The master power switch of the loading machine was in the "on" position, indicating this machine may have been in operation at the time of the explosion.

13. The shuttle car parked under the boom of the loading machine was about half loaded with coal, and the conveyor and pump control switches were in the "on" position. This indicated this machine could have been in operation at the time of the explosion.

14. The trailing cables of all equipment in room 6, 4 south, were connected to the power center.

15. Loose coal and coal dust were present on the shuttle-car roadway in room 6, 4 south.

16. Some mine-dust samples collected in the 4 south entry outside the area affected by flame disclosed areas that were deficient in rock dust.

Cause of explosion: The disaster was caused by the ignition of an accumulation of methane by an electrical arc or spark when a temporary splice in the trailing cable of the loading machine shorted out, or by an arc or spark when a bare power conductor in a splice in the trailing cable of the shuttle car came in contact with the frame of the shuttle car. Methane was being liberated from the face, ribs, and a large feeder in the floor in No. 3 crosscut off room 6. The gas accumulated because face ventilation was restricted by a pile of coal behind the continuous miner. Coal dust from the coal pile, from the face equipment, and from the shuttle-car roadway entered into the propagation of the explosion.

RECOMMENDATIONS

The following recommendations are made to prevent similar disasters:

1. Air in sufficient quantity to prevent accumulations of explosive gases shall be directed to the working faces at all times.

2. Coal should not be piled behind the continuous miner to the extent that the ventilating current is obstructed. The company rule limiting this amount of piled coal to 4 tons should be complied with at all times.

3. Testing for methane in face workings shall be at sufficiently frequent intervals to detect buildup of methane concentrations before they reach dangerous proportions.

4. When the air contains more than 1.0 percent methane, electrical equipment shall not be operated and power shall be cut off. Adjustments shall be made at once in the ventilation so that the air will not contain more than 1.0 percent methane.

5. Temporary splices in trailing cables should be made in a workmanlike manner, mechanically strong, and well insulated. Connectors on power conductors should be staggered properly to minimize the possibility of short circuiting the power conductors.

6. Loose coal or coal dust shall not be permitted to accumulate in dangerous quantities along shuttle-car roadways.

7. Metal telescopic stoppings should be installed and maintained at all times in all room crosscuts except the two nearest the working face.

8. To minimize loss of air, line curtains should be constructed of impervious bratticing material installed in a workmanlike manner and supported at the top and bottom.

9. Rock dust in adequate quantity shall be applied and maintained to within 40 feet of the faces in all working places that are not wet, including open crosscuts.

10. Rock dust shall be distributed upon the roof, ribs, and floor 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, plus 1 percent for each 0.1 percent of methane present in the ventilating current.

11. The number of temporary splices in trailing cables shall be kept to a minimum and in no case shall exceed five in number, including those in the extensions.

12. Care should be used to protect all trailing cables from avoidable mechanical damage; trailing cables of continuous miners and loading machines should be suspended, where possible, to prevent them from being run over.

13. Permissible flame safety lamps carried underground by officials and employees should be handled with extreme care and protected against damage such as allowing them to be run over by shuttle cars.

The following three recommendations have no bearing on the explosion but should be given careful consideration:

1. Surface power wires, particularly those serving the fans, should be so installed that high winds will not cause short circuiting.

2. All employees and supervisors should be given accident-prevention training.

3. Mine rescue teams should be trained at this mine. A mine rescue station equipped with at least five sets of 2-hour self-contained breathing apparatus should be provided.

The following good mining practices were inaugurated by management upon recommendation by the Bureau when mining was resumed:

1. Continuous methane monitors were installed on the two continuous miners in the mine. These were installed so that in addition to providing warning of methane buildup, a red-light alarm will come on and operation of the machin will be stopped automatically at a predetermined percentage of methane.

2. A program of installing metal telescopic stoppings in room crosscuts was instituted, so that at no time will there be more than one temporary brattice-cloth stopping.

3. The company has purchased heavy impervious plastic material for the erection of temporary stoppings and line curtains.

4. The company and the State mine inspection department are conducting a study to determine if a mining system can be developed that will not require the continuous miner to dump coal on the floor.

5. The permissible slow-feed rock-dusting machine was moved from return air and placed in intake air with the discharge end of the tubing extending into return air.

6. A program was instituted of holding periodic safety meetings with all employees and supervisors attending.

7. The company ordered five 2-hour, self-contained breathing apparatus.

8. Bleeder entries are planned in future development in the south side of the mine.

ACKNOWLEDGMENT

The writers gratefully acknowledge the courtesies, cooperation, and assistance extended by officials and employees of the operating company, officials and other members of the Redstone Workers Association, and representatives of the Colorado Coal Mine Inspection Department.

Respectfully submitted,

J. Freeman

J. Freeman

A. Z. Dimitroff

Approved:

James Westfield
Assistant Director--Health & Safety

A. C. Moschetti

A. C. Moschetti

Walter R. Hibbard, Jr.
Director

TABLE 1--ANALYSES OF AIR SAMPLES

MINE Dutch Creek COMPANY Mid-Continent Coal & Coke Company COLLECTED BY R. T. Reay

DATE AND TIME	BOTTLE NO.	LOCATION IN MINE	CARBON DIOXIDE	OXYGEN	METHANE	NITROGEN	CUBIC FEET AIR PER MINUTE	CUBIC FEET METHANE IN 24 HOURS
12/29/65 1:05 p.m.	Z-9122	Immediate split return 4 south section	0.30	20.44	1.75	77.51	54,000	1,400,000
12/29/65 12:05 p.m.	X-9366	80 feet outby face of room 6 off 4 south section	0.10	20.79	0.46	78.65	Moving	
12/29/65 12:15 p.m.	X-9365	Return from face of No. 3 crosscut 15 feet outby face at return line brattice room 6	0.38	20.62	1.61	77.39	15,000	350,000
12/30/65 12:45 p.m.	Z-1121	Return from No. 3 crosscut at end of line brattice room 6	0.15	20.69	0.81	78.35	53,800	630,000
12/30/65 12:35 p.m.	Z-1120	80 feet outby face of room 6 off 4 south, No. 3 crosscut	0.14	20.88	0.23	78.75		
12/30/65 1:20 p.m.	Z-9128	Immediate split return 4 south section	0.24	20.74	0.95	78.07	57,800	790,000

TABLE 2--ANALYSES OF DUST SAMPLES

Sheet No. 1

DATE COLLECTED December 31, 1965

MINE Dutch Creek COMPANY Mid-Continent Coal and Coke Co. COLLECTED BY A. C. Moschetti, J. Freeman, R. T. Reay, and T. T. Reay, Jr.

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	AS-RECEIVED PERCENT INCOMBUSTIBLE
		EXPLOSION SAMPLES		
L-1	Band	Between Nos. 2 and 3 crosscuts, room 6, 4 south	Small	20.9
L-2	Band	Between Nos. 1 and 2 crosscuts, room 6, 4 south	Trace	10.1
L-3	Band	Between No. 4 entry and No. 1 crosscut, room 6, 4 south	Trace	15.5
L-4	Band	In No. 20 crosscut, between No. 3 and 4 entries, 4 south	Trace	12.3
L-5	Band	In No. 20 crosscut, between Nos. 2 and 3 entries, 4 south	Trace	29.4
L-6	Band	In No. 20 crosscut, between Nos. 1 and 2 entries, 4 south	Trace	42.3
LXM-1	Band	In No. 2 crosscut, between rooms 5 and 6, 4 south	Trace	13.3
LXM-2	Band	In No. 4 entry between rooms 5 and 6, 4 south	Small	22.3
M-1	Band	Between Nos. 2 and 3 crosscuts, room 5, 4 south	Trace	22.1
M-2	Band	In No. 21 crosscut, between Nos. 3 and 4 entries, 4 south	Trace	20.0

TABLE 2--ANALYSES OF DUST SAMPLES

Sheet No. 2

DATE COLLECTED December 31, 1965

MINE Dutch Creek COMPANY Mid-Continent Coal and Coke Co. COLLECTED BY A. C. Moschetti, J. Freeman, R. T. Reay, and T. T. Reay, Jr.

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	AS-RECEIVED PERCENT INCOMBUSTIBLE
		EXPLOSION SAMPLES		
M-3	Band	In No. 21 crosscut, between Nos. 2 and 3 entries, 4 south	Trace	36.7
MX-1	Band	In No. 1 crosscut, between rooms 4 and 5, 4 south	Small	23.3
MX-2	Band	In No. 4 entry, between rooms 4 and 5, 4 south	Small	15.8
MX-3	Band	In No. 2 entry, between Nos. 21 and 22 crosscuts, 4 south	Trace	19.8
A-7	Band	In No. 1 slope, about 150 feet below 3 south	None	65.6
B-7	Band	In No. 2 slope, about 150 feet below 3 south	None	75.*
C-7	Band	In No. 3 slope, about 150 feet below 3 south	None	82.*
D-7	Band	In No. 4 slope, about 150 feet below 3 south	None	85.*
E-7	Band	In No. 5 slope, about 150 feet below 3 south	None	64.7
F-7	Band	In No. 6 slope, about 150 feet below 3 south	None	93.*
G-7	Band	In No. 7 slope, about 150 feet below 3 south	None	83.*

*By volumeter

TABLE 2--ANALYSES OF DUST SAMPLES

Sheet No. 3

DATE COLLECTED December 31, 1965

MINE Dutch Creek COMPANY Mid-Continent Coal and Coke Co. COLLECTED BY A. C. Moschetti, J. Freeman, R. T. Reay, and T. T. Reay, Jr.

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	AS-RECEIVED PERCENT INCOMBUSTIBLE
		EXPLOSION SAMPLES		
		No. 4 South entries. Centerline of No. 2 slope + 30 feet = 0.		
		A = No. 1 entry, 4 south		
A-6	Band	0 + 00	None	70.4
A-5	Band	0 + 400	None	93.*
A-4	Band	0 + 800	None	92.*
A-3	Band	0 + 1,200	Trace	58.2
A-2	Band	0 + 1,600	Trace	73.2
A-1	Band	0 + 2,000	Trace	70.0
		B = No. 2 entry, 4 south		
B-6	Band	0 + 00	None	61.2
B-5	Band	0 + 400	None	59.1
B-4	Band	0 + 800	None	57.8
BXC-4	Band	0 + 770 (crosscut)	None	66.9
B-3	Band	0 + 1,200	None	50.4
B-2	Band	0 + 1,600	Trace	51.1
B-1	Band	0 + 2,000	Trace	36.2
		C = No. 3 entry, 4 south		
C-6	Band	0 + 00	None	69.1
C-5	Band	0 + 400	None	74.*
C-4	Band	0 + 800	None	79.*
C-3	Band	0 + 1,200 *By volumeter	None	61.5

TABLE 2--ANALYSES OF DUST SAMPLES

Sheet No. 4

DATE COLLECTED December 31, 1965

MINE Dutch Creek COMPANY Mid-Continent Coal and Coke Co. COLLECTED BY A. C. Moschetti, J. Freeman, R. T. Reay, and T. T. Reay, Jr.

SAMPLE NO.	SAMPLE OF DUST FROM	LOCATION IN MINE	ALCOHOL COKE TEST	AS-RECEIVED PERCENT INCOMBUSTIBLE
		EXPLOSION SAMPLES		
C-2	Band	0 + 1,600	Small	49.0
CXD-2	Band	0 + 1,620 (crosscut)	None	80.*
C-1	Band	0 + 2,000	Trace	43.3
		D = No. 4 entry, 4 south		
D-6		0 + 00 No sample		
D-5	Band	0 + 400	None	97.*
D-4	Band	0 + 800	None	86.*
D-3	Band	0 + 1,200	None	13.*
D-2		0 + 1,600 No sample - water		
D-1	Band	0 + 2,000	Small	19.1
LL	Coke	Intersection No. 1 entry and No. 20 crosscut, 4 south (off cap piece over post)	Large	26.7
L	Coke	Intersection No. 2 entry and No. 20 crosscut, 4 south (off roof bolt header block)	Small	24.3
LXM	Coke	In No. 2 crosscut between rooms 5 and 6, 4 south (off side of post)	Large	14.3
M	Coke	In room 5 between Nos. 2 and 3 crosscuts, 4 south (off side of post)	Large	17.5
MX	Coke	In No. 1 crosscut between Nos. 4 and 5 rooms, 4 south (off side of post)	Large	17.8

*By volumeter

APPENDIX A

TELEGRAM

DECEMBER 29, 1965

JAMES WESTFIELD, ASST. DIR.--HEALTH AND SAFETY, BUREAU OF MINES
C/O MID-CONTINENT COAL AND COKE COMPANY
REDSTONE, PITKIN COUNTY, COLORADO

ARE DEEPLY DISTRESSED OVER TRAGIC DISASTER AT DUTCH CREEK MINE, NEWS OF WHICH REACHED US EARLIER THIS MORNING. MAKE CERTAIN WE ARE RENDERING ALL ASSISTANCE POSSIBLE. UNDERTAKE FULL INVESTIGATION AS SOON AS ALL RECOVERY OPERATIONS ARE COMPLETED. KEEP ME FULLY INFORMED OF PROGRESS.

Walter R. Hibbard, Jr.
DIRECTOR, Bureau of Mines

APPENDIX B

Victims of explosion

Name	Age	Occupation	Years Employed in this mine	Marital Status	Dependents (Incl. children under 18)
Magnus L. Abelin	47	Mine foreman	6 years 5 months	Married	Wife
James Clyde Amiday	36	Unit foreman	6 years 10 months	Married	Wife and 3 children
Glen J. Anderson	30	Miner operator	4 years 10 months	Married	Wife and 2 children
Marvin Cattoor	32	Tailpiece man	1 month	Married	Wife and 3 children
George Otis Dunlap	33	Mechanic	4 years 6 months	Married	Wife and 2 children
Albert Joseph Oberster	43	Shuttle car operator	4 years 8 months	Married	Wife and 1 child
Edward William Smith	27	Loader operator	3 years 7 months	Married	Wife and 2 children
Spencer Easton Snow	48	Shuttle car operator	4 years 3 months	Married	Wife
Robert LeRoy Story	22	Miner helper	6 months	Married	Wife and 1 child

APPENDIX D

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

4800 Forbes Avenue
Pittsburgh, Pennsylvania 15213

Branch of
Electrical-Mechanical Testing

Health and Safety

January 13, 1966

Memorandum

To : A. C. Moschetti, Acting District Manager, Health and Safety
District E, 1457 Ammons Street, Post Office Box 15037,
Lakewood, Colorado 80215

From : C. L. Brown, Chief, Branch of Electrical-Mechanical Testing

Subject: Report on two Koehler flame safety lamps recovered from explosion in Dutch Creek mine of the Mid-Continent Coal and Coke Company, Redstone, Pitkin County, Colorado

The lamps in question are model 257 aluminum Koehler flame safety lamps. One was designated as belonging to Glen Anderson, continuous miner operator, and the other to Magnus Abelin, mine foreman, second shift. The lamps were received at the Health and Safety Research and Testing Center, Pittsburgh, Pennsylvania, on January 7, 1966, at 10 a.m.

General Observations

Prior to any inspection or testing, an attempt was made to light both lamps. Both lamps functioned with the foreman's lamp burning in a capped position and the machine operator's lamp burning at a height slightly below a walking flame.

External Inspection

The lamps carry Bureau of Mines approval 209. All parts are genuine and were assembled properly. The magnetic locks are intact. Internally and externally, both lamps are covered with coal dust and none of the visible areas appear burned.

Safety Tests

Safety tests were conducted in gallery 3 using mixtures of natural gas and air varying between 6.9 and 9.0 percent. Six tests on each were made by injecting a heated and lighted lamp suddenly into the mixture. A second series of tests were made by surrounding the lamps in the gallery with the explosive mixtures and using the igniter to initiate internal lamp ignitions.

Seventy-five internal ignitions were created in each lamp, some with the mixing fan running to create turbulence; no external ignitions occurred. The safety tests were made with the lamps intact as recovered from the explosion.

Internal Inspection

The lamps were disassembled and examined for defects and variances from permissible construction. The results of this inspection are as follows:

1. Foreman's lamp.

The lamp was assembled properly with the magnetic lock in good working order. The fount is in good condition--no gouges or deep scratches on the top surface. The threads are not damaged and the igniter properly installed and working.

The lower air inlet ring is in good condition, having a flat surface and fitting the fount top in such a manner as to prevent a 0.002 inch feeler gage from entering. Gauzes are intact, not rusted, and the asbestos washer is relatively new.

The glass chimney is genuine and has no spawls or cracks. Both ends of the chimney are fired, smooth and less than 1/32 of an inch off perpendicular to the sides of the chimney. The asbestos washer and washer retaining ring are good. The expansion spring retains its resilience.

The outer and inner gauzes are of steel, unrusted, with no broken or distorted wires. There is no evidence of overheating. The gauzes are in very good condition.

The bonnet and top are in good shape except for two louvres that are partially closed.

2. Machine operator's lamp.

The results of the tests shown for the foreman's lamp are exactly the same as for the operator's lamp with the exception of the bonnet top, which is somewhat damaged from machine use, but still adequate for the safe operation of the lamp.

Conclusions

The two model 257 Koehler flame safety lamps appear to have been maintained in very good condition. There are no deviations from the allowable permissible tolerances. The lamps are hereby judged to have been in permissible condition when received at the Bureau.

/s/ C. L. Brown
C. L. Brown

APPENDIX G

Blown-out temporary splice in loading machine trailing cable, showing grounding conductors (fig. 1), and burned power conductors (fig. 2). The outside tape has been cut open to show inside of splice.

Figure 1

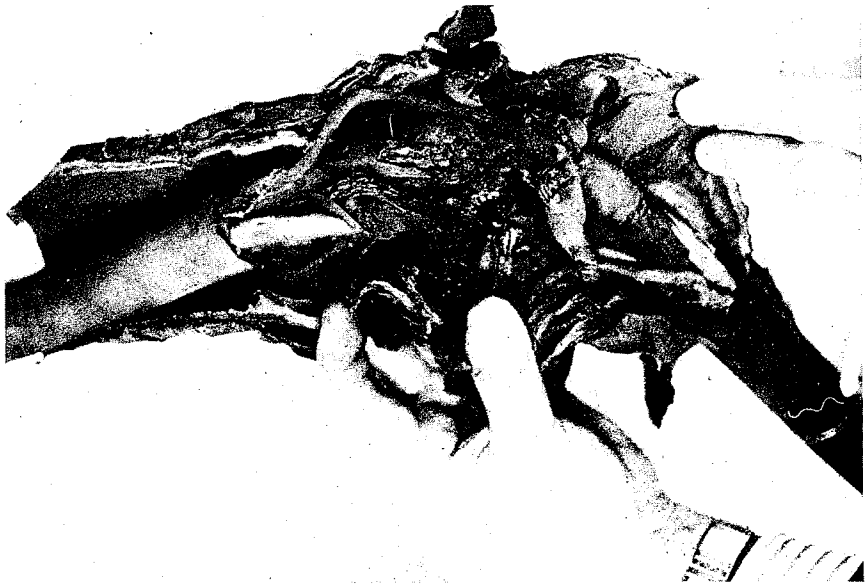


Figure 2

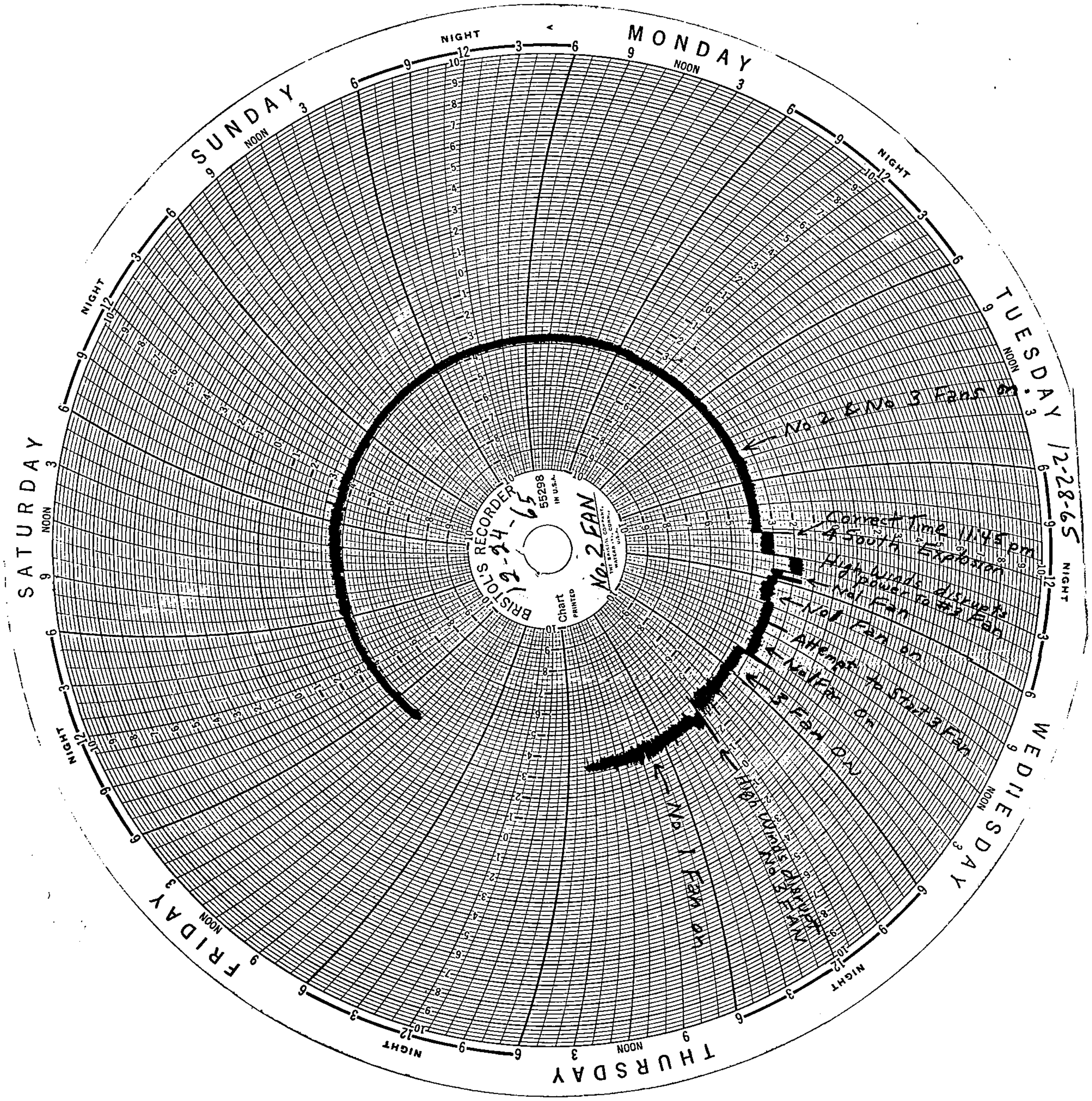
APPENDIX H

BAROMETRIC PRESSURES AND TEMPERATURE READINGS AS

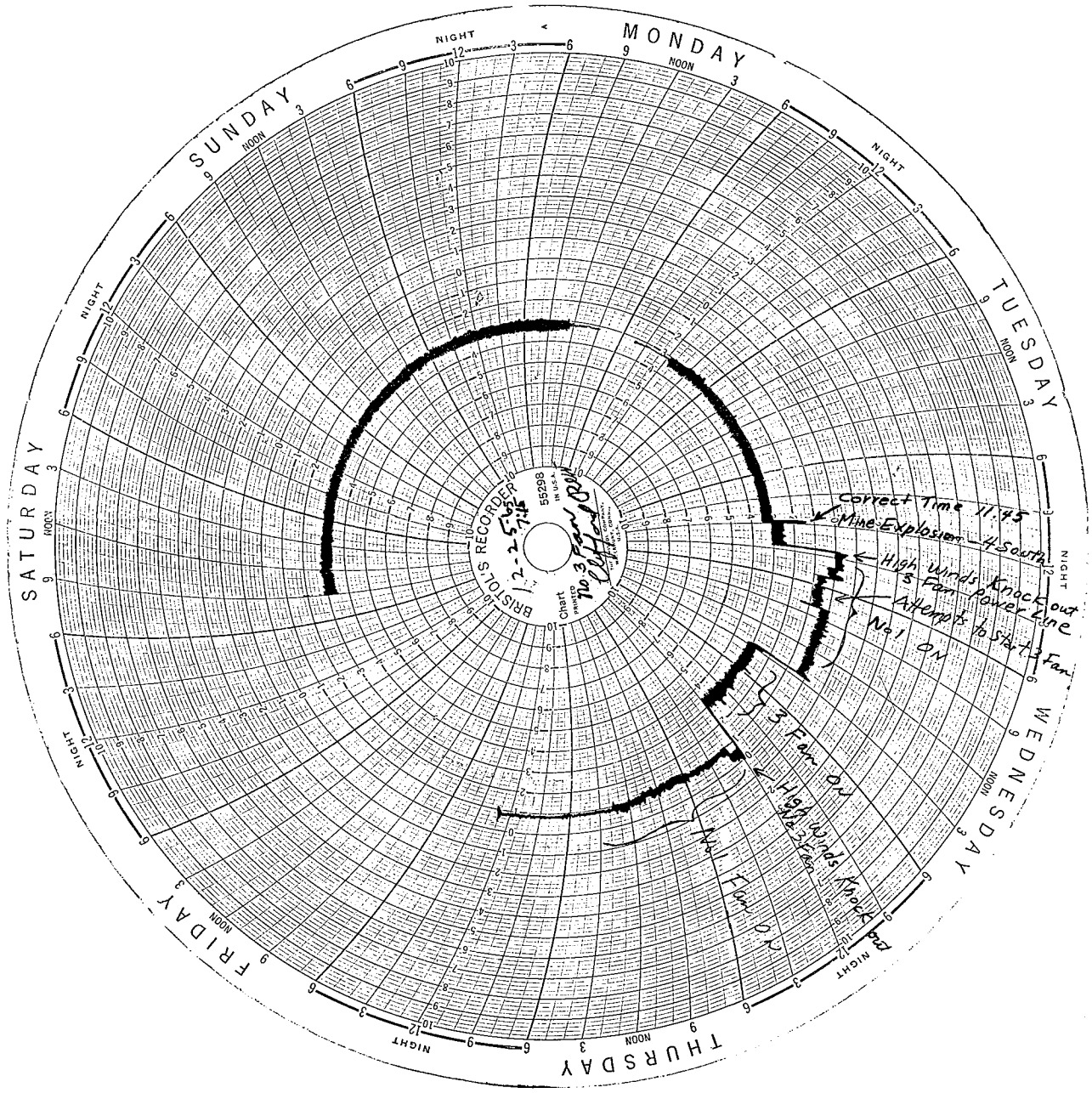
RECORDED AT ASPEN AIRPORT, ASPEN, PITKIN COUNTY, COLORADO

Time	Tuesday, December 28, 1965 Temperature	Barometric Pressure
6:30 a.m.	14°	30.24
8:00 a.m.	16°	30.22
9:00 a.m.	Missing	Missing
10:00 a.m.	Missing	Missing
11:00 a.m.	27°	30.21
12:00 Noon	27°	30.22
1:00 p.m.	34°	30.22
2:00 p.m.	34°	30.10
3:00 p.m.	32°	30.09
4:00 p.m.	28°	30.08

APPENDIX I


BRISTOL'S RECORDER
55298
12-24-65
No. 2 FAN
SUNDAY
MONDAY
TUESDAY 12-28-65
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY
No 2 & No 3 Fans on.
Correct Time 11:45 pm
4 South Explosion
High winds disrupts power to #3 Fan
No1 Fan
No1 Fan on
Attempt to Start 3 Fan
No1 Fan on
3 Fan ON
High Winds disrupt No 3 FAN
No 1 Fan on

APPENDIX J



GPO 858-767

APPENDIX K

CORONER'S JURY VERDICT

STATE OF COLORADO)
)
PITKIN COUNTY)

An inquisition holden at Aspen, Colorado, in Pitkin county, on the 4th day of January A.D. 1966, before Bernard Popish, coroner of said county, upon the dead bodies of MARVIN CATTOOR, JAMES AMIDAY, EDWARD SMITH, ROBERT STORY, ESTON SNOW, MAGNUS ABELIN, ALBERT OBERSTER, GLENN ANDERSON and GEORGE DUNLAP, lying there dead, by the jurors whose names are hereto subscribed; the said jurors upon their oaths, do say:

1. State when deaths occurred.

11:45 A.M. December, 1965

2. State how deaths occurred.

Explosion of Methane gas and air

3. Were deaths caused by person or persons?

No

4. By what means were the deaths caused?

Concussion and fire

5. Were the deaths accidental?

Yes

6. Were the deaths caused by felonious conduct?

No

In Testimony Whereof, the said jurors have hereunto set their hands the day and year aforesaid.

CORONER'S JURY

Donald Snyder
Donald Snyder

Storrs W. Bishop
Storrs Bishop

John Strong
John Strong, Jr.

Robert Smith
Robert Smith

Martin J. Cerise
Martin Cerise

Dale Alcorn
Dale Alcorn