UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Health and Safety District H

FINAL REPORT OF MAJOR MINE-EXPLOSION DISASTER
NO. 2 MINE
CARBON FUEL COMPANY
HELPER, CARBON COUNTY, UTAH

December 16, 1963

By

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Subdistrict Supervisor

and

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INTRODUCTION

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

A gas and coal-dust explosion occurred in the No. 2 mine of the Carbon Fuel Company near Helper, Carbon County, Utah, about 12 m., Monday, December 16, 1963. A total of 21 men was in the mine at the time of occurrence; 9 perished almost immediately, 1 was injured by the forces and required hospitalization, and 11 escaped uninjured.

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

Bureau of Mines investigators believe that the explosion originated at the face of No. 4 dip entry, fifth west dip section, where an explosive mixture of methane, air, and coal dust was ignited by frictional sparks from the bits of the continuous miner cutting in top rock, or by arcs or sparks from electrical equipment that was in nonpermissible condition. The main forces of the explosion traveled outwardly from the face of No. 4 dip entry throughout the fifth west dip section, fifth west section, three abandoned rooms east off the dip section and dissipated as they moved along the well rock-dusted fourth west main entries and main slope.

The fifth west dip entries had been developed about 100 feet on Federal land.

GENERAL INFORMATION

The No. 2 mine of the Carbon Fuel Company is situated in Hardscrabble Canyon about 2-1/2 miles off U. S. Highway Nos. 50-6 and about 4 miles northwest of Helper, Carbon County, Utah. Autotrucks were used to haul the coal from the tipple to the railroad loading ramp at Martin, Utah, about 2-1/2 miles from the mine. The loading ramp was served by the Utah Railway Company. Coal that was not transported by railroad was loaded into autotrucks at the mine tipple and delivered to the consumer or distributor.

The operating officials of the company were:

James J. Diamanti	President
Chris J. Diamanti	Mine Superintendent
Louis Vuksinick	Mine Foreman

A total of 30 men was employed of which 21 worked underground on the day shift and 3 maintenance men worked underground on the afternoon shift. The mine was operated 3 or 4 days a week and the average daily production was 1,000 tons of coal, mined and loaded mechanically, and transported by shuttle cars and belts.

The mine was opened by a slope about 2,300 feet long and an air shaft about 33 feet deep which extends from the surface into the Castlegate "B" coalbed which ranges from 8-1/2 to 15 feet in thickness and dips from 9 to 16 percent northerly. The immediate roof is shaly sandstone with sandstone of varying thickness underlain by occasional layers of shale up to 13 inches in thickness. The floor was a hard shale.

The coal is of high-volatile bituminous rank. The analysis of a tipple coal sample from the Castlegate "B" seam taken from No. 2 mine is as follows:

	Percent
Volatile Matter	46.1
Fixed Carbon	48.2
Ash	5.7

Tests by the Bureau of Mines have shown that coal dust having a volatile ratio of 0.12 is explosive and that the explosibility increases with the increase in the volatile ratio. The volatile ratio of the coal in this mine as determined from the aforementioned analysis is 0.49, indicating that the dust from this coal is highly explosive.

The last Federal inspection of this mine was completed on October 14, 1963.

MINING METHODS, CONDITIONS, AND EQUIPMENT

Mining Methods: The room-and-pillar method of mining was practiced, but pillars were not recovered. Entries in sets of from 2 to 7 were driven from 18 to 20 feet wide on 75-foot centers, rooms were 20 to 24 feet wide on 75-foot centers, and crosscuts ranged from 75 to 85 feet apart. Mining, accomplished by two ripper-type continuous miners, type CM 48Y-3E, was confined to developing the fifth west dip entries and driving rooms in the third east section. The adopted procedure for mining with the continuous miner in the dip section was to advance the right or intake air side of the face for a distance of 15 feet, then advance the left or return air side the same distance leaving a fender of coal down the center which had to be cut out with the miner. In the fifth west dip section each of the four entries would be developed at least 80 feet inby the last open crosscut without making any air connections. After the last entry was advanced a crosscut would be started from No. 1 dip entry and driven across to the No. 4 dip entry.

The coalbed in the fifth west dip section averaged about 8-1/2 feet in thickness and was overlain by approximately 1,400 feet of burden. A slickenside rock exposed in the face of No. 4 dip entry indicated a down throw or roll in the coalbed. Generally, about 2 feet of top coal was left as the immediate roof.

The roof was supported by a row of props with 4- by 6- by 18-inch cap pieces installed from 4 to 8 feet apart about 3 feet from each rib and maintained as close to the rear of the continuous miner as practicable. Expansion shell-type roof bolts 5 and 6 feet in length equipped with expansion shells and steel bearing plates were used in conjunction with props where a rock split was encountered and not taken down.

The adopted roof-bolting plan was approved by the Bureau of Mines

Explosives: Explosives were not used or stored underground.

Ventilation and Mine Gases: Ventilation was induced into the mine by means of a 7-foot axial flow fan installed on the surface in a metal housing equipped with a metal air duct and explosion doors, and was offset 25 feet from the nearest side of the shaft opening. The exhaust fan was driven electrically and operated continuously. An 8-foot axial flow and two 36-inch centrifugal fans were maintained on the surface as standbys. The fans were equipped with a pressure recording gage. A split system of ventilation was employed. Permanent stoppings were constructed of concrete blocks, and overcasts were built with concrete blocks and metal. Line brattices nailed to props or suspended from metal spads driven in the roof were used to conduct air from the last open crosscut to the face areas. Although the line brattice curtains in the fifth west dip section were destroyed by the explosion, evidence indicated that the inby ends of the curtains varied from 8 to 36 feet from the faces. A visit to the third east working section showed a well installed line brattice maintained to within 2 feet of the rear bumper of the continuous miner, a line brattice in one of the rooms was open about 18 inches at the outby end, and line curtains were not provided in several rooms that were deadended. At the time of the explosion the air current in dip entries 1, 2, and 3 was uncontrolled since check curtains were not installed where needed. The air was directed to the face of 4 dip entry by line brattice which extended from the last open crosscut to within 15 feet of the left side of the face and a distance of 36 feet from the right side of the face in which the miner was operating when the explosion occurred. To prevent float coal dust from passing over the continuous miner and shuttle car, air was coursed in over the equipment and miner operator and returned along the narrow side of the line curtain. During the October 1963 Federal inspection a minimum of 22,000 cubic feet of air a minute was passing through the last open crosscut of active entries, and approximately 136,800 cubic feet of air a minute was exhausted from the mine. During this same inspection methane was not detected with a flame safety lamp or a permissible electric methane detector, but the analysis of an air sample collected in the main return showed 0.04 percent methane indicating that the mine was liberating 81,000 cubic feet of methane in a 24-hour period.

Also, the analysis of an air sample collected in the return from the fifth west section off the fifth west dips contained 0.06 percent methane indicating that 41,000 cubic feet of methane was being liberated from this section in a 24-hour period. According to testimony at the hearing and the mine record books, methane had been detected but a few times in this mine, the most recent being on September 3, 1963, when the fire boss found about 1 percent of methane in a small crevice in the roof in the No. 3 entry in the fifth west section off the fifth west dip section. Tests made with a permissible flame safety lamp and a permissible electric methane detector about 1:15 p.m. on the day of the explosion showed at least 5 percent of methane present at the neck of No. 1 room east off the fifth west dip entries. The analyses of air samples collected later during the investigation and recovery operations are shown in table 1 of the report.

This mine was classed gassy by the Bureau of Mines on March 9, 1959, when the analysis of an air sample collected more than 12 inches from the roof, face, and ribs in No.15 room off south side entry showed 1.05 percent methane. Crude oil was seeping from the roof at several places in the working section of fifth west dip section. (See appendix I.) Oil or gas wells are not in the vicinity of the mine. Preshift, onshift, and weekly examinations of the mine for hazards, including tests for methane and oxygen deficiency with permissible flame safety lamps and a permissible electric methane detector were made by certified persons. The results of these tests and examinations were recorded in books provided for that purpose. Posted dates and initials indicated that preshift and weekly examinations of the mine were made, but it was evident that sufficient onshift examinations for gas were not made at the working faces. During the hearing it was disclosed that on Saturday prior to the explosion, roof-bolters on the afternoon shift worked in the face areas of Nos. 2 and 3 dip entries, fifth west dip section and they did not carry a permissible flame safety lamp to make tests for methane.

The continuous miner operator's flame safety lamp was found hanging in the cage of the continuous miner, and the section foreman's flame safety lamp was found hanging from a nail driven in the outby side of a prop in the face area of No. 4 dip entry. An examination of these lamps by the Bureau of Mines showed them to be in safe operating condition.

Air measurements were made weekly and the results recorded in a book on the surface. The air measurements taken December 13, 1963, and recorded in a book were: Main intake 130,200 cfm, main return 136,800 cfm, last open crosscut in third east section 39,690 cfm, last open crosscut in fifth west dip entries 15,000 cfm, and fifth west dip section return 49,400 cfm. The Joint Industry Safety Committee has authorized the use of auxiliary fans in the mine upon compliance with specified conditions, but auxiliary fans were not used.

Dust: The mine was dry, except water was produced in the face areas of the fifth west dip entries. Dangerous accumulations of coal dust were not observed during the October 1963 inspection. The belt entries and shuttle car roadways not affected by the explosion and observed during the investigation were reasonably free from coal-dust accumulations, but the return air course in the third east section contained much float coal dust over the top of the heavy applications of rock dust.

Water with a wetting agent (Aquedyne) under 80 psi was delivered through a 1-1/2-inch pipe to the face areas and was used to allay coal dust formed during mining operations. The continuous miners were each equipped by the manufacturer with 21 water sprays and, reportedly, the company added three to each miner. During the investigation it was discovered that the drive chain and a locking key were missing on the drive shaft to the water pump on the left side of the continuous miner in the fifth west dip section. According to the local Lee-Norse representative, this pump delivers 225 psi nozzle pressure and operates half of the sprays.

The mine was rock-dusted throughout, including the back slope and back entries. It was disclosed at the hearing that the face areas in the working section were rock-dusted after each coal-producing shift by a maintenance crew on the afternoon shift or on an idle day, but rock dust was not applied during the coal-producing shift even though the faces were advanced as much as 80 feet. During the October 1963 inspection 24 survey dust samples were collected in the fifth west dip section and 6 representative spot-location samples were collected in other areas. Of the 30 samples collected only one survey sample was substandard and the area represented by this sample was rerock-dusted before the close of the inspection. (Refer to table 4.)

A total of 251 dust samples was collected in the mine after the explosion and the results of the analyses are listed in table 2 and indicated on appendixes F and G. The samples were collected in the main slopes, fourth west entries, the explosion area on the west side of the mine, and 4 raise entries in the third east section.

Of the 46 dust samples collected in the main slopes, 6 contained less than 65 percent incombustible material. Twenty-eight samples were collected in the working area of the east section of the mine and 7 samples contained less than 65 percent incombustible material. Thirty-two dust samples were collected in fourth west entries and 15 contained less than 65 percent minimum incombustible material required. One hundred and forty-five samples were collected in the explosion area and 139 contained less than 65 percent incombustible material.

The results obtained from the analyses of the dust samples collected in the explosion area are not a true representation of conditions in the mine prior to the explosion. This is supported by the analyses of dust samples collected in the explosion area during the October 1963 Federal inspection, which indicated that the area was adequately rock dusted in that only one survey sample contained less than the required minimum.

Samples of the float dust were collected in the main east return entry from the face to about 4,000 feet outby the face, and the results of the analyses are listed in table 3.

The size test of the float dust samples showed that in 17 of the 20 collected samples, more than 60 percent passed through a 325 mesh screen. The maximum and minimum amounts of an individual sample to pass through a 325 mesh screen were 85.8 and 26.1 percent respectively.

Rock dust definitely reduced the violence of the explosion in the west side of the mine and prevented propagation of the explosion into other areas.

Transportation: Coal was transported from the working faces to loading heads of the belt conveyors in permissible-type cable-reel shuttle cars with a capacity of 10 tons each. The loaded shuttle cars discharged the coal onto the loading heads of the fire-resistant belt conveyors and the belts conveyed the coal through a series of transfer points to the tipple on the surface.

compartment. The sprocket on the left side drive for the water spray pump was loose on the drive shaft. The key of this sprocket and the drive chain were missing. This miner was equipped with a Type W, 3-Conductor cable and therefore did not have the frame grounded. The master (safety) switch of this machine was in the "on" position, the headlight switch was in the "off" position, and the only control not in neutral was that of the gathering head which was in "down" position. The throttle which is spring loaded was in the "off" position.

The permissible shuttle car next to the continuous miner, which was Joy Type 10SC6PH-10, had an opening in excess of 0.004 inch in the controller compartment. This car had a broken rod from the operator's cab to the power disconnecting breaker near the cable reel, and the breaker could not be thrown "on" or "off" without removing the cover of the explosion-proof compartment. The headlight switch on this car was in the "on" position as well as the hydraulic pump switch, but the conveyor switch was in the "off" position and the brake was also "off".

Two other shuttle cars were in this section, one of which was Type 10SC6PH-10 and the other Type 10SC6PXH-10. Permissibility defects were not observed on these two shuttle cars.

The Acme roof-bolting machine in this section had an opening in excess of 0.004 inch in the controller compartment of the permissible Model 325Ra4-C rotary air compressor.

A nonpermissible portable water pump was located in the face of No. 1 entry in the fifth west dip section. This pump evidently had not been in operation at the time of the explosion since it was not connected at the nipping station.

The permissible Joy loading machine, Type 11BU-11APH in this section was examined and permissibility defects were not observed.

The nonpermissible portable equipment in this section consisted of a rock-dusting machine, a greasing outfit, and an extra water pump. Nonpermissible battery operated Kersey cars were also used for transportation of supplies and equipment.

Extensive damage was not observed on the power distribution system except for damage to the oil breaker and a secondary power switch at the transformer station located in the 10 crosscut between 3 and 4 entries in the fifth west dip section.

East section

Similar face equipment as to make and type was used in the east section. Examination of this equipment disclosed the following permissibility defects on the permissible-type face equipment:

On the permissible-type Lee-Norse continuous miner an opening in excess of 0.004 inch was found in the right controller compartment. Two loose bolts were observed in the controller compartment of the permissible-type air compressor on the roof-bolting machine; however, this had not developed an opening in excess of 0.004 inch in the explosion-proof compartment.

Permissibility defects were not observed on any of the other permissible equipment in this section. The additional equipment in this section consisted of a portable nonpermissible air compressor used for inflating tires and an electric arc welding machine. A permissible-type splice box manufactured by Brad Harrison Company was used in the continuous miner power supply cable.

In the third east section the trailing cables to the continuous mining machine and the roof-bolting machines were of the 3-conductor Type W; therefore, the frames of the machines were not grounded.

Reportedly, checks for gas at the face with a flame safety lamp were made by the continuous miner operators prior to starting the equipment and at regular intervals during operation of the equipment. The section foreman, reportedly, made checks for methane with a flame safety lamp at 20 minute intervals, but under questioning, the mine foreman said that gas tests were made when the regular cut was completed or after the miner was withdrawn to change bits or oil, which might be longer than a 20-minute period.

Illumination and Smoking: Permissible electric cap lamps were used for portable illumination underground. Mobile equipment was equipped with headlights. At the time of the last Federal inspection, smoking was not permitted or observed underground. Men entering the mine were searched for smokers' articles. 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 apparatuses were kept at the mine.

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

Underground fire-fighting equipment consisted of waterlines from the surface to each working section and outlets and hoses were provided at strategic places. Dry chemical fire extinguishers were installed along the belt conveyors, near the stationary electrical equipment and mounted on portable electrically powered machines, welding carts and portable shop carts. Bags of rock dust were distributed along the conveyor belt lines and were stacked at various locations in the mine for fire-fighting service. A large supply of brattice material, pipe and hose was kept in the mine for use in fire fighting. Telephone service was maintained from the mine to the hoistman and the mine office.

STORY OF EXPLOSION AND RECOVERY OPERATIONS

Activities of Bureau of Mines Personnel: About 12:10 p.m. and 1:15 p.m. Monday, December 16, 1963, George Diamanti, surface foreman, Carbon Fuel Company, advised by telephone personnel in the Price and Salt Lake City offices of the United States Bureau of Mines, respectively, that an explosion had occurred in the Company's No. 2 mine. Federal coal mine inspectors Joe Freeman, Thomas T. Reay, Jr., and Percy Van Natter arrived at the mine about 12:45 p.m., 1 p.m. and 1:15 p.m., respectively; L. D. Knill, subdistrict supervisor, and D. E. Martin, safety representative, arrived at the mine about 4:20 p.m. the same day. These persons with the exception of Reay entered the mine after they were briefed regarding the explosion damage and underground activities, and assisted with recovery operations. Reay was stationed at the surface fan where he made tests for air returning from the mine for carbon monoxide and methane. The recovery and rescue crews returned to the mine surface with the last four bodies of the victims about 7:10 p.m. on the day of the explosion. The mine was then closed to all persons until the following morning, Tuesday, December 17.

Following the explosion Inspector T. T. Reay, Jr. posted a withdrawal Order because of an imminent danger due to a mine explosion.

The following Bureau of Mines personnel assisted in the recovery operations and/or subsequent investigations and hearing:

Joe Freeman
A. Z Dimitroff
L. D. Knill
T. C. Lukins
D. E. Martin
H. G. Plimpton
T. T. Reay, Jr.
P. C. Van Natter
James Westfield

James Westfield was in charge of the special investigation made December 18 and 23, and he was chairman of the informal hearing conducted December 21 at Helper, Utah.

Mine Conditions Immediately Prior to the Explosion: The weather was cool and clear on the day of the explosion. The temperatures and barometric pressures from 6 a.m. December 15 to 12 midnight December 17, 1963, recorded at Carbon County Airport, Price, Carbon County, Utah, are listed in appendix C. The barometric pressure raised from 24.32 inches at 6 a.m. December 15 to 24.44 inches at 11 a.m., December 16, 1963 and was 24.43 inches at the time the explosion occurred. The temperature ranged from 19° F. to 31° F. during the same period. It is the opinion of the Bureau of Mines investigators that the slight change in atmospheric pressure had no bearing on the explosion.

Normal mining operations were in progress when the explosion occurred. The main fan was operated continuously.

Evidence of Activities and Story of Explosion: Monday, December 16, 1963, about 3 a.m. the fire boss entered the mine to make the regular preshift examination, and methane or other hazardous conditions were not found. About 6:20 a.m. he reported, via telephone, his findings to a person delegated to receive the report on the surface. He also recorded his findings in a book kept for that purpose at the telephone station on the main slope.

The mine foreman entered the mine prior to the day shift crew and visited the fifth west dip section before going to the third east section where he acted as section foreman. Abnormal conditions were not found by the mine foreman. Ben Valdez, bratticeman, had also entered the mine about an hour early and installed a line brattice toward the face of No. 4 dip entry. Reportedly, it was customary for the bratticeman in this section to enter the mine early.

Ordinarily, the day shift crew entered the mine at 7 a.m., but on the day of the explosion, some of the men were delayed at a railroad crossing and the man-trip did not leave until 7:10 a.m. The superintendent accompanied the crew to the fifth west dip section and reported that they found the working section freshly rock dusted, the Lee-Norse continuous miner parked in the last open crosscut between Nos. 3 and 4 dip entries, and the face of No. 4 dip entry advanced about 20 feet inby the last open crosscut. The previous shift had made a cut down the right and left sides of the entry, but had left the fender of coal down the center of the working place.

The section foreman examined the faces of Nos. 1, 2, 3, and 4 dip entries with a permissible flame safety lamp and methane was not found. The continuous miner operator carried a permissible flame safety lamp and, reportedly, examined the face of No. 4 dip entry before tramming the miner to the face. While cutting the fender of coal, an oscillating disc broke on the continuous miner, and repairs were made promptly.

The superintendent, who carried a permissible electric methane detector but not a flame safety lamp, stated that while in the section he borrowed the section foreman's flame safety lamp and examined the faces of Nos. 1, 2, and 3 dips, but did not find methane. He said the bratticeman extended the brattice line as the continuous miner advanced, and ventilation appeared to be good. He departed from the dip section about 11:30 a.m. enroute to the third east working section about 7,000 feet away. (Refer to map of mine, appendix H.)

About 12 noon the workmen in the third east section said their ears "popped". The superintendent telephoned to the surface and was informed that large clouds of rock dust were exhausting from the fan. Immediately the main electric power switch located near the slope portal was opened and all power cut off the mine. Harry Draper and Claude Jensen, mechanics, were about 300 feet inby the portal of the main slope walking out of the mine when the explosion occurred. They reported that a large gust of air came up the slope and pushed them toward the surface. Jesus Nunez, belt attendant, was on the main slope a short distance outby the fourth west entry, was knocked down and received bruises

and superficial lacerations. He was able to walk to the surface, but required hospitalization.

James Diamanti, Draper, and Jensen proceeded underground along the main slope while the crew from the third east section, including the superintendent, left the section enroute to the west side. The two groups met on the main slope at fourth west, where they found a large amount of rock dust in suspension. Using a carbon monoxide indicator, permissible flame safety lamps, and a permissible electric methane detector, they advanced along the fourth west entries, checking stoppings between the intake and return airways, to the top of the fifth west dip entries. Here they found smoke, heavy concentrations of carbon monoxide, and the dip entries blackened with soot.

The investigation revealed that when the explosion occurred the continuous miner was working on the right side of the No. 4 dip entry and had advanced 21 feet beyond the face of the last cut and 96 feet inby the last open crosscut. (Refer to appendix E.) The cutterhead of the miner was in a raised position and marks from the cutter bits indicated that roof rock was cut. The continuous miner controls were: Master (safety) switch "on", light switch "off", throttle (spring loaded) "off", gathering head in down position. The gate on the cage to the continuous miner was open, and a shuttle car parked under the conveyor was about half loaded with coal. The controls on the shuttle car were: Lights "on", conveyor "off", brake "off", pump "on".

The bodies of Andy Juvan, continuous miner operator, and John Senechal, shuttle car operator, were found side by side on the right side of No. 4 dip entry between the face and last open crosscut. Juvan's left hand was on Senechal's back. Their electric cap lamps were lighted. The section foreman's hat was found behind a prop near the shuttle car in No. 4 dip entry, but his body was 108 feet outby in the last open crosscut near the inby right side corner of No. 3 dip entry, and his electric cap lamp lighted. The second shuttle car was near the shuttle car discharge point at the tail end of the belt conveyor indicating that the operator had just discharged a load of coal onto the belt. The body of Archie Larsen, operator of this shuttle car, was lying about 30 feet away. (Refer to map appendix E.)

Recovery Operations: Shortly after notification of the disaster, Federal Inspector Joe Freeman drove from Price to the mine. Enroute he found that the Utah State Highway Patrol had established a road block at Martin, Utah, about 2-1/2 miles from the mine and was permitting only authorized persons to proceed to the mine. The Carbon County Sheriff's Department was on the scene when Freeman arrived at the mine, about 12:45 p.m.

Inasmuch as Freeman was the first inspector to arrive at the mine, he requested that an up-to-date map of the mine be posted near the portal and the area roped off. He also requested that a check-in and check-out system be established and that only authorized persons be allowed to enter the mine.

After checking the main fan return for carbon monoxide and methane, and finding not a trace of either gas, Freeman and Homer Hyatt, safety engineer, Independent Coal & Coke Company, entered at the portal of the main slope (intake airway). Enroute to the disaster area they passed through a door into the return air course at the third west and again made tests for methane and carbon monoxide obtaining negative results. Returning to the main slope, they proceeded along the intake airway to the fifth west dip entries. At 1:15 p.m. they met James Diamanti, president, Carbon Fuel Company, and the mine crew from the third east section congregated in the No. 1 dip entry a short distance outby the neck of No. 1 room east off the dips. The atmosphere was hot at the neck of No. 1 room and tests made showed a heavy concentration of carbon monoxide and at least 5 percent of combustible gases. Mr. Diamanti informed Freeman that most of the air from the third east section had been diverted to the disaster area and that the permanent concrete block stoppings between the intake and return air courses in the fourth west entries had been examined. These stoppings were undamaged except that a sheet metal door installed in a stopping directly above the dip entries had been blown off, but temporary repairs had been made.

After being briefed Freeman and Hyatt proceeded to check the permanent stoppings between the Nos. 3 and 4 (return airway) dip entries. They found the first two stoppings below the fourth west entries undamaged, but stopping No. 3 was demolished and the air was short circuiting. Freeman and Hyatt then returned to the group and reported their

findings. Some of the men were sent for brattice and materials to build temporary stoppings while the others used salvaged brattice cloth, etc. to build a temporary stopping in the No. 3 crosscut. The men soon returned with the stopping materials and after a short time the air had cleared sufficiently to allow a temporary stopping to be erected in No. 4 crosscut. At this time some of the men, under the direction of Hyatt, were dispatched to No. 1 dip entry to begin erecting temporary seals at the necks of the three abandoned rooms and the three fifth west entries. All this work was accomplished without the aid of breathing apparatus.

John Peperakis, manager, Sunnyside Coal Mines, Kaiser Steel Corporation, arrived on the scene underground and reported that he had two teams provided with 2-hour self-contained oxygen breathing apparatus in readiness at the portal. After briefing Peperakis, the fresh air crew continued installing temporary stoppings. Brattice curtains were also erected in crosscuts between the Nos. 2 and 3 dip entries as the crew advanced.

About 2:35 p.m. a decision was made to bring the Kaiser Steel apparatus crews underground and they arrived in the disaster area about 3:05 p.m. One crew, under oxygen, was used to complete a temporary seal in the No. 3 room and erect temporary seals at the entrances of the fifth west entries east off No. 1 dip entry. The area in No. 3 dip entry between Nos. 9 and 10 crosscuts was established as a fresh air base from which the other apparatus crew operated. Wearing 2-hour self-contained oxygen breathing apparatus, they completed installing the temporary stoppings in the open crosscuts on each side of No. 3 dip entry and explored the working section. About 5:10 p.m. they returned to the fresh air base and reported that the missing miners had been located and that none had survived the explosion. The discovery was reported to the surface via telephone and a request made for additional apparatus crews. Immediately the three crews in readiness on the surface, two from the Columbia-Geneva Steel Division, United States Steel Corporation mines, and one from the King mine, United States Fuel Company, were dispatched to the explosion area. The apparatus crews carried the bodies of the victims to the fresh air base from whence they were carried to the main slope by fresh air crews, loaded into the man train, and transported to the

United States Bureau of Mines

James Westfield	Assistant Director--Health and Safety
L. D. Knill	Subdistrict Supervisor
Joe Freeman	Coal Mine Inspector
A. Z. Dimitroff	Supervising Mining Health and Safety Engineer
T. C. Lukins	Mining Health and Safety Engineer

A detailed examination of the explosion area was made by the entire committee. Examinations were also made of the third east working section, not affected by the explosion, by members of the committee. To expedite the work, the committee was divided into two groups, each composed of representatives of the respective agencies. Each group was provided with a mine map properly inscribed so that when the examination was completed, each agency had a complete record of the findings.

The electrical equipment in the explosion area was studied by an electrical engineer, and his findings were recorded heretofore in this report

An informal hearing was conducted on December 21 at the Civic Auditorium, Helper, Utah. James Westfield, assistant director --Health and Safety, Bureau of Mines, served as chairman of the hearing. Representatives of the United Mine Workers of America, the Carbon Fuel Company, The Industrial Commission of Utah, and the United States Geological Survey, were invited to participate in the interrogation of anyone who may have had knowledge of events or practices that might have set the stage for the disaster.

Methane and Dust as Factors in the Explosion: Methane had been detected, although not frequently, with a permissible flame safety lamp in the fifth west dip section, and the analysis of an air sample collected in the return from the fifth west section during the October 1963 inspection indicated that 41,000 cubic feet of methane was liberated in a 24-hour period. During recovery operations tests with a permissible flame safety lamp and a permissible electric methane detector showed that at least 5 percent methane was present at the neck of No. 1 room east off the fifth west dip entries about 1:15 p.m. on the day of the explosion. An air sample collected near the face of No. 4 dip entry after ventilation was reestablished and the continuous miner removed contained 0.26 percent methane.

It is a known fact that the type of continuous miner in use produces an excessive amount of float coal dust which is difficult to control even when all means available are employed, and as disclosed during the investigation, the water pump on the left side of the continuous miner was not in operating condition. An excessive amount of float coal dust was observed in the return air course in the third east working section during the investigation. Therefore, it is reasonable to believe a similar condition existed in the fifth west dip section at the time of the explosion. It is also believed that dust from coal hauled on the conveyor belt aided the explosion.

Flame: Evidence of soot was present throughout the fifth west dip section, fifth west entries, and three rooms east off the dip entries. Charred pieces of paper were found at various places in the fifth west dip entries as far outby as No. 1 room east off the dips. Small particles of coke were visible in the coal face and charred pieces of cardboard were present at the face of No. 1 entry, fifth west section. The analyses of dust samples collected after the explosion showed from traces to very heavy coked particles. (Refer to table 2, appendixes F and G)

The coke content of dust samples collected in the explosion area indicated that the flame travelled up all the entries of the fifth west dip section, but principally in the No. 4 return entry, to the intersection of fifth west section, and thence up the fifth west section to the faces thereof and the faces of the three rooms. It is the opinion of the Bureau investigators that the float coal dust in the return airway caused the explosion to be propagated.

The exposed surfaces of the victim's bodies received first to third degree burns, but death was caused by carbon monoxide poisoning and burns. Some of the victims travelled a distance after the explosion.

Forces: The main forces from the explosion traveled outwardly from the face of the No. 4 dip entry throughout the fifth west dip section, fifth west section, three abandoned rooms east off the dip entries and dissipated as they moved along the well rock-dusted fourth west main entries and main slope. The forces demolished 1 curtain and 13 cement block stoppings between the Nos. 3 and 4 dip entries, all line

brattices and check curtains in the area, 6 cement block stoppings in fifth west section, blew off a sheet metal door installed in a stopping in the fourth west entries directly above the dip entries, ripped open a thin sheet metal floor of an unused overcast in the third east return entry, knocked down a workman on the main slope outby the fourth west intersection, and pushed two men walking up the main slope. (Refer to appendix E for direction of forces.)

Probable Point of Origin: Bureau of Mines investigators believe that the explosion originated at the face of No. 4 dip entry in the fifth west dip section.

Factors Preventing Spread of Explosion: The explosion was propagated by the float coal dust atop the rock dust in the return airway (No. 4 dip entry). Heavy application of rock dust in the fifth west dip entries and in the fourth west entries was the principal factor that 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 previous Federal inspection, interrogation and discussions with officials and employees of the Carbon Fuel Company provided evidence as to 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. The explosion involving methane and coal dust occurred about 12 m. Monday, December 16, 1963. The time of occurrence was arrived at by the fan chart and statements from men in other areas of the mine. (Refer to appendix D.)

2. The victims died in a relatively short time from carbon monoxide poison and burns. All received first to third degree burns, one a fractured right skull and compound fracture of the left hand, one a severe concussion, and one a possible skull fracture.

3. Methane was being liberated in the face areas, and had been found infrequently with a flame safety lamp in the fifth west dip section. Methane was detected in the disaster area about 1:15 p.m. the day of the explosion and an air sample collected at the face of No. 4 dip entry after ventilation had been reestablished contained 0.26 percent methane.

4. The section foreman's permissible flame safety lamp was found hanging from a nail driven in a timber in the face area of No. 4 dip entry, and the continuous miner operator's flame safety lamp was hanging in the operator's cage on the machine.

5. Saturday, December 14, 1963, roof bolters on the afternoon shift operated a roof-bolting machine in the face area of Nos. 2 and 3 dip entries, and tests for methane were not made.

6. All 4 dip entries were advanced at least 80 feet before any air connections were made. (Refer to appendix E.)

7. The line brattice was installed loosely on the (return) side of No. 4 entry about 3 feet from the rib and winged toward the bumper of the continuous miner.

8. The line brattice was 36 feet from the face of No. 4 dip entry, and would not direct the ventilation to the face.

9. Check curtains were not used where needed to assure positive ventilation in the face areas.

10. The continuous miner was making the first cut down the right or intake air side of the No. 4 dip (return) entry and had advanced 21 feet inby the previous cut on the left side and 96 feet inby the last open crosscut. (Refer to appendix E.)

11. The explosion was propagated by float coal dust in the return airway, and by coal dust from coal being transported on the belt conveyor.

12. The face of the right side of No. 4 dip entry was advanced approximately 76 feet on the day of occurrence, and according to evidence revealed at the hearing, rock dust was not applied during coal-producing shifts.

13. Dust surveys conducted in parts of the mine not affected by the explosion disclosed areas that were deficient in incombustible material.

14. An excessive amount of float coal dust was present in the return airway in the third east working section; therefore, it is reasonable to believe a similar condition existed in the disaster area.

15. The cutterhead of the continuous miner was in a raised position and roof rock was cut.

16. The water pump on the left side of the continuous miner was not in operating condition; the drive chain and locking key to the drive shaft were missing.

17. Permissibility deficiencies were found in three of the permissible type machines in the explosion area.

18. Bureau of Mines tests of the permissible flame safety lamps found in the explosion area showed them to be in safe operating condition. (Refer to appendix J.)

19. A nonpermissible pump was in the face area of No. 1 dip entry, but was not operating at the time the explosion occurred.

20. This explosion points out two common weaknesses. In a slightly gassy mine, enough attention is not given to directing the ventilating current to the working faces and tests for gas are not made frequently enough to determine whether a dangerous gas condition is developing. In most coal mine explosions, Bureau of Mines investigators have found that frequent tests for gas were not being made.

Cause of Explosion: The disaster was caused by ignition of a body of methane and coal dust by a friction spark or electrical spark or arc. Methane and dust were liberated in the face of No. 4 dip entry, and accumulated because the line brattice was 36 feet from the face and not directing the ventilation to the face. The explosion was propagated by float coal dust in the return airway and by dust from coal being transported on the belt conveyor.

RECOMMENDATIONS

1. Insofar as possible, mining operations should progress from the return-air side toward the intake-air side.

2. Crosscut connections between rooms and entries should be made as soon as possible.

3. To improve ventilation in the face area, the continuous miner should be sumped no deeper than 12 feet.

4. Care should be exercised to prevent the continuous miner from cutting roof rock.

5. The volume and velocity of the air current passing over the face area shall be sufficient to dilute so as to render harmless and to carry away flammable or harmful gases.

6. Check curtains should be installed where needed to control the air current.

7. Well maintained line curtains with a sufficient area on the tight side should be kept as close to the face as practicable.

8. The use of auxiliary fans to improve ventilation and float dust conditions in the face areas during mining operations should be considered.

9. The practice of leaving places deadended should be discontinued.

10. Permissible flame safety lamps carried underground by officials and other employees should not be left unattended.

11. All underground face workings where electrically driven equipment is operated shall be examined for methane with a permissible flame safety lamp by a person trained in the use of such lamp before such equipment is taken into or operated in the face regions, and frequent examinations shall be made during such operations.

12. A means shall be provided to better control and render harmless the float coal dust formed during mining operations.

13. Rock dust shall be maintained to within 40 feet of the working faces at all times, and, if open crosscuts are less than 40 feet therefrom, such crosscuts shall be rock dusted.

14. Where rock dust is applied, it shall be distributed upon the top, floor, and sides 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. Where methane is present in any ventilating current the 65 percent of incombustible content of such combined dust shall be increased 1 percent for each 0.1 percent of methane.

Where float coal dust is present, the incombustible content should be not less than 80 percent.

15. Continuous miners shall not be operated when the water sprays are not functioning properly.

16. Permissible-type electric face equipment shall be maintained in permissible condition.

17. Electric pumps used in face areas should be of a permissible type.

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

1. Mine rescue teams should be trained and maintained at this mine.

2. Self-rescuers should be provided for each man underground.

3. Branch circuits of the underground high-voltage (primary) distribution system should be sectionalized through breakers or disconnecting switches. Disconnecting devices should be incorporated, where necessary, to provide visual evidence that the circuit is deenergized when the switches are opened.

4. Overload and short circuit protection should be provided for each individual trailing cable furnishing power to electrical equipment. Such protection should preferably be provided by means of an automatic circuit breaker that will open all three phases of the circuit simultaneously.

5. Ground-fault protection should be provided on the underground low-voltage power feeder circuit. Alternating-current face equipment should be served from a power source having a neutral grounding circuit, either direct or derived, which will permit proper ground-fault protection for each machine.

6. The frames or enclosures of electrical equipment should be properly grounded.

ACKNOWLEDGMENT

The writers gratefully acknowledge the courtesies, cooperation, and assistance extended by officials and employees of the Carbon Fuel Company, representatives of The Industrial Commission of Utah, and the United Mine Workers of America.

Respectfully submitted,

/s/ Lester D. Knill

Lester D. Knill
Subdistrict Supervisor

/s/ Joseph Freeman

Joseph Freeman
Coal Mine Inspector

Approved by:

/s/ James Westfield

James Westfield
Assistant Director--Health and Safety

/s/ Marling J. Ankeny

Marling J. Ankeny
Director

TABLE 1

ANALYSES OF AIR SAMPLES December 1963

Joe Freeman, D. E. Martin

MINE No. 2 COMPANY Carbon Fuel Company COLLECTED BY H. G. Plimpton & P. C. Van Natter

Bottle No.	Lab. No.	LOCATION IN MINE	Carbon Dioxide CO_2	Oxygen O_2	Carbon Monoxide CO	Methane CH_4	Nitrogen N_2	Cubic Ft. air per Minute	Cubic Ft. Methane in 24 hrs
Z-109	19270	Air during establishing ventilation, No.3 dip entry between Nos. 6 & 7 crosscuts, fifth west dip section.	0.09	20.82	0.043	0.04	79.01	Perceptible	
Z-110	19271	Establishing ventilation after explosion, No. 2 room off fifth west dip section.	1.30	18.85	0.850	0.92	78.08	Perceptible	
Z-111	19272	Establishing ventilation after explosion, No. 3 dip entry at the No. 10 crosscut, fifth west dip section.	0.06	20.84	0.012	0.01	79.08	Perceptible	
Z-112	19273	Establishing ventilation after explosion, between Nos. 2 and 3 dip entries in No. 11 crosscut fifth west dip section.	0.11	20.72	0.048	0.03	79.09	Percep-	

TABLE 1

ANALYSES OF AIR SAMPLES (Cont.)

Bottle No.	Lab. No.	Location in Mine	Carbon Dioxide CO_2	Oxygen O_2	Carbon Monoxide CO	Methane CH_4	Nitrogen N_2	Cubic Ft. Air Per Minute	Cubic Ft Methane in 24 hr
X-1934	19274	Establishing ventilation after explosion, No. 3 dip entry at No. 12 crosscut, fifth west dip section.	0.13	20.76	0.035	0.03	79.04	Perceptible	
X-1933	19275	Establishing ventilation after explosion No. 3 dip entry at No. 14 crosscut, fifth west dip section.	0.20	20.53	0.092	0.07	79.11	Perceptible	
X-1999	19276	Main return air, main exhaust fan.	0.07	20.74	0.010	0.03	79.15		
X-1998	19277	Main return air, main exhaust fan.	0.05	20.83	0.009	0.04	79.07		
Z-56	19278	Face No. 2 room right off fifth west dip section.	0.10	20.85	0.000	0.06	78.99	Still	
Z-57	19279	Face No. 1 room right off fifth west dip section.	0.27	20.19	0.010	1.77	77.76	Still	

TABLE 1

ANALYSES OF AIR SAMPLES (Cont.)

Bottle No.	Lab. No.	Location in Mine	Carbon Dioxide CO_2	Oxygen O_2	Carbon Monoxide CO	Methane CH_4	Nitrogen N_2	Cubic Ft. Air Per Minute	Cubic Ft. Methane in 24 hrs
X-1977	19280	Face No. 1 entry, fifth west dip section.	0.25	20.39	0.044	0.68	78.64	Still	
X-1978	19281	Face No. 2 entry, Fifth west dip section.	0.26	20.50	0.042	0.56	78.64	Still	
Z-115	19282	20 feet outby face of No. 4 entry fifth west dip section.	0.11	20.67	0.000	0.22	79.00	Percep-tible	
X-1954	19283	Face No. 2 entry fifth west dip section.	0.06	20.77	0.000	0.18	78.99	Percep-tible	
X-1953	19284	Face No. 1 entry fifth west dip section.	0.05	20.79	0.003	0.18	78.98	Perceptible	
Z-116	19285	Face No. 3 entry fifth west dip section.	0.08	20.70	0.000	0.16	79.06	Percep-tible	

TABLE 1

ANALYSES OF AIR SAMPLES (Cont.)

Bottle No.	Lab. No.	LOCATION IN MINE	Carbon Dioxide CO_2	Oxygen O_2	Carbon Monoxide CO	Methane CH_4	Nitrogen N_2	Cubic Ft. Air Per Minute	Cubic Ft Methane in 24 hr
X-1375	19286	Return fifth west dip section.	0.05	20.84	0.000	0.04	79.07	85,000	48,900
Z-71	19287	Face No. 4 entry (after miner was removed) fifth west dip section.	0.07	20.78	0.000	0.15	79.00	Still	
Z-76	19288	Face No. 4 entry (after miner was removed) fifth west dip section.	0.10	20.72	0.000	0.26	78.92	Still	
X-1426	19289	Main return near bottom of shaft.	0.05	20.79	0.000	0.02	79.14	130,000	

TABLE 2

ANALYSES OF DUST SAMPLES — DATE COLLECTED December 1963

MINE No. 2 COMPANY Carbon Fuel Company — COLLECTED BY T. T. Reay, Jr., D. E. Martin, H. G. Plimpton, P. C. Van Natter

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		Sampling area - Main slopes from portal to fourth west entry		
		Main slope portal = 0 + 00		
		Return Slope		
A-1	Band	0 + 250 feet	None	96.6
A-1A	Roof & Ribs	0 + 250	None	70.9
A-2	Band	0 + 450	None	94.7
A-3	Band	0 + 750	None	86.2
A-3A	Roof & Ribs	0 + 750	None	87.7
A-4	Band	0 + 1,000	None	71.3
A-5	Band	0 + 1,300	None	64.7
A-5A	Roof & Ribs	0 + 1,300	None	82.5

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust From	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		Return Slope (Cont.)		
A-6	Band	0 + 1,650	None	68.6
A-7	Band	0 + 1,900	None	81.0
A-7A	Roof & Ribs	0 + 1,900	None	74.1
A-8	Band	0 + 2,200	Trace	55.6
		Belt Slope		
B-1	Band	0 + 250 feet	None	87.2
B-1A	Roof & Ribs	0 + 250	None	94.9
B-2	Band	0 + 450	None	94.8
B-3	Band	0 + 750	None	90.3
B-3A	Roof & Ribs	0 + 750	None	97.2
B-4	Band	0 + 1,000	None	96.1

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		Belt Slope (Cont.)		
B-5	Band	0 + 1,300	None	94.1
B-5A	Roof & Ribs	0 + 1,300	None	98.6
B-6	Band	0 + 1,650	None	89.5
B-7	Band	0 + 1,900	None	86.9
B-7A	Roof & Ribs	0 + 1,900	None	96.4
B-8	Band	0 + 2,200	None	85.7
		No. 1 Parallel Slope		
C-1		(Not Developed)		
C-2	Band	0 + 450 feet	None	90.8
C-2A	Roof & Ribs	0 + 450	None	95.8
C-3	Band	0 + 750	None	90.9

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 1 Parallel Slope (Cont.)		
C-4	Band	0 + 1,000	None	81.2
C-4A	Roof & Ribs	0 + 1,000	None	99.3
C-5	Band	0 + 1,300	None	71.7
C-6	Band	0 + 1,650	None	80.5
C-6A	Roof & Ribs	0 + 1,650	None	94.6
C-7	Band	0 + 1,900	None	82.8
C-8	Band	0 + 2,200	None	78.1
		No. 2 Parallel Slope		
D-1		(Not Developed)		
D-2	Band	0 + 450 feet	None	79.8
D-2A	Roof & Ribs	0 + 450	None	94.9

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 2 Parallel Slope (Cont.)		
D-3	Band	0 + 750	None	52.2
D-4	Band	0 + 1,000	None	79.8
D-4A	Roof & Ribs	0 + 1,000	None	91.7
D-5	Band	0 + 1,300	None	71.3
D-6	Band	0 + 1,650	None	41.1
D-6A	Roof & Ribs	0 + 1,650	None	87.4
D-7	Band	0 + 1,900	None	51.6
D-8	Band	0 + 2,200	None	63.5
D-8A	Roof & Ribs	0 + 2,200	None	80.2

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No		Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		Fourth west entry. Left rib line of main belt slope = 0 + 00		
		No. 1 Back Entry		
1-1	Band	0 + 400 feet	None	67.4
1A-1	Roof & Rib	0 + 400	None	74.8
2-1	Band	0 + 800	None	63.7
3-1	Band	0 + 1,200	None	60.8
3A-1	Roof & Rib	0 + 1,200	None	50.5
		No. 2 Back Entry		
1-2	Band	0 + 400 feet	None	73.5
1A-2	Roof & Rib	0 + 400	None	87.0
2-2	Band	0 + 800	None	62.6
3-2	Band	0 + 1,200	None	69.1
3A-2	Roof & Rib	0 + 1,200	None	93.3

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 1 Parallel Entry - South		
1-3	Band	0 + 400 feet	None	79.5
1A-3	Roof & Rib	0 + 400	None	90.8
2-3	Band	0 + 800	None	79.8
3-3	Band	0 + 1,200	None	72.3
3A-3	Roof & Rib	0 + 1,200	None	58.8
		Belt Entry		
1-4	Band	0 + 400 feet	None	82.3
1A-4	Roof & Rib	0 + 400	None	90.9
2-4	Band	0 + 800	None	72.7
3-4	Band	0 + 1,200	None	56.8
3A-4	Roof & Rib	0 + 1,200	None	62.9

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 1 Parallel Entry - North		
1-5	Band	0 + 400 feet	None	78.1
1A-5	Roof & Rib	0 + 400	None	86.1
2-5	Band	0 + 800	None	59.2
2A-5	Roof & Rib	0 + 800	None	78.3
3-5	Band	0 + 1,200	None	34.2
3A-5	Roof & Rib	0 + 1,200	None	39.9
		No. 2 Parallel Entry-North		
1-6	Band	0 + 400 feet	None	85.0
1A-6	Roof & Rib	0 + 400	None	58.9
2-6	Band	0 + 800	None	43.1
2A-6	Roof & Rib	0 + 800	None	42.6

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 2 Parallel Entry - North (Cont.)		
3-6	Band	0 + 1,200	None	39.5
3A-6	Roof & Rib	0 + 1,200	None	45.4
		Fifth west dip section, north rib of 6 entry fourth west - 0 + 00 Samples with B represent crosscuts between entries.		
		No. 4 Dip Entry		
E-1	Band	0 + 25 feet	None	27.7
E-1A	Roof & Rib	0 + 25	None	64.2
E-2	Band	0 + 175	None	25.1
E-3	Band	0 + 300	Trace	44.8
E-3A	Roof & Rib	0 + 300	Trace	59.1
E-4	Band	0 + 450	Small	69.8
E-5	Band	0 + 675	Small	46.4

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 4 Dip Entry (Cont.)		
E-5A	Roof & Rib	0 + 675	Small	57.9
E-6	Band	0 + 750	Large	52.4
E-7	Band	0 + 850	Large	46.4
E-7A	Roof & Rib	0 + 850	Small	53.6
E-8	Band	0 + 950	Very Large	36.2
E-9	Band	0 + 1,000	Small	62.6
E-9A	Roof & Rib	0 + 1,000	Large	43.2
E-10	Band	0 + 1,075	Large	37.2
E-11	Band	0 + 1,150	Very Large	45.4
E-11A	Roof & Rib	0 + 1,150	Large	43.8
E-12	Band	0 + 1,225	Large	29.1

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustibl
		No. 3 Dip Entry		
F-1	Band	0 + 25 feet	Trace	53.1
F-1A	Roof & Rib	0 + 25	None	72.0
F-1B	Band	0 + 75	None	59.0
F-2	Band	0 + 175	Trace	60.7
F-3	Band	0 + 325	Trace	74.1
F-3A	Roof & Rib	0 + 325	None	73.1
F-3B	Band	0 + 350	Large	71.4
F-4	Band	0 + 475	Small	53.7
F-5	Band	0 + 700	Small	40.4
F-5A	Roof & Rib	0 + 700	Trace	48.5
F-5B	Band	0 + 750	Very Large	41.0

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 3 Dip Entry (Cont.)		
F-6	Band	0 + 775	Small	30.9
F-6B	Band	0 + 800	Very Large	78.9
F-7	Band	0 + 850	Large	37.4
F-7A	Roof & Rib	0 + 850	Small	61.1
F-7B	Band	0 + 900	Small	36.9
F-8	Band	0 + 950	Small	33.4
F-8B	Band	0 + 1,000	Large	39.8
F-9	Band	0 + 1,050	Large	39.8
F-9A	Roof & Rib	0 + 1,050	Small	40.8
F-9B	Band	0 + 1,075	Large	38.8
F-10	Band	0 + 1,125	Large	44.7
F-10B	Band	0 + 1,165	Very Large	37.2

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 3 Dip Entry (Cont.)		
F-11	Band	0 + 1,200	Very Large	32.9
F-11A	Roof & Rib	0 + 1,200	Small	43.5
F-11B	Band	0 + 1,225	Very Large	32.1
F-12	Band	0 + 1,250	Very Large	46.1
F-12B	Band	0 + 1,285	Very Large	26.1
		No. 2 Dip Entry		
G-1	Band	0 + 25 feet	Trace	41.4
G-1A	Roof & Rib	0 + 25	None	55.2
G-1B	Band	0 + 75	None	47.8
G-2	Band	0 + 175	None	38.5
G-3	Band	0 + 375	Trace	52.9

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustibl
		No. 2 Dip Entry (Cont.)		
G-3A	Roof & Rib	0 + 375	None	64.3
G-3B	Band	0 + 400	Small	34.1
G-4	Band	0 + 525	Small	54.2
G-5	Band	0 + 700	Trace	37.7
G-5A	Roof & Rib	0 + 700	Small	59.8
G-5B	Band	0 + 725	Small	53.3
G-6	Band	0 + 775	Small	39.7
G-6B	Band	0 + 825	Small	42.9
G-7	Band	0 + 850	Small	41.8
G-7A	Roof & Rib	0 + 850	Small	48.8
G-7B	Band	0 + 900	Small	37.6

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 2 Dip Entry (Cont.)		
G-8	Band	0 + 925	Large	42.6
G-8-1/2	Band	0 + 975	Large	52.7
G-8-1/2-B	Band	0 + 1,025	Small	27.5
G-9	Band	0 + 1,075	Small	40.7
G-9A	Roof & Rib	0 + 1,075	Small	39.8
G-9B	Band	0 + 1,100	Small	33.4
G-10	Band	0 + 1,150	Large	32.8
G-10B	Band	0 + 1,175	Large	42.3
G-11	Band	0 + 1,225	Very Large	33.7
G-11A	Roof & Rib	0 + 1,225	Very Large	40.5
G-11B	Band	0 + 1,250	Very Large	25.4

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustibl
		No. 2 Dip Entry (Cont.)		
G-12	Band	0 + 1,300	Very Large	35.9
G-12B	Band	0 + 1,325	Very Large	23.9
		No. 1 Dip Entry		
H-1	Band	0 + 25 feet	None	29.7
H-1A	Roof & Rib	0 + 25	None	44.9
H-1B	Band	0 + 75	None	55.5
H-2	Band	0 + 175	Trace	36.2
H-3	Band	0 + 375	Trace	45.9
H-3A	Roof & Rib	0 + 375	Trace	57.9
H-3B	Band	0 + 400	Trace	51.9
H-4	Band	0 + 500	Trace	64.0

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 1 Dip Entry (Cont.)		
H-5	Band	0 + 650	Small	60.0
H-5A	Roof & Rib	0 + 650	Small	55.0
H-5B	Band	0 + 700	Small	42.7
H-6	Band	0 + 750	Small	46.0
H-6B	Band	0 + 775	Small	48.9
H-7		Caved, no sample		
H-7A		Caved, no sample		
H-7B	Band	0 + 825	Large	45.3
H-8	Band	0 + 925	Large	38.3
H-8B	Band	0 + 950	Large	34.9
H-8-1/2	Band	0 + 1,000	Large	39.0
H-8-1/2-B	Band	0 + 1,025	Large	43.3

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustibl
		No. 1 Dip Entry (Cont.)		
H-9	Band	0 + 1,075	Large	38.4
H-9A	Roof & Rib	0 + 1,075	Small	47.1
H-9B	Band	0 + 1,125	Large	47.0
H-9B	Band	0 + 1,125	Very Large	33.8
H-10	Band	0 + 1,150	Large	39.6
H-10B	Band	0 + 1,180	Large	31.3
H-11	Band	0 + 1,225	Very Large	32.3
H-11A	Roof & Rib	0 + 1,225	Large	44.0
H-11B	Band	0 + 1,250	Large	35.3
H-12	Band	0 + 1,275	Very Large	45.8
H-12B	Band	0 + 1,300	Very Large	22.9

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		Fifth west section. East rib of No. 1 dip entry = 0 + 00. Samples with B represent crosscut between entries.		
		No. 1 entry		
J-1	Band	0 + 25 feet	Large	52.5
J-2	Band	0 + 175	Large	55.0
J-2A	Roof & Rib	0 + 175	Large	51.7
J-3	Band	0 + 350	Large	32.9
J-4	Band	0 + 500	Large	25.2
J-4A	Roof & Rib	0 + 500	Small	22.6
J-5	Band	0 + 650	Very Large	28.5
J-6	Band	0 + 800	Very Large	34.8

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	LOCATION IN MINE Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 2 entry (Cont.)		
K-1	Band	0 + 50 feet	Large	49.8
K-2	Band	0 + 200	Small	46.8
K-2A	Roof & Rib	0 + 200	Small	35.2
K-1B	Band	0 + 325	Small	43.0
K-3	Band	0 + 375	Small	39.4
K-4	Band	0 + 550	Large	23.6
K-4A	Roof & Rib	0 + 550	Large	26.0
K-2B	Band	0 + 650	Very Large	48.2
K-5	Band	0 + 700	Very Large	24.3
K-6	Band	0 + 850	Very Large	17.6

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustib
		No. 3 entry		
L-1	Band	0 + 75 feet	Large	43.8
L-1B	Band	0 + 325	Large	28.0
L-2	Band	0 + 400	Large	34.5
L-2A	Roof & Rib	0 + 400	Large	42.9
L-2B	Band	0 + 700	Very Large	32.9
L-3	Band	0 + 575	Large	26.8
L-4	Band	0 + 750	Very Large	29.0
L-4A	Roof & Rib	0 + 750	Very Large	26.4

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		Rooms off No. 1 dip entry. East rib of No. 1 dip entry = 0 + 00 Samples with B represent crosscuts between entries		
		No. 1 room		
M-1	Band	0 + 25 feet	Trace	27.7
M-2	Band	0 + 175	Trace	33.5
M-2A	Roof & Rib	0 + 175	Trace	38.7
M-3	Band	0 + 325	Small	26.2
		No. 2 room		
N-1	Band	0 + 25 feet	Small	39.5
N-1B	Band	0 + 275	Small	30.5
N-2	Band	0 + 175	Small	32.2
N-2A	Roof & Rib	0 + 175	Large	47.7

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 2 room (Cont.)		
N-2B	Roof & Rib	0 + 425	Very Large	27.2
N-3	Band	0 + 325	Large	30.7
		No. 3 room		
O-1	Band	0 + 25 feet	Small	44.2
O-1B	Band	0 + 275	Trace	35.0
O-2	Band	0 + 175	Trace	39.4
O-2A	Roof & Rib	0 + 175	Trace	45.6
O-3	Band	0 + 325	Trace	29.6

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		4 raise entries third east section South rib of 3 east raise belt entry = 0 + 00.		
		No. 1 Parallel West		
P-1	Band	0 + 875 feet	None	80.9
P-2	Band	0 + 665	None	72.6
P-3	Band	0 + 455	None	70.2
P-4	Band	0 + 245	None	73.6
P-5	Band	0 + 35	None	80.0
		Belt entry		
Q-1	Band	0 + 875 feet	None	76.2
Q-2	Band	0 + 665	None	71.9
Q-3	Band	0 + 455	None	61.3
Q-4	Band	0 + 245	None	73.4

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		Belt entry (Cont.)		
Q-5	Band	0 + 35	None	77.0
		No. 1 Back Entry		
R-1	Band	0 + 875 feet	None	47.7
R-2	Band	0 + 665	None	72.0
R-3	Band	0 + 455	None	71.8
R-4	Band	0 + 245	None	73.7
R-5	Band	0 + 35	None	77.3
		No. 2 Back Entry		
S-1	Band	0 + 875 feet	None	51.6
S-2	Band	0 + 665	None	52.6
S-3	Band	0 + 455	None	59.0

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustible
		No. 2 Back Entry (Cont.)		
S-4	Band	0 + 245	None	60.2
S-5	Band	0 + 35	None	68.4
		No. 3 conveyor belt section, third east Loading head of belt conveyor = 0 + 00		
		Samples collected outby the transfer point		
		Back Entry		
T-1	Band	0 + 40 feet	None	77.4
T-2	Band	0 + 295	None	76.8
U-1	Band	0 + 40	None	71.0
U-2	Band	0 + 295	None	64.4

TABLE 2

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust Survey Samples	Alcohol Coke Test	As Received Percent Incombustibl
		Belt Entry		
V-1	Band	0 + 40 feet	None	90.8
V-2	Band	0 + 295	None	86.1
		No. 1 Parallel Entry		
W-1	Band	0 + 40 feet	None	73.4
W-2	Band	0 + 295	None	71.4

TABLE 3

Mine No. 2 Company Carbon Fuel Company

Collected By H. G. Plimpton, T. T. Reay, Jr. & D. E. Martin Date December 1963

Float Dust Samples - Main East Return
Face Main East Return = 0 + 00

Sample No.	Location	*+20m	+ 100m	+ 200m	+ 325m	-325m	% As-Received (-20 mesh) Moist.	Ash	CO_2
1	0 + 25	0.6	4.9	6.8	10.8	76.9	1.4	25.7	17.6
2	0 + 225	5.7	9.9	4.9	7.4	72.1	0.8	38.7	26.0
3	0 + 425	5.4	9.5	5.0	11.0	69.1	0.9	39.5	25.6
4	No sample taken. Heavy rock dust.								
5	0 + 825	0.5	2.0	5.6	9.3	82.6	0.3	51.8	37.1
6	0 + 1025	3.1	6.1	6.1	12.1	72.6	0.5	47.1	34.0
7	0 + 1225	0.5	1.0	7.1	12.7	78.7	0.2	52.4	37.1
8	0 + 1425	0.6	1.6	7.9	15.4	74.5	0.4	50.7	34.8
9	0 + 1625	8.8	11.3	7.6	9.8	62.5	0.8	43.7	30.2
10	0 + 1825	4.5	6.9	2.1	0.7	85.8	1.2	33.5	23.1
11	0 + 2025	0.6	3.1	6.0	10.4	79.9	0.4	50.8	36.1
12	0 + 2225	1.6	3.3	7.4	40.7	47.0	0.5	48.9	35.9
13	0 + 2425	0.6	1.0	6.3	46.8	45.3	0.4	50.3	36.8
14	0 + 2625	4.8	9.2	5.2	6.1	74.7	0.5	45.8	32.2
15	0 + 2825	5.1	9.8	7.4	9.9	67.8	0.5	47.4	33.2
16	0 + 3025	3.6	8.4	7.0	8.7	72.3	0.5	48.5	32.7
17	0 + 3225	6.0	10.2	9.2	11.6	63.0	0.5	46.1	32.4
18	0 + 3425	7.7	16.6	10.3	39.3	26.1	0.8	42.0	28.4
19	0 + 3625	0.9	2.6	7.0	12.9	76.6	0.3	52.1	37.1
20	0 + 3825	3.1	7.2	6.3	11.2	72.2	0.6	49.1	33.9
21	0 + 4025	5.2	12.5	6.1	7.6	68.6	1.0	39.2	26.4

*+ 20 mesh not included in analyzed portion.

TABLE 4

ANALYSES OF DUST SAMPLES DATE COLLECTED October 1963

MINE No. 2 COMPANY Carbon Fuel Company COLLECTED BY Thomas T. Reay, Jr.

Sample No.	Sample of Dust from	Location in mine Spot-Location Samples	As Received Percent Incombustible
1		At tail piece, 4 west main entry belt line	87.
2		Midway main west belt line	82.
3		At tail piece main belt conveyor line	87.
4		600 feet outby faces main return east entries	83.
5		Discharge station main east belt line	93.
6		Midway main conveyor belt line	90.

TABLE 4

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in mine Dust Survey Samples	As Received Percent Incombustible
		Sampling area - Fifth west dip entries Low rib off 4 west main entry = 0 + 00	
		Right side material haulageway	
A-1	Band	0 + 00 feet	77.*
A-2	Band	0 + 200	76.*
A-3	Band	0 + 400	75.*
A-4	Band	0 + 600	76.*
A-5	Band	0 + 800	77.*
A-6	Band	0 + 1,000	80.*

*By Volumeter

TABLE 4

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in mine Dust Survey Samples	As Received Percent Incombustible
		Belt entry	
B-1	Band	0 + 00 feet	85.*
B-2	Band	0 + 200	85.*
B-3	Band	0 + 400	85.*
B-4	Band	0 + 600	75.*
B-5	Band	0 + 800	86.*
B-6	Band	0 + 1,000	66.*
		Material haulageway left side	
C-1	Band	0 + 00 feet	80.*
C-2	Band	0 + 200	80.*
C-3	Band	0 + 400	72.*
C-4	Band	0 + 600	85.*

*By Volumeter

TABLE 4

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in Mine Dust survey samples	As Received Percent Incombustible
		Material Haulageway left side (Cont.)	
C-5	Band	0 + 800	82.*
C-6	Band	0 + 1,000	72.*
		Return airway	
D-1	Band	0 + 00 feet	80.*
D-2	Band	0 + 200	71.*
D-3	Band	0 + 400	64.5
D-4	Band	0 + 600	79.*
D-5	Band	0 + 800	73.*
D-6	Band	0 + 1,000	88.*

*By Volumeter

TABLE 4

ANALYSES OF DUST SAMPLES (Cont.)

Sample No.	Sample of Dust from	Location in mine Check Dust Survey Sample	As Received Percent Incombustible
		Return airway	
D-3	Band	0 + 400 feet	86.

APPENDIX A

Victims of Explosion

Name	Age	Occupation	Years Employed in this mine	Marital Status	Dependents (Incl. children under 18)
Mike Ardohain	38	Stopping builder	1 year 6 months	Married	Wife
Victor Fossat	47	Section Foreman	4 years 11 months	Married	Wife and 1 child
Andy Juvan	42	Continuous miner operator	2 years 4 months	Married	Wife and 1 child
Archie A. Larsen	40	Shuttle car operator	7 years 2 months	Married	Wife and 2 children
Heino Liin	38	Supplyman and roof bolter	3 years 7 months	Married	Wife and 3 children
Benino Montoya	40	Timberman and bratticeman	7 years 10 months	Married	Wife and 4 children
Gerald L. Nielsen	43	Mechanic and relief man on continuous miner and shuttle car	7 years 6 months	Married	Wife and 3 children
John Senechal, Jr.	32	Shuttle car operator	8 years 0 months	Married	Wife and 3 children
Benjamin Valdez	39	Utility man	8 years 9 months	Married	Wife and 2 children

List of Injured

Jesus Nunez	56	Conveyor belt attendant	6 years 6 months	Married	Wife and 8 children

APPENDIX B

Names and addresses of personnel of mine rescue teams that participated in recovery work after the explosion:

Independent Coal & Coke Company

Homer Hyatt	Castle Gate, Utah

Kaiser Steel Corporation

John Peperakis	Sunnyside, Utah
Harry Elkin	Sunnyside, Utah
George Ferguson	Sunnyside, Utah
James Harvey	Dragerton, Utah
Lynn Huntsman	Sunnyside, Utah
Lloyd Jaramillo	Sunnyside, Utah
Newel Kefford	Castle Dale, Utah
LaMar T. Lindsay	Sunnyside, Utah
Caratat Olsen	Dragerton, Utah
Troy Patrick	Dragerton, Utah
Clive D. Peterson	Sunnyside, Utah
John Schmidt	Sunnyside, Utah
Clair Self	Sunnyside, Utah
William Shumway	Sunnyside, Utah
Fred W. Tatton	Sunnyside, Utah

United States Fuel Company

Max Robb	Hiawatha, Utah
LaMar Bishop	Hiawatha, Utah
Ted Fitzgerald	Hiawatha, Utah
Fred Jensen	Elmo, Utah
Jethro Killpack	Huntington, Utah
Kevin Rowley	Huntington, Utah
Wright Sheldon	Hiawatha, Utah
Ray Thurman	Price, Utah
Clarence Wall	Hiawatha, Utah

APPENDIX B (Continued)

United States Steel Corporation
Columbia-Geneva Steel Division

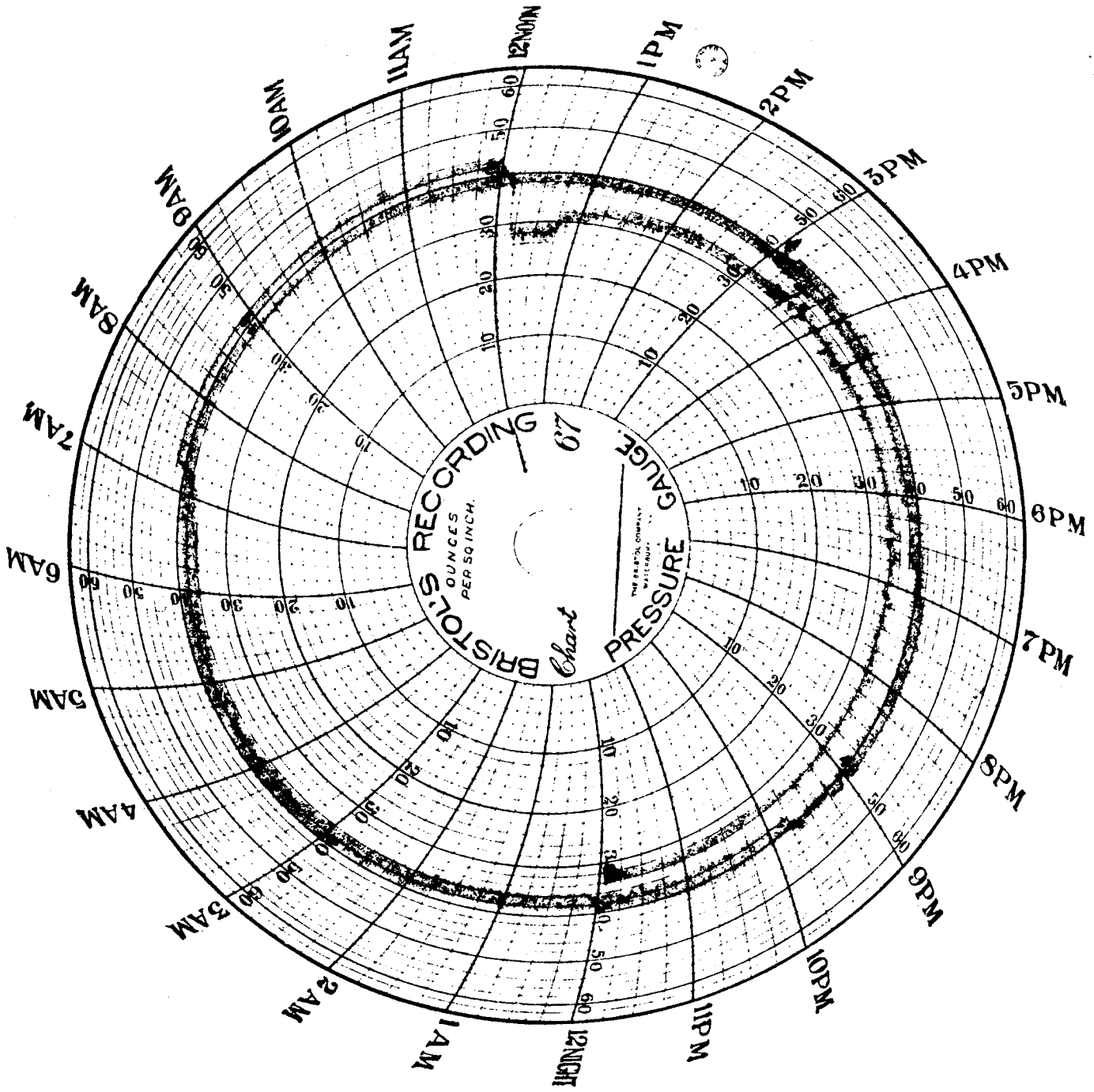
R. M. von Storch	Dragerton, Utah
Hugh Behling	Dragerton, Utah
Bert Frandsen	Dragerton, Utah
Philip Halamandaris	Dragerton, Utah
LeRoy Hersh	Dragerton, Utah
Lowell Hersh	Dragerton, Utah
Weldon Keele	Dragerton, Utah
Robert Kilcrease	Dragerton, Utah
W. C. Mahan	Dragerton, Utah
Lloyd Miller	Dragerton, Utah
Emery C. Olsen	Dragerton, Utah
W. J. Poglajen	Columbia, Utah
S. R. Taylor	Columbia, Utah

APPENDIX C

Records of Barometric Pressures and Temperature Readings Taken by United States Weather Bureau, Price, Utah, Airport.

Time	Sunday December 15		Monday December 16		Tuesday December 17	
	Temp.	Bar.	Temp.	Bar	Temp.	Bar.
1:00 a.m.			13°	24.39	Missing	24.39
2:00 a.m			12°	24.39	Missing	24.39
3:00 a.m.			11°	24.40	14°	24.38
4:00 a.m.			11°	24.40	13°	24.38
5:00 a.m.			12°	24.40	14°	24.37
6:00 a.m.	19°	24.32	11°	24.39	11°	24.37
7:00 a.m.	19°	24.34	11°	24.40	12°	24.38
8:00 a.m.	19°	24.35	12°	24.41	Missing	24.39
9:00 a.m.	20°	24.37	21°	24.42	22°	24.40
10:00 a.m.	23°	24.38	25°	24.43	26°	24.40
11:00 a.m.	25°	24.39	29°	24.44	31°	24.40
12:00 noon	27°	24.38	30°	24.43	31°	24.40
1:00 p.m.	Missing	24.37	29	24.40		
2:00 p.m.	29°	24.35	31°	24.40		
3:00 p.m.	31°	24.35	31°	24.38		
4:00 p.m.	31°	24.36	31°	24.38		
5:00 p.m.	27°	24.37	Missing	24.38		
6:00 p.m.	20°	24.37	22°	24.38		
7:00 p.m.	19°	24.37	20°	24.39		
8:00 p.m.	16°	24.37	20°	24.39		
9:00 p.m.	16°	24.37	Missing	24.38		
10:00 p.m.	Missing	24.38	17°	24.39		
11:00 p.m.	Missing	24.39	16°	24.39		
12:00 p.m.	14°	24.39	Missing	24.39		

APPENDIX D



FAN CHART - DECEMBER 16, 1963

APPENDIX I

BUREAU OF MINES
PITTSBURGH, PENNSYLVANIA
JANUARY 16, 1964

L. D. KNILL
SUBDISTRICT SUPERVISOR
BUREAU OF MINES, HEALTH AND SAFETY
SALT LAKE CITY, UTAH

SUBJECT: OIL SEEPAGE SAMPLE, NO. 2 MINE, CARBON FUEL COMPANY, HELPER, CARBON COUNTY, UTAH

FLASH POINT (CLOSED CUP) OF OIL AS RECEIVED WAS APPROXIMATELY 58° F. OIL BECAME NEARLY SOLID WHEN COOLED TO 53° F. AND WOULD NOT FLASH AT THIS TEMPERATURE. COMPOSITION OF GASES FROM FREE SPACE ABOVE OIL IN CONTAINER:

	VOLUME PERCENT
CARBON DIOXIDE	0.3
OXYGEN	12.3
NITROGEN	74.9
METHANE	5.0
ETHANE	0.4
PROPANE	0.3
BUTANES	3.5
PENTANES	2.3
HIGHER THAN PENTANES	1.0

CALCULATED AIR-FREE COMPOSITION OF MIXTURE:

	VOLUME PERCENT
CARBON DIOXIDE	0.7
NITROGEN	69.0
METHANE	12.1
ETHANE	1.0
PROPANE	0.7
BUTANES	8.5
PENTANES	5.6
HIGHER THAN PENTANES	2.4

APPENDIX I (Cont.)

ON AN AIR-FREE BASIS THE CALCULATED FLAMMABLE RANGE EXTENDS FROM 7.4 TO 24.4 VOLUME PERCENT OF THE MIXTURE IN AIR. THE SAMPLE AS COLLECTED CONTAINED 58.8 PERCENT OF AIR AND 41.2 PERCENT OF MIXTURE, HENCE IS ABOVE THE UPPER LIMIT AND IS NOT FLAMMABLE.

HYDROCARBONS FOUND WERE CHARACTERISTIC OF THE GASES AND MORE VOLATILE LIQUID COMPONENTS (NATURAL GASOLINE) ASSOCIATED WITH CRUDE PENTROLEUM. METHANE THROUGH THE BUTANES ARE GASES AT NORMAL TEMPERATURE AND PRESSURE, THE PENTANES BOIL AT ORDINARY ROOM TEMPERATURE OR SLIGHTLY HIGHER. VACUUM EXTRACTION OF 25 MILLILITERS OF OIL YIELDED 1.8 MILLILITERS OF GASEOUS HYDROCARBONS. IT IS PROBABLE THAT A LARGE PART OF THE GASES AND LOW BOILING LIQUIDS HAD BEEN LOST EARLIER.

DISTILLATION OF 325 MILLILITERS OF OIL OVER 61° TO 110° C. TEMPERATURE RANGE YIELDED 21 MILLILITERS OF DISTILLATE HAVING FLASH POINT BELOW 28° F., WHICH WAS THE LOWEST TEMPERATURE TRIED. THE DISTILLATE WAS MUCH MORE VOLATILE AND FLAMMABLE THAN KEROSENE AND WAS IN THE LOWER DISTAL-LATION RANGE FOR GASOLINE.

/s/ H. A. WATSON

H. A. WATSON, CHIEF
GAS ANALYSIS AND RESEARCH
SECTION

APPENDIX J

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Health and Safety Activity

Branch of
Electrical-Mechanical Testing

4800 Forbes Avenue
Pittsburgh, Pennsylvania
December 23, 1963

Air Mail

Memorandum

To : James Westfield, Assistant Director--Health and Safety
Through: D. S. Kingery, Research Director, Health and Safety Research and Testing Center

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

Subject: Investigation of two flame safety lamps recovered from an explosion that occurred December 16, 1963, in the No. 2 mine, Carbon Fuel Company, Helper, Utah

The following report covers the inspection and safety tests made on the above-mentioned flame safety lamps.

The two flame safety lamps were sent to the Pittsburgh Research Center via air mail on December 21, 1963, at 12:30 p.m. Each lamp was identified by a tag with a brief description of recovery location and name and company. The lamps were dirty from coal dust and rock dust. The initial external examination made indicated that both lamps were in very good physical condition.

The lamps were carefully brushed to remove excess dust and the external area of the glass chimneys cleaned to permit observation of the internal ignitions initiated during safety tests.

APPENDIX J (Cont.)

External Inspection of Lamp Tagged "Hung on Timber"

The flame safety lamp was a Koehler aluminum low-type. The lamp was properly assembled with genuine Koehler parts. There was a little coal dust inside the chimney area. The wick was in a capping position as the lamp was received and could not be ignited. No adjustment of the wick was made prior to the safety tests. The magnetic lock and igniter were both in working order.

Safety Tests of Lamp Tagged "Hung on Timber"

The lamp was preheated in an oven prior to the start of the safety tests in gas. The lamp was placed in gallery No. 3, in the Branch of Electrical-Mechanical Testing laboratory. The safety tests were conducted in gas and air mixtures ranging from 6.3% to 10.2% CH_4. Internal ignitions occurred within the flame safety lamp but no external ignition of the surrounding explosive CH_4-air mixtures occurred.

Internal Inspection of Lamp Tagged "Hung on Timber"

The lamp was opened with a magnet. The gauzes (both steel) were covered with coal dust but otherwise in very good condition. The expansion ring, upper gasket, and upper gasket ring were all in good condition. The pyrex chimney was in very good condition. The lower gasket and gauzes in the air-admission ring were in very good condition. A .003-inch feeler gage could not be inserted between the bottom surface of the air-admission ring and the top surface of the fount. The air-admission ring was undamaged and judged to be in very good condition. The threads on the fount and those on the magnetic lock ring were in good condition. The fount was in good condition although the bottom flared portion of the fount had been deformed until it was flush with the side of the fount. The planarity of both edges of the pyrex chimney was near perfect.

Conclusion

The Koehler flame safety lamp tagged "Hung on timber" as received by the Bureau's Branch of Electrical-Mechanical Testing was judged to be in a safe operating condition.

APPENDIX J (Cont.)

External Inspection of Lamp from Miner at the Face of 4 Entry

The lamp was a Koehler aluminum low-type with lined chimney. The lamp as received was covered with both rock dust and coal dust. The chimney had to be cleaned to permit inspection of the wick and the internal area of the lamp. The wick was in a position that produces a walking flame when lit. The igniter functioned properly and ignited the wick. A flame approximately 1/2 inch in height burned. The flame was allowed to burn to preheat the lamp prior to making the safety tests. The internal area of lamp around the chimney had a small amount of coal dust present. There was no evidence of charring of the coal dust. The lamp was judged to be properly assembled and appeared to be in very good physical condition. The magnetic lock was functioning properly. No prior adjustment of the wick was made.

Safety Tests of Lamp from Miner at the Face of 4 Entry

The flame safety lamp was allowed to preheat prior to the safety tests. It was then placed in gallery No. 3 in the Branch of Electrical-Mechanical Testing laboratory. Twenty tests were conducted with the lamp surrounded by gas and air mixtures ranging from 6.4% to 10.0% CH_4. Internal ignitions occurred within the flame safety lamp but no external ignitions of the surrounding explosive gas-air mixtures occurred.

Internal Inspection

A magnet was used to open the lamp. Both gauzes were covered with coal dust, but were in very good condition. The gauzes were made of brass and were genuine parts. The expansion ring and upper and lower asbestos gaskets were in good condition. The gauzes in the air-admission ring were in good condition. A .003-inch feeler gauge could not be inserted between the bottom surface of the air-admission ring and the top surface of the fount. The complete air admission ring assembly was considered to be in very good condition. The threads on the fount and those on the magnetic lock ring were in good condition. The pyrex chimney was lined. The top surface of the chimney with respect to the bottom surface was out of parallel by .0325 inch. The fount was judged to be in good condition.

APPENDIX J (Cont.)

Conclusion

The Koehler flame safety lamp tagged "From Miner at Face of No. 4 Entry" as received at the Bureau's Branch of Electrical-Mechanical Testing was judged to be in a safe operating condition.

/s/ C. L. Brown

C. L. BROWN