.FINAL REPORT OF MAJOR MINE-EXPLOSION DISASTER ROBENA NO. 3 MINE

UNITED STATES STEEL CORPORATION

COAL DIVISION, FRICK DISTRICT CARMICHAELS, GREENE COUNTY, PENNSYLVANIA

December 6, 1962

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December 6, 1962

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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).

Two gas and coal-dust explosions, the first at about 1:05 p.m. and the second at about 1:25 p.m., occurred on Thursday, December 6, 1962, in the 4 mains right area of Robena No. 3 mine, United States Steel Corporation, Coal Division, Frick District, Carmichaels, Greene County, Pennsylvania. Thirty-seven men, all of those working in the 8 left section of the explosion area, are believed to have died as a result of the first explosion, as attested by the fact that some of the watches, including the watch on the body of the outermost victim, had been stopped between 1:03 and 1:05, while two other men who approached the area after the first explosion were knocked down but not injured by the forces of the second explosion. The other 133 men in the Robena No. 3 mine at the time were withdrawn without mishap.

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 first explosion originated in the face area of 8 left inby 90 crosscut between Nos. 4 and 8 entries when a mixture of methane and air was ignited by one of four possible sources: A nip station just outby 90 crosscut on No. 6 entry, a car puller activated by an open-type electric motor located on intake air at the inby right corner of No. 6 entry at 90 crosscut, friction sparks from bits of a continuous miner being operated at the face of the slant place between Nos. 7 and 8 entries inby 91 crosscut, or an auxiliary fan in operation and in nonpermissible condition in 91 crosscut between the slant and No. 8 entry. (See appendix E.)

The second explosion originated somewhere in 8 left section when gas and/or dust was ignited by residual fires or by an electric arc, since the main fan had been restarted and the mine power system had been reenergized soon after the first explosion. Coal dust assisted in the propagation of both explosions.

The forces of the first explosion radiated from the face area of 8 left section extending throughout 8 left and 4 mains and terminating in the emission of dust from the downcast side of Frosty Run shaft. The forces of the second explosion extended throughout the same general area and also caused dust to issue from the downcast side of Frosty Run shaft. Each explosion resulted in stoppage of the Frosty Run fan.

GENERAL INFORMATION

The Robena mine, operated as one unit, consists of three interconnected mines, Nos. 1, 2, and 3, located at Greensboro and Carmichaels, Greene County, Pennsylvania, which are served by barges on the Monongahela River.

The operating officials of the company were:

J. C. Gray	Administrative Vice President, Raw Materials	525 William Penn Place, Pittsburgh 30, Pa.
Jesse F. Core	Vice President, Operations-Coal	do.
E. B. Nelson	Assistant Vice President, Coal Production	do.
Woods G. Talman	Assistant Vice President, Coal Staff	do.
Ralph C. Beerbower, Jr.	General Superintendent	509 Fayette National Bank Building, Uniontown, Pa.
W. E. Cook	Assistant General Superintendent	do.
Wayne D. Snell	Chief Mine Inspector	do.
Oran Hartzel	Mine Inspector	do.
Leo Pliss	Mine Inspector	do.
Michael Wydo	Superintendent, Robena No. 3 mine	R. D. 1, Box 149, Carmichaels, Pa.
Marion Misiak	Mine Foreman, Robena No. 3 mine	do.

unexpectedly, due to caving ground and an inrush of what is locally referred to as quicksand. Plans for opening the mine were suspended until April 23, 1959, when ground was broken for the present hoisting shaft. The hoist or main shaft was completed November 24, 1960; however, the further development of the mine was temporarily halted until the surface structures were erected. Coal on one shift was first produced July 30, 1961, and continued to be produced intermittently until the day of the explosion. A full crew on the second shift started to produce coal nine working shifts prior to the disaster.

The partly completed air shaft, located 520 feet east of the main shaft, was started November 7, 1961. The 6-foot circular steel-lined air shaft had been driven periodically to a depth of 70 feet below the surface soil and to within 74 feet of the coal bed at the time of the explosion.

The immediate roof is a medium-firm gray shale which is about 12 inches in thickness, overlaid by 12 feet of hard shale, 3 to 5 feet of limestone, and by 49 feet of sandstone, successively. The immediate roof disintegrates after it is exposed to the mine atmosphere, and to protect it from weathering approximately 12 to 18 inches of top coal is left. The floor is a smooth soft fire clay that also disintegrates when exposed to the mine atmosphere.

The analysis of a coal sample from the Illinois No. 6 coal seam obtained from a coal company located in the immediate vicinity is as follows: Moisture - 7.2 percent; volatile matter - 34.8 percent; fixed carbon - 51.0 percent; ash - 7.0 percent.

The 4 mains section consisted of 11 entries which had been developed about 1,800 feet inby 8 left junction. Entry development in 4 mains had been stopped and the section was idle at the time of the explosions.

Development in 8 left 4 main section consisted of driving 10 entries on 75-foot centers with crosscuts at 90-foot intervals. The 8 left entries had been turned off 4 mains and driven about 5,500 feet, at which point it was necessary to change the direction of development to intersect a recently sunk shaft (Kirby) located about 4,300 feet to the right of the active faces.

At this point the customary system of development, which was to advance entries from the return-air side of the split toward the intake or from left and right toward the center, a very commendable system from a ventilation standpoint, was temporarily discontinued, and the center or intake entries of both the right and left splits were advanced to get the radii driven and expedite the construction of overcasts in the section to permit splitting the air when the 90° turn would be made toward Kirby shaft. Apparently the fact that this rather drastic deviation from the usual development system would adversely affect ventilation of the faces was overlooked, and areas with sluggish ventilation inviting gas accumulation as well as reversal of airflow direction resulted.

Roof bolts were installed in all working sections in compliance with the plan approved by the Bureau of Mines, supplemented by timbers, steel channels, steel I-beams, and hydraulic roof jacks where necessary. In 8 left the bolts were installed on 3- and 4-foot centers to within 4 feet of the working face before the Goodman boring machine run was started. The boring machine advanced one half the side of a block or a maximum of 50 feet into solid coal, then the machine was moved from the place while roof bolts were installed. The roof was supported by safety posts and/or safety jacks during drilling and bolting operations. Roof bolts were 5/8-inch high-strength steel, 5 to 6 feet in length. In addition to steel straps, 6- by 6- by 1/4-inch flat high-carbon-steel bearing plates were used. Roof-bolting operations were performed with compressed-air-activated equipment.

Two face units consisting of two Goodman 400 Borer machines, six shuttle cars, two of which were not in use, and two 11-BU Joy cleanup loading machines were being used to develop 8 left section. Other electric face equipment included two auxiliary-type exhaust fans with tubing, which were used for face ventilation during loading operations, and a Joy 10-RU cutting machine.

Explosives

Permissible-type American Cyanamid Model A explosives and Hercules E.B. instantaneous electric detonators were used for blasting, and they were properly stored in well-constructed magazines on the surface and transported into the mine in specially constructed explosives cars. The amount of explosives and detonators stored in the section boxes in 8 left for use by the construction crew in the explosion area, as found during the investigation, was in excess of a 48-hour supply.

Explosives were not used in the production of coal except when clay veins too hard to cut with the boring machines were encountered. Reportedly, the face was undercut or sheared before clay veins were blasted. The face was blasted on the third (construction and maintenance) shift by certified shot firers using permissible blasting units, and the clay and coal was loaded into shuttle cars by either the boring machine or a loading machine. Explosives were not stored in the face areas but were taken to the faces in individual containers when needed.

Construction work in the 8 left section (explosion area) consisted mainly of installing additional roof supports and advancing the main haulage road, approximately 3 feet of bottom rock being removed to make the desired grade. Boreholes were drilled in the bottom on 4-foot centers to a depth of about 3 feet, and, reportedly, these holes were stemmed with incombustible materials and fired by certified shot firers during the nonproducing shift. Reportedly, tests for explosive gas were made before firing each shot or group of shots.

Evidence brought out during the official hearings on the disaster disclosed that blasting was not done on the construction shift on December 6, and there was no indication during the investigation of the disaster that blasting had been done on the shift on which the explosions occurred.

Ventilation and Mine Gases

Ventilation in the Robena mine was induced by seven propeller-type fans properly installed on the surface and equipped with the necessary safety devices. One fan, operated blowing, served to ventilate the slope bottom and rotary dumps and, combining with the Colvin fan, ventilated the haulage road on 2 main butts of Robena No. 1 mine. The other six fans were operated exhausting, three of which (Garards Fort, Bailey, and Frosty Run) were used to ventilate the No. 3 mine. A fan was installed at the recently completed Blaker shaft portal and will be put into operation when required by future development. This shaft (Blaker) and the Hartley shaft serve as intake air shafts. Separation doors were placed at various locations throughout the mine to regulate and/or isolate the various fan splits.

The Frosty Run fan, which was affected by the explosion (see appendix D), was operated at a speed of 900 revolutions per minute and developed a negative pressure of 6.2 inches of water gage. The volume of air measured at the bottom of the shaft and returning to this fan was about 415,000 cubic feet a minute. Methane liberation collected by the air returning to this fan was calculated to be 2,260,000 cubic feet in 24 hours. Eleven splits of air provided ventilation for the active workings in 5 left, 7 right, 8 left, and 4 mains. The two other main fans at No. 3 mine were not affected by the explosions and continued to operate. (See appendix D.)

A split system of ventilation was used throughout the mine. Overcasts and permenent stoppings were constructed of incombustible material. Temporary metal stoppings were used in face areas in addition to those constructed of masonry materials. Line brattice, auxiliary fans with tubing, and check curtains were used to direct air to the face areas. The quantities of air passing through the last open crosscuts in developing entries and being delivered to the intake end of the pillar lines during the February 1962 Federal inspection were considered to be adequate.

Air measurements and methane determinations made during the Federal inspection in progress at the time of this disaster were as follows:

Location		Volume of air, cfm	Methane, percent	Cubic feet of methane in 24 hours
Return.	No. 1 door, Long shaft	102,050	0.24	350,000
Return.	No. 2 door, Long shaft	103,200	.24	360,000
Return.	No. 3 door, Long shaft	139,360	.26	520,000
Return.	No. 4 door, Long shaft	136,680	.25	490,000
Return.	No. 1 split, Bowlby shaft	97,500	.09	130,000
Return.	No. 2 split, Bowlby shaft	86,400	.06	75,000
Return.	No. 3 split, Bowlby shaft	81,510	.06	70,000
Return.	No. 4 split, Bowlby shaft	98,150	.06	85,000
Return.	No. 1 split, Colvin shaft	74,700	.12	130,000
Return.	No. 2 split, Colvin shaft	111,030	.16	260,000
Return.	No. 3 split, Colvin shaft	238,520	.13	450,000
Return.	Slope fan	31,000	.00	--
Return.	No. 1 split, Bailey shaft	114,240	.21	350,000
Return.	No. 2 split, Bailey shaft	105,000	.12	180,000
Return.	No. 3 split, Bailey shaft	95,200	.10	140,000
Return.	No. 4 split, Bailey shaft	108,500	.07	110,000
Return.	No. 1 split, Garards Fort shaft	126,000	.28	510,000
Return.	No. 2 split, Garards Fort shaft	109,000	.27	420,000
Return.	No. 3 split, Garards Fort shaft	117,000	.22	370,000
Return.	No. 4 split, Garards Fort shaft	102,000	.14	210,000
Return.	No. 1 split, Frosty Run shaft	93,000	.60	800,000
Return.	No. 2 split, Frosty Run shaft	107,000	.42	650,000
Return.	No. 3 split, Frosty Run shaft	116,000	.23	380,000
Return.	No. 4 split, Frosty Run shaft	99,000	.30	430,000

The mine is classed gassy by the State and the Bureau of Mines. Preshift examinations for gas and other hazards were made by certified officials before the first operating shift of each day, and preshift examinations for succeeding shifts were made by the onshift certified official during his regular tour of duty. Onshift examinations for gas and other hazards were made by assistant foremen, mine foremen, safety inspectors, certain equipment operators, and shot firers. Gas wells penetrating the property were protected by blocks of coal left in place. An abandoned and plugged gas well was situated about 1,150 feet to the right of the faces in 8 left section.

Two splits of air ventilated 8 left 4 mains. The intake air was conducted through Nos. 3, 4, 5, and 6 entries to the face area, where it was split right and left. Regulators installed in the right and left return entries of 8 left just inby the junction with 4 mains were used to control the quantities in the two separate splits.

Air readings taken by the preshift examiner on the shift prior to the disaster showed 26,000 cubic feet of air a minute in the left return split and 36,000 in the right return split. At this time only construction work was in progress, and the electric face equipment had been moved back from the working faces. The auxiliary fans used for face ventilation were not in operation, and the air current was conducted to the entry faces by check curtains and line brattices. The ventilating split for the left side was conducted through No. 5 entry to 91 crosscut where it subdivided. One split was directed to the face of the radius crosscut between Nos. 5 and 6 entries and then used to ventilate the working places on the left side and returned through No. 0 entry to 87 crosscut where Nos. 1 and 2 entries also became returns. The other subsplit was directed to the face of No. 6 entry, thence through 91 crosscut, and returned to join the right split at 91 radius crosscut between Nos. 6 and 7 entries. Air from this point was coursed through the active workings on the right side and returned through No. 10 entry to 89 crosscut where No. 10 ended, thence through No. 9 entry to 86 crosscut where Nos. 7 and 8 entries also became returns.

The 4 mains idle section inby 8 left was ventilated by a separate air split controlled by regulators on the intake airways just outby the faces. Testimony of the ventilation engineer disclosed that 9,600 cubic feet of air a minute (measured in this intake) entered this section. In addition, return air from the right split of 8 left passed through this section.

Dust

At the time of the February 1962 Federal inspection of the Robena mine, the mine surfaces were generally dry. Dangerous accumulations of loose coal or coal dust were not observed. Water was used to allay dust during cutting and mining operations, on belt conveyors, and to wet down shuttle-car runways.

Dust samples collected on 4 mains right haulageway, in the left parallel entry near the junction of 8 left, and in the right parallel of 8 left 1,000 feet inby the junction during the Federal inspection in progress when the explosions occurred contained 90.0, 76.0, and 94.0 percent incombustible, respectively. A mixture of coal and rock dust from 6 to 8 inches in depth was observed along shuttle-car runways.

Dust surveys (see appendix F) made in 4 mains and 8 left (explosion area) after the explosions, during which 356 samples were collected, showed only 16.8 percent above the minimum 65 percent incombustible; however, these samples are not indicative of the dust conditions in the area prior to the explosions.

Visual observations in the explosion area indicated a possible deficiency in rock-dusting, so dust surveys were made in areas of the mine (5 flats right 4 mains left, 4 mains 4 left 5 butt left, and 4 mains left) not affected by the explosions to determine if rock-dusting was satisfactory in these sections, and also as an indication of what might have been in 8 left prior to the explosions. Of the 225 samples collected in these nonexplosion-affected areas (see table 1), 24 percent were below the required minimum of 65 percent incombustible. However, the deficient areas were relatively small.

The hearings disclosed that loose coal on the entries and in the crosscuts was cleaned up promptly after the crosscuts were tapped, but that coal spillage was not promptly removed from the shuttle-car runways and occasionally blanket rock-dusting was done in face areas before all loose coal and coal dust had been removed. It was further revealed that rock-dusters were used for other work, but management maintained that a regular schedule of rock-dusting was and is being followed.

Further testimony during the hearings revealed that 53 loaded cars and one partly loaded car of coal were in the section (2 loaded and a partly loaded car near the loading ramp between 89 and 90 crosscuts, 10 cars in 84 crosscut, 36 cars extending inby from 45 crosscut, and 5 on the right side pickup at 72 crosscut). Sixty-three tons of coal were swept from these cars by the forces of the explosions, and that portion smaller than 20 mesh would have been fuel to propagate the explosions. This tonnage figure was determined by comparing the average weight of coal in cars loaded before the disaster with the average weight of coal in the cars in the disaster area. Testimony also revealed that it was believed that the explosion originated from an ignition of gas in the face area of 8 left and was propagated by the abovementioned coal dust in addition to 1,400 or more pounds on the mine floor resulting from timber hitches cut in the ribs between 76 and 77 crosscuts No. 5 entry and other coal dust in the entries. This same testimony, together with the directional forces observed during the investigation (see appendix E), disclosed that the explosions appeared to travel the haulageways and parallels (intake airways) in 8 left, pushing the stoppings toward the returns on both sides, and that this was because of the fuel source in the intake airways (coal dust).

Observation in the explosion area revealed that the boring-type continuous miner leaves rather smooth roof and rib surfaces to which rock dust does not readily cling, but coal dust does because the surfaces are wet when the coal dust is produced and possibly dry when rock-dusted.

Bureau of Mines experiments have proved that blanket rock-dusting even though properly done will not always stop an explosion where the roof and rib dust is not in excess of the 65 percent minimum incombustible, which indicates a possible need for additional protection such as some new type of rock-dust barriers to be installed near the working areas, at loaded-car storage areas, and in belt-conveyor entries where coal dust is plentiful.

Transportation

Permissible-type and explosion-tested cable-reel shuttle cars were used in 8 left to transport coal from the face areas. The coal was discharged from them directly into mine cars that were pulled by trolley locomotives to the bottom of the Robena slope where they were unloaded by a rotary dump. The coal was then transported to the surface cleaning plant by belt conveyor. Men were lowered into and hoisted from the mine by elevators at various shaft locations and transported to and from working sections in covered man-trip cars. Self-propelled mine jitneys were used for miscellaneous transportation requirements. Traffic on the haulage roads was directed by dispatchers using telephones (trolley and conventional) and by a manually operated signal system. The track and rolling stock were maintained in good condition.

Electricity

Direct-current power, at 550 volts, was provided for use underground by 14 rectifiers and 11 motor-generator sets, with a total rated capacity of 12,400 kilowatts. However, at the time of the explosions, the Blaker substation was not in service. The conversion equipment, installed in 13 fire-resistant structures on the surface, was interconnected for parallel operation by automatic reclosing circuit breakers located near the bottom of boreholes and shafts. In addition to overcurrent protective devices in substations, 45 automatic reclosing circuit breakers were installed throughout the underground d.c. power system. The automatic reclosing circuit breakers were equipped with a load-measuring device. This device is used to determine the load current that will flow when the circuit breaker is closed by determining the load resistance before the circuit breaker is closed. The load-measuring device responds to the difference in voltage drop measured across one-half of a load-measuring resistor, as compared with the voltage drop measured across the other half of the load-measuring resistor and the load resistance in series. The device will operate to close the circuit breaker when the load resistance increases to a predetermined value. If, for example, a zero resistance fault exists in the system inby the circuit breaker, the device will prevent the breaker from closing. The load-measuring resistor is bridged across the circuit breaker to provide a test current of approximately 30 amperes. It is therefore possible to energize the underground power system with this test current by one or more conversion units feeding power into the system. Power wires were supported on well-installed insulators, and cutout switches were provided at required locations. Devices for protection against lightning were installed on power-transmission circuits that entered the mine through shafts and boreholes. Polarity of the trolley wire was positive. (See appendix H.)

A central supervisory control system for mine ventilating fans and substations was installed in the Colvin substation. The system provides continuous monitoring of 7 ventilating fans and remote operation of 22 mine-feeder circuit breakers located in all substations except Colvin. The circuit breakers in Colvin substation are manually operated, and others are monitored on a programmed schedule. A minimum of approximately 4 minutes is required to open all circuit breakers connected to the supervisory control system, and complete removal of electric power from the mine is usually accomplished in approximately 8 minutes.

Visible and audible signal devices are installed at each fan location, and they supplement the signals sent back to the supervisory control system in the Colvin substation from each fan. An audible horn and visible light signaling device was installed in and on the outside of the Colvin hoist room which is adjacent to the substation. When an indication of a fan failure is received at the control center, the hoisting engineer or other qualified persons are instructed to remove all electric power from the mine. This function is accomplished by opening the Colvin substation circuit breakers manually, and all other substation circuit breakers are actuated through the supervisory control system.

All main exhaust fans are equipped with various protective devices, which include instantaneous and inverse time overload relays, phase failure or reversal, incomplete starting sequence, bearing temperature, and reduction of water gage. Stoppage of the fan for any reason will cause a primary audible and visible signal to be given at Colvin shaft through the remote fan signal system. Supplementary audible and visible signals will function simultaneously at the affected fan.

During the February 1962 Federal inspection, operators of electric face equipment made suitable tests for methane before electric equipment was taken inby the last open crosscut and at frequent intervals while such equipment was being operated in the face regions. Testimony by witnesses during the hearings revealed that tests for methane were not made before electric equipment was energized. However, tests for methane were made in face areas before the machines were advanced to the face.

The electric face equipment in 8 left section consisted of two permissible-type Goodman 400 boring machines, six Joy 10-SC shuttle cars (one permissible type and five explosion-tested type, which were similar to permissible cars but were manufactured before the Bureau of Mines tested cable-reel shuttle cars for permissibility), two permissible-type auxiliary ventilating fans, two permissible-type Joy 11-BU loading machines, and one permissible-type Joy 10-RU rubber-tire-mounted cutting machine. Fire-resistant-type (polyvinyl-chloride-jacketed) trailing cables were used on face equipment in this section, and each cable was provided with a power tap and suitable fuse or a fuse and circuit breaker. Trailing cables connected to electric face equipment were thoroughly examined and tested, but no defects were found. As a result of heat developed by the explosions, the plastic jackets of numerous trailing cables were deformed. Only one trailing cable contained more than the allowable number (five) of temporary splices, and the splices were well made. Tests for continuity of frame-ground wires were made, but defects were not indicated.

The electric equipment in 8 left section was examined during the investigation, and the following permissibility defects were found in the permissible-type equipment:

1. A substitution of trailing-cable size and type and omission of packing in the cable packing gland resulted in an opening in the contactor compartment of the Jeffrey auxiliary fan in 91 crosscut between Nos. 7 and 8 entries. The packing gland was designed for a No. 10 three-conductor Type-W round cable, but a No. 6 two-conductor Type-G flat cable was used. The cable conductors were separated and the negative power conductor was bare at the entrance to the packing gland.

2. The Goodman boring machine in No. 8 entry had an opening in excess of 0.004 inch in a cable connection box for the pump motor. A cap screw was also missing from the cover plate. The trailing-cable packing gland at the entrance to an isolating-switch compartment was not packed. The cable was not provided with a hose conduit and was not clamped securely. In addition, the machine was equipped with the following electrical components not covered by Bureau of Mines approval: A compartment containing an isolating switch, the headlight and resistor were replaced with other types, a connection box was installed in the pump-motor circuit, the control switch for the pump motor was relocated and replaced with a switch of different design, and an emergency-stop switch was added.

3. A hose conduit for the pump-motor cable was not clamped to a connection box on the Joy 11-BU loading machine in No. 7 entry between 89 and 90 crosscuts.

4. The trailing-cable packing gland at the entrance to the main contactor compartment was inadequately packed on the Joy auxiliary fan in 91 crosscut between Nos. 3 and 4 entries. A 19-inch length of 1/4-inch packing is required, but only 6-1/2 inches was used.

5. The following defects were found in the Goodman boring machine in 92 crosscut between Nos. 6 and 7 entries: An inspection cover in the main contactor compartment was not provided with a locking screw, an opening was present in the main contactor compartment as a result of the entrance of the rotor-motor cable into the compartment without the use of a suitable packing gland, the emergency-stop-switch control cable was connected to other cables in the connection box in a haphazard manner, the isolation-switch and emergency-stop-switch control cables were not clamped and the hose conduit was inadequate, and packing was not used in the cable packing glands in the isolating-switch compartment. This machine was equipped with the following components that are not covered by Bureau of Mines approval for this type of machine: A compartment containing an isolating switch, headlight and resistor, and an emergency switch.

6. The headlight cable and hose conduit on a Sullivan 7-AU track-mounted cutting machine in No. 5 entry between 76 and 77 crosscuts were severed, possibly by the explosions. This machine was not used inby the last open crosscut, since trackless mining methods were used at the face.

7. Openings in excess of 0.004 inch were present in the main contactor, resistor, and conveyor-motor control compartments on a Myers-Whaley track-mounted loading machine in No. 5 entry 62 crosscut. Many cap screws on the main contactor compartment cover plate were loose, and the motor cable hose conduit at the entrance to the main contactor compartment was broken. This machine was not used inby the last open crosscut, since trackless mining methods were used at the face.

These deficiencies in the permissible-type equipment indicated general sub-standard inspection and maintenance of such equipment.

Defects in permissibility were not found in other permissible-type face equipment. An examination of the five explosion-tested-type shuttle cars used in face areas disclosed no openings into electrical compartments; however, an opening in excess of 0.004 inch was found in the main contactor compartment of a Joy 10SC1F (explosion-tested-type) shuttle car in No. 2 entry 50 crosscut.

The electrical controls of the Goodman boring machine and Joy shuttle car in the slant between Nos. 7 and 8 entries were found in the operating position. The control switch on the Jeffrey fan in 91 crosscut is a momentary-contact type, and therefore a definite determination as to whether the fan was in operation could not be made. The position of electrical controls found on the Goodman boring machine in 92 crosscut (left side), Joy auxiliary fan in 91 crosscut between Nos. 3 and 4 entries, shuttle cars, and other electric face equipment indicated that they were not in operation at the time of the explosions.

An examination of the electric face equipment disclosed no electrical faults except a headlight circuit in the main contactor compartment on the Goodman boring machine between Nos. 6 and 7 entries. The conductors had been severed. Testimony during the hearings revealed that the headlight was not in operating condition for several days prior to the explosions.

There was no evidence of burning in the control compartment of the auxiliary ventilating fan between Nos. 7 and 8 entries.

A distance of 4.75 inches was measured between the frames of the shuttle car and the boring machine in the slant between Nos. 7 and 8 entries.

Illumination and Smoking

Permissible electric cap lamps were used for portable illumination underground. Smoking was not permitted or observed underground during any Federal inspection, and searches for smokers' articles were conducted frequently. Smoking material was not found in the section or among the personal effects of the victims, which is substantial proof of strict compliance with a no-smoking requirement.

Mine Rescue and Firefighting Facilities

A total of 24 trained and active members of mine rescue teams and 3 trained and active station attendants were available, and 29 McCaa self-contained breathing apparatus were maintained at the Central Rescue Station at Robena No. 1 mine (Colvin shaft). Also 12 Chemox half-hour oxygen-generating self-contained breathing apparatus were available in various company mines in the district. In addition, other fully equipped and trained mine rescue teams were available at other mines within a 30-mile radius.

All employees in the Robena No. 3 mine carried self-rescuers on their persons, and two self-rescuers were kept on each locomotive. In addition, two universal gas masks were stored at each loading ramp and belt head. Each mine jitney was equipped with one universal gas mask.

Suitably marked escapeways were available from each working section to the surface. A check-in and check-out system provided positive identification upon each person underground.

Firefighting equipment consisted of waterlines from the surface to each working section, air lines that could be converted readily to waterlines, hose trucks located at strategic points along haulage roads, and dry-type chemical fire extinguishers on each piece of mobile equipment in the mine, at belt heads and tailpieces, and at permanent electric installations. High-pressure rock-dusting machines, with ample supplies of rock dust, and a foam-generating machine, with an ample supply of foaming agent, were available for firefighting service.

STORY OF EXPLOSIONS AND RECOVERY OPERATIONS

Activities of Bureau of Mines Personnel

About 3:00 p.m. December 6, 1962, Edward J. Sullivan, superintendent of Robena No. 2 mine, informed Gerald D. Young, Federal coal mine inspector, Waynesburg, Pennsylvania, that 16 men were trapped in the Frosty Run section of Robena No. 3 mine. Young informed the Pittsburgh office of the Bureau of Mines of the occurrence immediately, and then notified Federal Coal Mine Inspector James B. Shannon, also from the Waynesburg, Pennsylvania, office. Shannon was making an inspection of the Robena mine and was traveling the return airways of Robena No. 1 mine (Colvin shaft) with I. J. Menarcheck, mine foreman, at the time of the occurrence. Shannon had left the mine property about 1:20 p.m. and was unaware of the occurrence until contacted by Young.

Young and Shannon arrived at the mine about 4:00 p.m. and conferred with company officials on the surface. Shannon accompanied a mine rescue team into the mine to join another team and company officials already underground, while Young remained on the surface to check the fan (Frosty Run), determine the quality of the air returning from the mine, and relay to the Pittsburgh office of the Bureau of Mines any information gained by Shannon.

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

F. Delbert Baker
Richard E. Barr
John Barry
James A. Bennett
Joseph S. Bochna
Jennings D. Breedon
Wilburn C. Cagley
John T. Callahan
Gordon W. Chastain
Wymar G. Cooper
Robert T. Davis
William M. Demkowicz
William R. Devett
John S. Eakins
Omar Elkins
Frank Heffers
John W. Holcomb
William H. Hoover
Donald W. Huntley
Benjamin J. Jones
Donald S. Kingery
Robert J. Kirk
Earl M. Klees
Ralph I. Krek
James B. McCarty, Jr.
Thomas J. McDonald
Donald W. Mitchell
John Nagy
John A. Noon
David T. Parry
Richard H. Reid
John Risko
Earle M. Rudolph
James B. Shannon
R. Ward Stahl
Stacy L. Stiles
Everett Turner
W. Dan Walker, Jr.
Harry F. Weaver
James Westfield
Fred A. Williams
Gerald D. Young
Michael A. Yuhase
Henry Zavora

On December 6, 1962, a Withdrawal Order was issued under Section 203(a)(1) of the Federal Coal Mine Safety Act, debarring all persons from the Robena mine (Nos. 1, 2, and 3), except those needed for exploratory and recovery work. Before the Order was issued the company officials had withdrawan all men, except those mentioned above, from the Robena mine (Nos. 1, 2, and 3).

Mining Conditions Immediately Prior to the Explosions

The mine was operating normally on the day of the explosions, and the weather was cold and stormy. The temperatures and barometric pressures from 6:00 a.m. December 4 to 6:00 a.m. December 7, 1962, recorded at Morgantown Municipal Airport, Morgantown, West Virginia, are listed in appendix C. The barometric pressure dropped from 30.04 at 6:00 a.m. December 4 to 29.35 at 1:00 p.m. December 6, 1962. The temperature ranged from a high of 61° F. to a low of 27° F. during the same period. It is the opinion of the Bureau investigators that the variation in atmospheric pressure did not contribute materially to the explosions.

The reports of the examinations by the fire boss and assistant mine foreman made on the last production shift (4:00 p.m. to 12:00 midnight on December 5, 1962) in the 8 left section prior to the explosions indicated that gas had not been detected in the affected section. However, during the official hearings on the explosions, a continuous-miner operator on that shift stated that he had found gas at the intersection of No. 5 entry and the inby radius from No.5 to No. 6 entries, and that the air movement in this area was sluggish. He stated also that the section foreman was present when the gas was found and ordered a check curtain erected to improve the ventilation. A bratticeman on the same shift stated that he was present and observed that the continuous-miner operator did detect this gas. The foreman insisted that gas was not found on this shift, and that he had never found gas during his 2 months' supervision of the section. Furthermore, the section foreman on the construction shift, who made the preshift examinations for the day shift, stated that he had not found any gas in this section during the 2 years he supervised operations therein. The report of the preshift examiner (construction foreman) made prior to the entrance of the 8:00 a.m. to 4:00 p.m. shift on December 6 indicated that gas had not been detected in this section. The hearings disclosed that, in addition to supervising construction work in the 8 left section, the construction foreman made preshift examinations in both 7 right and 8 left sections, necessitating travel of about 12 miles during the shift, 6 miles of which was by locomotive between sections.

Evidence of Activities and Story of Explosions

The day shift entered the mine about 7:00 a.m. December 6, 1962, and those working in the 8 left 4 main butts area arrived at the work area about 7:30 a.m., according to the preshift examiner (construction foreman) who met and conversed with the foreman of the oncoming shift. The 37 persons in the 8 left area consisted of two production crews, comprised of a continuous mining-machine operator and two shuttle-car operators each and two roof-bolters who worked wherever bolting was necessary; thus the bolters may be with either machine. If the regular bolters were busy in one area and the place being worked by the other machine required bolting, the machine operator and shuttle-car operators would do the bolting. The bratticeman, mechanic, and a Joy 11-BU operator and 2-man section transportation crew served both machines. These 13 men were under the supervision of the production foreman. Others in the area were 14 construction men and a foreman, 2 repairmen and a foreman, 3 engineers, and 2 main-line transportation men. Since all persons in the section perished in the first explosion, it can only be presumed what work was in progress when the explosion occurred.

Comparing the extent to which places had been driven on the previous production shift and the places where men and machines were found after the explosions, the following work or activity pattern was established: The radius being driven from No. 5 to No. 6 entry had been extended from the 58-foot mark, cut through to No. 6 entry, and driven 16 feet beyond No. 6 entry where the machine was stopped with the controls in the "off" position. The machine operator had joined the section foreman and engineers at the junction of 91 crosscut and No. 7 entry. The auxiliary fan furnishing air to the faces of this place had been shut down after the inby radius had cut through to No. 6 entry, making the radius a dead-air space. Later tests simulating ventilation conditions presumed to exist before the explosions proved that the radius between Nos. 4 and 5 entries was a dead-air space and the area between Nos. 5 and 6 entries showed a slight air movement. With the auxiliary fan in operation, the length of tubing (200 feet) installed reduced the fan intake to about 3,300 cubic feet a minute, and the low-air velocity moving through the radius may not have properly ventilated this area. No. 7 entry had been extended from 63 feet inby 91 crosscut to about 85 feet. The slant off 91 crosscut between Nos. 7 and 8 entries had been advanced from the 60-foot point and coal was being mined at the time of the explosion, since the machine was at the face with controls in the "on" position, a shuttle car under the continuous-miner boom was partly loaded and the conveyor control was in the "on" position, the shuttle-car operator was on the seat, and the continuous-miner operator was found outby the machine controls near the shuttle-car operator. The auxiliary fan ventilating this place must be presumed to have been operating, since it furnished air to this working place and the nip was on the powerline. The location of the spad supports indicated that the tubing was about 32 feet from the face. The continuous miner was cutting a hard clay vein extending over much of the face. Other persons in the section were found at points where they might have been in the performance of their duties.

The first indication of trouble in the mine was noted by two repairmen, who had just completed repairing a compressor in the combination fanhouse and compressor station. According to John Syrek, repairman, the compressor was started at 1:00 p.m., and the two repairmen went to the lamp section of the

Appendix A

Victims of Explosions

Name	Age	Occupation	Years experience in this occupation	Years experience in coal mines	Marital status	Dependents (incl. children under 18)
Adam Andrews, Jr.	45	Cutting-Machine-Operator Helper	15	24	Married	Wife
Norman A. Benninghoff	57	Machine Repairman	8	27	Married	Wife
William J. Blacka	43	Transitman	17	25	Married	Wife and 2 children
James H. Boyd	43	Continuous Miner Faceman	6 months	22	Married	Wife and 4 children
Albert F. Bronakoski	18	Cooperative Student	2-1/2 months	2-1/2 months	Single	None
Nicola Caromano	57	Mason, Inside	3	32	Married	Wife and 1 child
Albert Cavalcante	48	Machine Repairman	6	27	Married	Wife
Frank Hainzer, Jr.	40	Continuous Miner Operator	2	21	Married	Wife and 3 children
James W. Hribal	39	Assistant Mine Foreman	12	21	Married	Wife and 1 child
Frank Hudock	51	Roof Bolter	3	33	Married	Wife and 3 children
Andy J. Hvizdos	47	Motorman	17	25	Married	Wife and 1 child
Andrew K. Kanyuch	54	Cutting-Machine Operator	2	29	Married	Wife
John Karlyak	38	Timberman	15	20	Married	Wife and 2 children
Arthur Labons	37	Mason, Inside	6	18	Married	Wife
Charles Laucher	49	Continuous Miner Operator	7	29	Married	Wife and 4 children
Alex Marra	62	Rock Driller	2	34	Married	Wife
John E. Martoncik, Jr.	45	Motorman	3 months	23	Married	Wife and 1 child
Elmer W. McCann	48	Roadman	14	27	Married	Wife and 2 children
Orrin E. McDowell	46	Transitman	21	25	Married	Wife and 2 children
Ernest Mollica	58	Timberman	15	38	Married	Wife
Homer F. Pitts	37	Loading-Machine Operator	10	19	Married	Wife and 4 children
Samuel Rain	47	Brakeman	16	27	Widower	Three children
Franklin H. Rifenburg	51	Machine Repairman	7	28	Married	Wife
Allen J. Sanner	49	Bratticeman	2	28	Married	Wife and 1 child
John M. Santer	53	Assistant Mine Foreman	16	25	Married	Wife and 4 children

service building about 50 feet from the compressor station. Soon after entering the lamp area, Syrek was apprised by Paul Honseker, his helper, that the audible fan signal was sounding an alarm. Looking out the window, Syrek said that he saw a white cloud of dust issuing from the nearby elevator shaft. He immediately went to the fan and found it stopped and was soon joined by Honseker and Ernest Benchek, the lampman. He told Benchek not to start the fan but to call the mine superintendent and Robert Rennie, surface maintenance foreman, whose headquarters was at Colvin shaft (Robena No. 1) and who was in charge of all fans. He also asked Honseker to check the air line leading to the shaft, as he thought it might have ruptured causing the white dust cloud.

In the meantime, Donald Sherrow, an electrician, upon telephoned instructions from Rennie, had arrived from the nearby Blaker shaft, checked the fan and, finding nothing wrong, started it.

One might conjecture at this point that the fan should not have been started, since neither a power failure nor mechanical difficulty was indicated by the various safety devices on the fan. Certainly the fan chart would not indicate a mine difficulty, since the pressure would drop to zero when the fan stopped. The only apparent indication of trouble underground was the dust cloud which emerged from the shaft, and this was not interpreted as an explosion.

The hoisting engineer and Rennie deenergized the mine immediately through the substation supervisory-control equipment, headquartered at Colvin shaft, and Rennie then remained near a telephone awaiting further instructions. He stated that the fan was restarted at 1:10 p.m. Soon thereafter he received a call from Sullivan, superintendent of No. 2 mine, saying that Nos. 2 and 3 mines were ready for power. Sullivan had received the message concerning No. 3 mine after a call from Misiak, mine foreman of No. 3 mine. Shortly thereafter Wydo, superintendent of No. 3 mine, called Walter Cook, assistant general superintendent, and informed him that the affected fan (Frosty Run) was operating and everything was O.K.

Wydo had been underground in the Garards Fort area when the first fan stoppage occurred, but upon learning of the trouble went immediately to Frosty Run, and the fan was operating when he arrived. Soon thereafter Wydo called Rennie telling him to put the power on, and Rennie stated that he had received this message from Sullivan but had no message from No. 1 mine, except that a company inspector, James P. Flynn (former superintendent of No. 1 mine), had said that No. 1 mine was O.K. for power. Wydo replied, "That is good enough for me; put the power on." This action had been taken without knowledge of conditions in the 8 left section whereas other sections had been contacted.

According to Rennie, the mine was only partly reenergized (not all of the 13 substations were restored) when the Frosty Run fan stopped again and the mine was again deenergized by the hoisting engineer.

After this second fan stoppage Wydo, recognizing an unusual occurrence, called Rennie via the superintendent's clerk at No. 1 mine to keep the power off. He further told the mine foreman to pull power switches underground outby Frosty Run bottom to make certain that power would not enter the affected area and, further, sent an electrician to lock out the breakers on the Mason and Frosty Run substations, the only stations feeding directly into the area inby the power switches deenergized by the mine foreman.

After the second fan stoppage, at which time Wydo was at Frosty Run giving various instructions and had observed the emergence of black dust from the downcast (elevator) shaft, other officials arrived and plans were made to cope with the underground trouble.

Another indication of trouble in the mine was noted by an assistant mine foreman, who observed a small cloud of dust as he approached the Frosty Run shaft bottom from 5 left 4 mains on a mine jitney. This, together with a fluctuation and subsequent loss of power in the trolley line, caused him to conclude that a trip had wrecked somewhere inby the Frosty Run shaft, never realizing that he had witnessed a result of the first explosion. Then, while walking toward 4 mains to find the trouble, the assistant foreman and a mechanic, who was following him about 200 feet distant, were knocked down but not injured by the second explosion.

Recovery Operations

Soon after the second explosion, recovery operations were started and mine rescue teams were summoned. It was soon discovered that the forces of the explosions had destroyed stoppings, the air was short-circuited about 4,000 feet from Frosty Run shaft bottom, and explosive and noxious gases permeated the atmosphere inby this point. Thus it was necessary to explore all entries leading to 8 left with self-contained oxygen breathing apparatus to ascertain the presence of and extinguish any fires before ventilation was reestablished. The following procedure was established and essentially followed during the entire recovery operations, which encompassed about 8,500 feet of the 10- to 11-entry system and connecting crosscuts. A mine rescue team or teams equipped with oxygen breathing apparatus would explore all entries for varying distances up to 1,000 feet but generally not more than two to three crosscuts (200 to 300 feet), erect temporary stoppings across all the entries at the inby point of exploration, and return to the fresh-air base. One or more fully equipped rescue teams were kept in readiness at the fresh-air base should an emergency arise while exploratory work was being conducted. The area thus explored would then be ventilated progressively until all gas had been removed and fresh air extended to the advance barrier in all entries. A new base would then be established at the barrier and the procedure repeated. Any fires found during the exploration by apparatus crews would be extinguished before any attempt was made to ventilate the explored area.

The recovery was a long and tedious operation, taking from about 3:00 p.m. December 6 until the morning of December 11, 1962, when the face area was finally ventilated. The recovery procedures were supervised by management personnel with the continuous assistance of the Secretary and staff of the Pennsylvania Department of Mines and Mineral Industries, as well as the Assistant Director--Health and Safety and staff of the Bureau of Mines. The then Acting President, the Director of the Safety Division, and other representatives of the United Mine Workers of America kept in constant contact during the recovery operations.

Six mine rescue teams of the United States Steel Corporation and seven teams from other companies participated in the recovery work, and the names of the members are listed in appendix B.

The successful completion of the recovery operations in the face of extremely hazardous conditions without a single injury demonstrated the competence and efficiency of all those who had to do with supervising and directing the operations. The Bureau of Mines pays special tribute to the members of the superbly trained mine rescue teams who provided the manpower, the unique skills flawlessly coordinated, the comprehension, and the oneness of purpose that are so vitally important in such a dangerous, exacting business.

The body of the first victim was found at 3:15 a.m. December 8 and the last was brought to the surface at 2:04 p.m. December 11, 1962. The face area was temporarily ventilated about 9:00 a.m. December 11 so that the remaining victims could be removed from the mine without the use of oxygen breathing apparatus.

After the last victim had been removed from the mine it was decided that the investigation would begin December 17, 1962. The official hearing was started January 3 and ended January 15, 1963.

During the interim period the area was patrolled continuously by teams composed of company, State, and Bureau of Mines personnel, and ventilation was further improved throughout the entire explosion area by replacing temporary ventilating devices with permanent stoppings. Any equipment moved by necessity to expedite ventilation improvements was carefully surveyed, located, and marked for further scrutiny.

When the recovery work and investigation were completed, the explosion area and other sections that appeared to be deficient in incombustible content were re-rock-dusted. Defects found in electric equipment and other substandard conditions in the explosion area as well as in other sections of the three mines were corrected. Field approval for modifications to the Goodman 400 continuous mining machines was requested by management and granted by the Bureau of Mines on January 29, 1963.

A special inspection was made of Robena mine (Nos. 1, 2, and 3) on December 21-22 and 27-28, 1962, and the danger described in the Withdrawal Order issued December 6 was found to be abated to the extent that on

December 28, 1962, the Director of the Bureau of Mines revised the Order to permit operation of the Robena mine (Nos. 1, 2, and 3), except the areas beginning at the equalizing overcasts inby the Frosty Run shaft, Robena No. 3 mine, which included 8 left and 4 main butts right section (explosion area). A second special inspection made on January 30, 1963, revealed that the danger described in the Withdrawal Order of December 6, 1962, had been totally abated, and the Director annulled the Order on January 30, 1963.

INVESTIGATION OF CAUSE OF EXPLOSIONS

Investigation Committee

United States Steel Corporation, Coal Division, Frick District

James C. Gray	Administrative Vice President, Raw Materials
Jesse F. Core	Vice President, Operations-Coal
E. B. Nelson	Assistant Vice President, Coal Production
Woods G. Talman	Assistant Vice President, Coal Staff
Ralph C. Beerbower, Jr.	General Superintendent
W. E. Cook	Assistant General Superintendent
Wayne D. Snell	Chief Mine Inspector
Oran Hartzel	Mine Inspector
J. P. Flynn	do.
Leo Pliss	do.
A. R. Werft	Chief Engineer
Robert R. Godard	Assistant Chief Engineer
George Person	Electrical Engineer
Michael Wydo	Superintendent, Robena No. 3 mine
Marion Misiak	Mine Foreman, Robena No. 3 mine
H. O. Hess	Electrical Maintenance Foreman

United Mine Workers of America

Charles Ferguson	Director, Safety Division
Rex Lauck	United Mine Workers Journal
John L. Mayo	President, District 4
John Cassidy	Representative, District 4
Steve Kattaron	Safety Committeeman, Local Union No. 6321
William Raho	do.
Paul Simon	do.

Pennsylvania Department of Mines and Mineral Industries

Lewis E. Evans	Secretary of Mines and Mineral Industries
Lester D. Kimmel	State Mine Inspector, Bituminous
W. Roy Cunningham	do.
Edward N. Connor	do.
J. M. Muchnok	do.
Edward J. Onuscheck	do.
Albin Johnson	State Electrical Inspector, Bituminous
Steve Marsinek	do.

United States Bureau of Mines

James Westfield	Assistant Director--Health and Safety
T. J. McDonald	Assistant to District Supervisor Health and Safety District B
R. Ward Stahl	Mining Health and Safety Engineer
R. J. Kirk	Federal Coal Mine Inspector
Ralph I. Krek	Federal Coal Mine Inspector (Electrical)
John A. Noon	Federal Coal Mine Inspector

A detailed examination of the area affected by the explosions was carefully made by the entire investigating committee. To expedite the work of such a large group, the committee was divided into four teams, each composed of representatives of the respective agencies. Each team was provided with a work book containing a mine map properly inscribed so that when the examination was completed each agency had a complete record of the findings. At the end of each shift the data collected were transferred to a large-scale map for final record.

The machines in the explosion area were studied by electrical inspectors of the interested groups, and their findings have been recorded heretofore in this report.

The flame safety lamps in the explosion area were tested in the Bureau of Mines gallery provided for this purpose, but no lamp transmitted an internal explosion to the gallery; thus the lamps were eliminated as a source of ignition. However, one Koehler lamp contained a Wolf chimney and igniter, and a Wolf lamp contained an asbestos gasket under the gauze, which rendered these lamps nonpermissible.

An analysis of the fan charts of the three main ventilating fans serving the No. 3 mine is given in appendix G.

Hearings conducted by the Pennsylvania Department of Mines and Mineral Industries, beginning January 3, 1963, were headed by Hon. Lewis E. Evans, Secretary of Mines and Mineral Industries, assisted by State mine and electrical inspectors. Mr. Evans invited representatives of the United Mine Workers of America, the United States Steel Corporation, and the Bureau of Mines to participate in the interrogation of anyone who might have knowledge of events prior to the explosions or practices which might have set the stage for the disaster.

Methane as a Factor in the Explosions

The following evidence proves that methane was liberated rather freely in the 4 mains and 8 left area of No. 3 mine:

1. The official record books kept at the mine indicate that gas had been found, although not frequently. The mine foreman recorded finding gas near the face of No. 7 entry (referred to as No. 6 entry in this report) 8 left

on December 5, 1962. One of the section foremen declared that he had not found gas in the 8 left section in the 2 years he supervised operations therein, and another section foreman stated that he had not found gas during his 2 months' supervision of the section--an unusual experience in any gassy mine.

2. Air samples collected during the Federal inspection in progress during the explosions showed a methane liberation of 2,260,000 cubic feet in 24 hours from the Frosty Run shaft.

3. Heavy concentrations of methane were found in the explosion area during recovery operations. One bottle sample collected ahead of ventilation showed 28 percent methane, 1.8 percent hydrogen, and 1.3 percent carbon monoxide. (See appendix K.)

4. During the rehabilitation of 8 left prior to the official investigation, an accumulation of methane was found at the face of 4 mains inby 8 left.

5. Samples collected on December 18, 1962, in the returns of 8 left inby 50 crosscut after the recovery operations and during the investigation showed that as much as 445 cubic feet of methane a minute was being liberated from the faces and entry surfaces. (See appendix K.)

6. A gas-emission test conducted by members of the investigating party on December 19, 1962, after the 8 left section had been ventilated for 8 days, showed 467 cubic feet a minute of methane being liberated from the 8 left faces and the return entry surfaces to No. 52 crosscut. (See appendix J for complete results of these tests.)

7. Numerous gas feeders were observed in the face areas of 8 left during the investigation.

8. During the hearings a continuous-mining-machine operator and others stated that an accumulation of gas had been found at the beginning of the second shift on December 5, 1962, in the inby radius extending from the face to the continuous miner that had been pulled back to the intersection of the radius and No. 5 entry. The assistant foreman stated that he did not find any gas at the beginning of the second shift on December 5, 1962.

9. The first explosion started from ignition of a body of methane.

Flame

Very heavy soot deposits were found in the faces of working places in 8 left, and heavy deposits of coke were found at numerous places throughout 8 left and in 4 mains inby 8 left. Coke was found adhering to the roof and timbers along 4 mains outby 8 left to a point just inby the first radius inby Frosty Run shaft. Other evidences of flame included seven smoldering fires along

4 mains inby and outby 8 left, burned paper, burned and charred timbers, melted plastic brattice cloth, and charred cable insulation. The flame extended from the faces of 8 left to the faces of 4 mains and to the first radius inby Frosty Run shaft. (See appendix D.) The most outby evidence of fire was a burned rock-dust bag near the first radius inby Frosty Run shaft. Dust samples collected in the explosion area showed anything from traces to very heavy coke particles. (See appendix F.)

Forces

Statements of witnesses during the hearings and evidence in the mine indicated that the forces of the first explosion radiated from the faces of 8 left, traversed all entries in 8 left, and in general displaced the stoppings from the intake airways toward the returns. The forces then divided and traveled to the face of 4 mains inby 8 left, thence outby 8 left in 4 mains, diminishing near Frosty Run shaft but still sufficient in intensity to force dust to the surface through the downcast side of the shaft a distance of about 2-1/2 miles from the faces of 8 left. (See appendix D.) Additional information that substantiates the fact that forces emanated from the faces of the 8 left entries is evidenced by the outward pressure that destroyed the metal stoppings in Nos. 1 and 2 entries between 87 and 88 crosscuts and those in Nos. 7 and 8 entries between 86 and 87 crosscuts.

The second explosion traversed the same general area and is believed to have been more violent than the first; however, the forces abated as they traveled toward the shaft, but these also caused dust to emerge from the surface entrance to the downcast side of the shaft.

Violence occurred throughout the explosion areas, as evidenced by bent steel crossbars, derailed equipment, blown-out stoppings (153 in number), demolished overcasts, severed cables, disengaged trolley and feeder wires, and displaced roof supports.

Probable Point of Origin

Bureau of Mines investigators believe that the first explosion originated in an area of 8 left face inby 90 crosscut and between Nos. 4 and 8 entries and that the second explosion originated somewhere in 8 left section.

Factors Preventing Spread of Explosions

The area covered by the two explosions was so extensive that a lack of fuel possibly was the greatest retarding factor. Rock dust prevented the full forces of the explosions from extending to the Frosty Run shaft and throughout the other two mines.

Summary of Evidence

Evidence and information educed during the official investigation of and hearings on the disaster are summarized as follows:

1. There were two explosions about 20 minutes apart.

2. The victims were killed by the first explosion, as attested by the fact that some of the watches, including the watch on the body of the outermost victim, had been stopped between 1:03 and 1:05.

3. The mining sequence was changed temporarily from an established simple routine to a more complex system that made ventilation more difficult to direct and control.

4. There was no indication that blasting had been done on the shift on which the explosions occurred or that explosives entered into the explosions.

5. Each explosion resulted in stoppage of the Frosty Run fan.

6. Methane was liberated freely from the coalbed and adjacent strata.

7. The explosions were propagated by coal dust.

8. Loose coal was observed along shuttle-car runways during a recent inspection, and the hearings revealed that spilled coal in face areas was not always removed before rock-dusting.

9. Dust surveys conducted in parts of the mine not affected by the explosions disclosed small areas that were deficient in incombustible material.

10. Permissibility deficiencies were found in seven of the permissible-type machines in the explosion area.

11. Since all the workmen in 8 left, origin area of the first explosion, were killed, the activities of persons in the area can only be assumed from their positions and the positions of the machines after the explosions.

12. It is assumed that coal was being loaded at the face of the slant place between Nos. 7 and 8 entries off 91 crosscut, since the operating controls of the continuous miner were in the "on" position; coal was present on the conveyor of the continuous miner; the shuttle car was partly loaded with the conveyor control in the "on" position; the shuttle-car operator was found on the seat; and the continuous-miner operator was near the shuttle-car operator along the rib as if fleeing from the face. The auxiliary fan between Nos. 7 and 8 entries in 91 crosscut can be assumed to be operating, since it was the source of air circulation through the slant place. The continuous miner in the radius just inby No. 6 entry was stopped, as was the fan which caused ventilation in this face. Other machinery in the face area indicated no motion at the time of the explosions.

13. Bureau of Mines tests of the flame safety lamps found in the explosion area disclosed that these were not a source of ignition.

14. Four possible sources of ignition present in the presumed path of gas travel were: A nip station just outby 90 crosscut in No. 6 entry; an open-type motor on a car puller at the right inby corner of 90 crosscut in No. 6 entry; friction sparks from a continuous miner cutting a hard clay vein at the face of the slant off 91 crosscut between Nos. 7 and 8 entries; and the auxiliary fan in nonpermissible condition between Nos. 7 and 8 entries.

Discussion of Evidence and Special Tests

The actual cause of the disaster can only be presumed, since all persons in the area encompassed by the first explosion were killed. Knowing the extent to which the places were advanced during the previous production shift and the general method of face ventilation from the testimony of both the last production-shift foreman and the preshift examiner just prior to the shift on which the explosion occurred, coupled with the position and condition of men and machines after the explosions, the following conjectural pattern of activities just prior to the first explosion was established. The pertinent points follow:

1. The continuous miner in the radius near the junction with No. 6 entry was stopped, having cut through to No. 6 and advanced about 16 feet beyond No. 6 entry. This is substantiated by the controls being in the "off" position and the operator's body being found at the junction of No. 7 entry and 91 crosscut with the bodies of the section foreman and engineers.

2. The auxiliary fan between Nos. 3 and 4 entries, used to circulate air through the upper radius from No. 4 to No. 6 entry, was stopped with the controls in the "off" position.

3. The continuous miner at the face of the slant place between Nos. 7 and 8 entries off 91 crosscut was operating, as attested by the controls being in the "on" position, a partly loaded shuttle car under the miner conveyor boom with the conveyor control in the "on" position, coal on the conveyor, the shuttle-car operator on the seat, and the continuous-miner operator near the shuttle-car operator as if fleeing from the face. The auxiliary fan installed in 91 crosscut between the slant and No. 8 entry was presumed to be operating, since it coursed air circulation through the slant place.

It was also known that a permanent stopping was being built across No. 7 entry between 89 and 90 crosscuts during this shift, since the masons were in the section, the lower course of blocks was in place, other blocks displaced by the explosions had mortar adhering to them, and the mortar marks appeared on the roof.

Having the foregoing established, it was assumed that when the auxiliary fan between Nos. 3 and 4 entries was stopped, air movement through the upper radius between Nos. 4 and 6 entries would be sluggish and gas might accumulate in this area. Actual tests on January 15, 1963 (see appendix I for details), disclosed that, when the inby radius cut through to No. 6 entry, the auxiliary fan that was used to ventilate the radius received all its air from the No. 6 entry and thus made the radius between Nos. 4 and 6 entries virtually a dead-air space where methane accumulated. The same tests also showed that, with the auxiliary fan stopped, the air would move toward the loading ramp on No. 6 entry. Even though the 8 left face area had been ventilated since December 11, 1962, gas started to accumulate near the face of No. 6 entry and backed up at least 20 feet from the face within the 15-minute test period.

Assuming that the stopping in No. 7 entry between crosscuts 89 and 90 was completed after the gas had accumulated in the radius between Nos. 4 and 6 entries, a test was made to determine what action the air might take as a result of this entry being closed. This test disclosed that any gas accumulated in the radius would be moved to the face of the radius, down No. 6 entry toward 91 crosscut and splitting here with a part going toward No. 7 entry through 91 crosscut and another part traveling toward the ramp and nip station at 90 crosscut, thence through 90 crosscut to No. 7, thence back through No. 7 entry to 91 crosscut and joining the air and gas which had passed through No. 7 entry.

In passing down No. 6 entry to the ramp this gas could also pass over the open-type motor of the car puller and the nip station. The total volume of air in 91 crosscut containing the aforementioned gas split at the slant. Five thousand cfm of this air ventilated the face of the slant place where the continuous miner was cutting a hard clay vein, which could emit sparks capable of igniting methane. The remaining 30,000 cfm of this air passed across the auxiliary fan which was not in permissible condition.

The special tests on January 15 disclosed that the auxiliary fan between Nos. 3 and 4 entries exhausted only 3,300 cubic feet of air a minute, which may not have been enough to keep the long radius and face properly ventilated.

A complete description of the foregoing tests and sketches portraying them are included in appendix I.

Cause of the Disaster

This disaster was caused by the ignition of a body of methane by friction sparks or electric arc. The methane had accumulated in a portion of the face development that was not ventilated for a short period of time and was moved over operating equipment when completion of a permanent stopping in the section resulted in a reversal of face airflow.

RECOMMENDATIONS

1. Insofar as possible, mining operations should progress from the return-air side of the section toward the intake-air side so that any gas emitted from places already driven will not pass over operating equipment or through active faces.

2. When it is necessary to deviate from the normal or customary plan of mining, such as starting a new section off a set of entries, a plan of ventilation should be made and each foreman in the affected section should be informed about the ventilation changes necessary as places are cut together.

3. If an auxiliary fan used to induce face ventilation is stopped for any reason, a line brattice should be installed immediately so the face is continuously ventilated.

4. When a main fan stops at a gassy mine, immediate action should be taken to cut off the power and withdraw the men from the face regions of the mine. When ventilation is restored, the face regions and other places where methane is likely to accumulate should be reexamined by certified or competent supervisors, and, if found to be free from explosive gas, power may be restored and work resumed. However, a main fan should not be restarted when there is an indication that an underground explosion has occurred until the effect thereof on the safety of the operation is known, and power should not be restored until all sections of the mine have been contacted and reported safe. Where a mine is ventilated by multiple fans and the split system of ventilation is employed, the foregoing should apply only to the area that is affected by such failure.

5. A special effort should be made to obtain and use larger-capacity auxiliary fans to assure an adequate amount of air in the places they are supposed to ventilate.

6. Fan tubing should be kept ahead of the machine operator and close enough to the face to properly ventilate the face area.

7. More effort shall be made to clean up loose coal between loading ramps and faces, and especially along the shuttle-car runways.

8. Flame safety lamps should be maintained in permissible condition.

9. Frequent and thorough gas tests should be made in active working places with a flame safety lamp, preferably using a capping flame. Each time gas is detected by an official, it should be recorded in the official mine record books.

10. 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.

11. Consideration should be given to designing and installing effective rock-dust barriers near working faces, in areas where loaded cars are stored, and along belt conveyors.

12. A regular schedule of rock-dusting should be established and followed without interruption.

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

14. Not more than a 48-hour supply of explosives and detonators should be stored in underground section magazines.

15. Electric equipment in face areas, even though pulled back from the face during idle periods or between shifts, should not be energized until the place has been examined and found to be free from gas.

The following recommendation has no bearing on the explosions but its adoption should receive careful consideration:

A modification of the fan monitoring and substation control system should include provisions for removing the power from the mine automatically in the event of main-fan interruption. Such system should have fail-safe features.

ACKNOWLEDGMENT

The writers gratefully acknowledge the courtesies, cooperation, and assistance extended by officials and employees of the United States Steel Corporation, the Pennsylvania Department of Mines and Mineral Industries, and the United Mine Workers of America.

Respectfully submitted,

T. J. McDonald

R. W. Stahl

R. G. Kirk

Ralph I. Krek

John A. Noon

Approved by:

James Westfield
Assistant Director--Health and Safety

Marling J. Ankeny
Director

Appendix A (Con.)

Victims of Explosions

Name	Age	Occupation	Years experience in this occupation	Years experience in coal mines	Marital status	Dependents (incl. children under 18)
Charles J. Sebeck	41	Roadman	15	21	Married	Wife and 5 children
Charles J. Seper	44	Continuous Miner Faceman	2 months	21	Married	Wife and 1 child
George L. Speelman	57	Continuous Miner Faceman	5	44	Married	Wife
Hurley C. Stalnaker	50	Motorman	17	30	Married	Wife and 3 children
Mike E. Stanik	60	Roof Bolter	6	33	Married	Wife and grandson
John J. St. Clair	42	Maintenance Foreman	6	21	Married	Wife and 2 children
John H. Steech	60	Rock-Loading-Machine Operator	10	43	Married	Wife and 2 children
Joseph V. Tokish	43	Pipeman	6	20	Married	Wife and 3 children
Charles S. Van Divner	39	Loading-Maching Operator	6	21	Married	Wife and 3 children
William H. R. Wright	55	Motorman	2	28	Single	Sister
Eugene G. Zuzak	46	Bratticeman	17	21	Married	Wife and 1 child
Paul C. Zvolenski	40	Motorman	7	19	Married	Wife and 6 children

Appendix B

Names and Addresses of Personnel of Mine Rescue Teams
That Participated in Recovery Work After the Explosions

Frick District Team No. 1

Walter Vicinelly, Captain	-	Masontown, Pa.
Walter Scarton	R.D. 1, Box 62	do.
Martin Kimes	R.D. 1, Box 203	Carmichaels, Pa.
Richard Murphy	-	New Salem, Pa.
Andrew Kostelnik	R.D. 1, Box 221-A	Brownsville, Pa.
Joseph Pennacchini	Dixon Boulevard	Uniontown, Pa.

Frick District Team No. 2

Tofil Myers, Captain	Main Street	Smock, Pa.
Henry Bacan	168 Maple Street	Carmichaels, Pa.
James Caffrey	House 83	Nemacolin, Pa.
Rex Hartzel	72 Liberty Street	Smithfield, Pa.
James Richards	Box 187	Grindstone, Pa.
William Caffrey	512 North Gallatin Extension	Uniontown, Pa.
Charles Zabrosky	Route 88	Carmichaels, Pa.
Walter Kasievich	65 Marion	Uniontown, Pa.

Frick District Team No. 3

Alex Whoolery, Captain	Box 306	McClellandtown, Pa.
Robert Monaghan	House 68, Ralph	Hibbs, Pa.
Charles Schuessler	R.D. 1, Box 598	Uniontown, Pa.
Steve Wydo	Box 86, Footedale Road	New Salem, Pa.
John Chambers	House 76, Cumberland Village	Carmichaels, Pa.
William Humbert	R.D. 1, Box 70	Greensboro, Pa.
Ronald Hartzel	-	Smithfield, Pa.
Harry Stacoviak	Box 233	McClellandtown, Pa.

Attendants

Arthur Zawacki	-	New Salem, Pa.
Marvin Gates	R.D. 1, Box 347	McClellandtown, Pa.

Appendix B (Con.)

Lynch District Team

Ted R. Hollin, Captain	Box 763	Lynch, Ky.
Charles S. Steel	Box 696	do.
Lee A. Marszli	Box 35	do.
Louis E. Henegar	305 Wise Street	Appalachia, Va.
Frank L. Sizemore	-	Lynch, Ky.

Gary District Team

Albert Wagers, Captain	-	Gary, W. Va.
Frank Billings	-	Welch, W. Va.
John Bodner	-	Havaco, W. Va.
Russel Burge	-	Thorpe, W. Va.
John Dickinson	-	Gary, W. Va.

Tennessee Coal and Iron Team

Robert E. Burdette, Captain	613 Glenpark Drive	Fairfield, Ala.
William D. Powell	Route 13, Box 468	Birmingham, Ala.
Eugene B. Leslie	1312-44th Street West	Birmingham, Ala.
Robert C. Bice	P.O. Box 12	Mulga, Ala.
Leonard N. McCarty	1129 Heflin Avenue	Birmingham, Ala.
Jesse E. McGill	Box 57	Graysville, Ala.

Attendants

Robert A. Dietz	222 Highland Drive	Hueytown, Ala.
E. L. Baker	533 Clearview Road	Birmingham, Ala.
John Q. Pugh	1016-58th Street South	Birmingham, Ala.
Richard B. Johnson	445 Ridgewood Avenue	Fairfield, Ala.

Pursglove No. 15 Mine Team

Louis Krushansky, Captain	206 Rhode Island	Westover, W. Va.
Perry Sheets	Route 1, Box 246	Mount Morris, Pa.
John Pysh	Route 1, Box 2	do.
Luther B. Simpson	-	Wana, W. Va.
Paul Evanoff	-	Cassville, W. Va.
Robert Verbosky	629 Protzman Street	Morgantown, W. Va.

Attendant

Robert H. Williamson	912 Stewart Street	Morgantown, W. Va.

Osage No. 3 Mine Team

Phillip Hines, Captain	402 Sanford Street	Morgantown, W. Va.
Woodrow Brinegar	537 Milford Street	do.
John White	202 Savanah Street	Westover, W. Va.
Worth Greer	Box 116	Dellslow, W. Va.
Rev. Robert Fox	Route 1	Mount Morris, Pa.
Charles Jimmie	Box 171	Rivesville, W. Va.

Montour No. 4 Mine Team

James A. Beck, Captain	5381 Main Street	Bethel Park, Pa.
Nello Menozzi	2501 Milford Drive	do.
Edward Zemaitis	Box 38	Westland, Pa.
Amzi Snyder	R.D. 2, Box 253	Canonsburg, Pa.
Joe Astorino	2836 Washington Road	Bridgeville, Pa.
Charles Morgan	Box 53	Lawrence, Pa.

Attendants

Leslie G. Black, Safety Inspector	R.D. 1	Eightyfour, Pa.
William Parisi, Director of Safety	-	Mount Lebanon, Pa.

Mathies Mine Team

John Tosic, Captain	1301 Edna Street	Pittsburgh, Pa.
James B. Campbell	R.D. 3	Finleyville, Pa.
Mike Wallo	496 Regent Street	Houston, Pa.
Francis R. Williams	Box 382	New Eagle, Pa.
William Lendvai	417 Walde Street	Pittsburgh, Pa.
Angelo Grosso	Box 33	Houston, Pa.

Mather Collieries Team

Rudolph Milovac, Captain	-	Mather, Pa.
James Bartoroni	-	do.
Theodore Fazzari	-	Jefferson, Pa.
John Machesky, Jr.	-	Mather, Pa.
Richard Machesky	-	do.
Pete Shenal, Jr.	-	do.
Raymond E. Boyles	-	do.

Appendix B (Con.)

Allegheny-Pittsburgh Coal Company Team

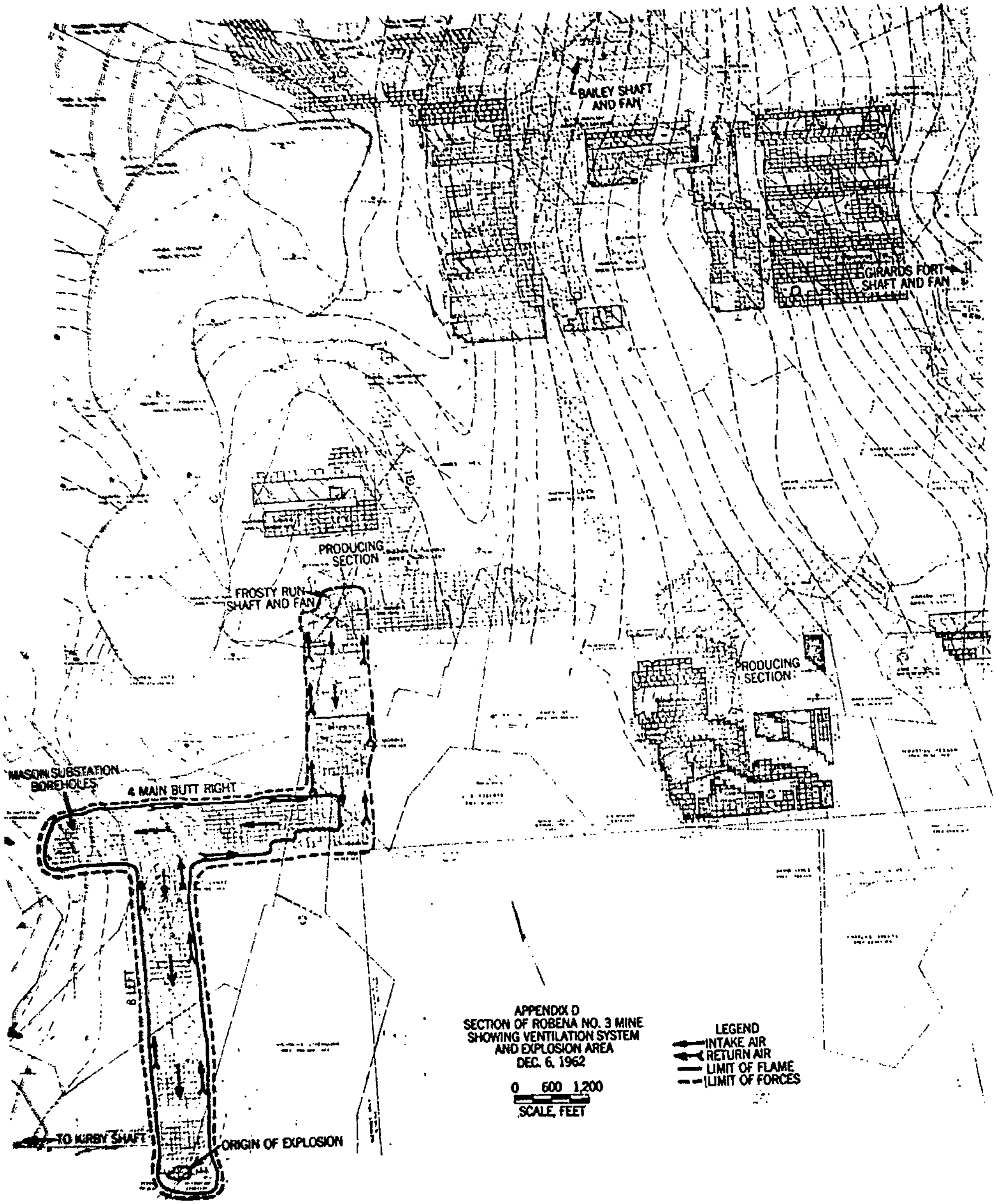
Danie E. Campbell, Captain	641 Memorial Drive, Logans Ferry Heights	New Kensington, Pa.
William E. McCullough	1819 Kimball Avenue	Arnold, Pa.
Leo E. Malobisky	314 Kertis Avenue, Logans Ferry Heights	New Kensington, Pa.
Joseph A. Waitkus	Box 252, Parnassus Station	do.
William A. Simpson, Jr.	9907 Saltsburg Road	Pittsburgh, Pa.
Robert Couturiaux	201 Dombroski Avenue, Logans Ferry Heights	New Kensington, Pa.

Mountaineer No. 9 Mine Team

Harry Floyd, Captain	Box 714	Farmington, W. Va.
William Floyd	Box 238	do.
George Hennis	1239 Bellrun Road	Fairmont, W. Va.
Charles Draft	Route 1, Box 186-A	Farmington, W. Va.
John G. Metz	Box 28	do.
George Glover	Sycamore Addition	Mannington, W. Va.

Attendant

Jesse G. Bowers	Route 1, Box 154-A	Fairmont, W. Va.



APPENDIX D
SECTION OF ROBENA NO. 3 MINE
SHOWING VENTILATION SYSTEM
AND EXPLOSION AREA
DEC. 6, 1962

Appendix G

Analysis, Frosty Run Fan Operating Chart

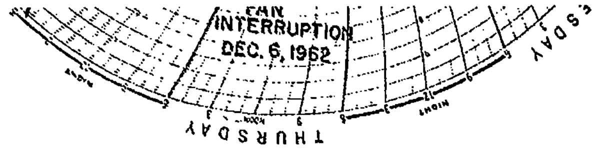
Thursday, December 6, 1962 - 12:55 to 2:00 p.m.

Comment - Inaccuracy of clock mechanism is such that chart times should be corrected by possibly plus 8 to 10 minutes to compare with times of the first fan stoppage, 1:02 p.m., attested to during the official hearings on the disaster.

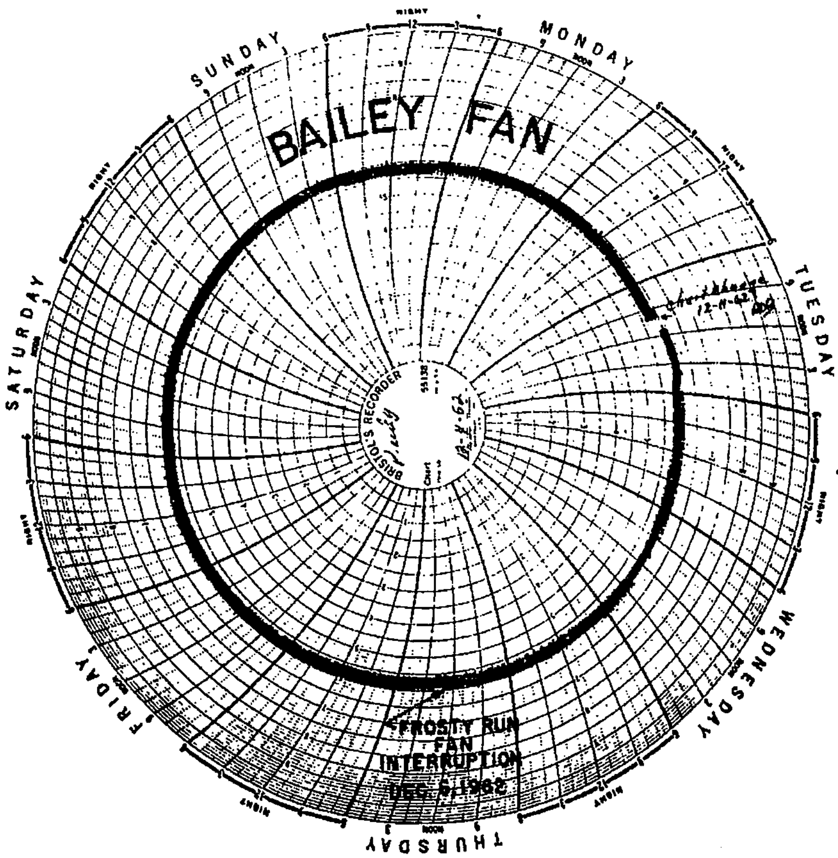
Summary - The fan chart indicates that two separate explosions occurred within the mine, approximately 20 to 25 minutes apart. Both explosions exerted sufficient energy acting on the mine ventilation resistance to cause a marked reduction of water gage at the fan. The reduced operating-pressure protective device functioned and stopped the fan in both cases. Neither explosion, although evidenced on the surface by dust clouds emanating from the intake side of the Frosty Run shaft, was sufficiently violent to force open the explosion protective cover plate on top of the return shaft. The first explosion created sufficient permanent change in the underground ventilating system to reduce the normal fan operating pressure from 6.2 inches normal operation to 5.8 inches after the fan was restarted. The second explosion, obviously more violent, reduced the water gage from the previous 5.8 inches to 5.5 inches, as shown after the fan was restarted and remained in operation. There was no evident damage to the fan or protective devices by either explosion as shown by the fan having been started on two occasions.

Chronological analysis of the fan chart - Times given as chart times actual times plus 8 to 10 minutes.

12:55 p.m.	Fan operating normal, average water gage reading 6.2 inches.
12:55 - 1:15 p.m.	Fan water gage dropped from 6.2 to an average of 0.3 inches, fluctuating both above and below the zero line of the fan chart until the protective reduced pressure switch shut off the fan. This fluctuation was caused as the result of action of explosion forces within the mine. The fan remained idle for approximately 15 minutes.
1:15 - 1:25 p.m.	The fan was restarted at approximately 1:15 p.m. Lines on the chart indicate that the fan did not immediately find its stable operating point then settled with a variation of 0.6 inches water gage, average water gage reading of 5.8 inches. This reduced water gage of 0.4 inches below normal indicates a definite abrupt reduction in mine resistance, such as short circuits for air travel. The fan operated for approximately 10 minutes.



APPENDIX G



APPENDIX G

Method

These tests were conducted by officials of the United States Steel Corporation, Coal Division, Frick District, conforming with a general plan previously accepted by the commission investigating the cause of the Robena disaster. Observers consisted of representatives from the Pennsylvania Department of Mines and Mineral Industries, the United Mine Workers of America, the United States Steel Corporation, and the Bureau of Mines.

Comment

These tests were beneficial and, although conducted under varying assumed conditions, data were obtained from which certain evaluations were made possible.

Test A-1

Purpose - To establish airflow direction and air quantities existing immediately prior to the cut-through between the upper radius and No. 6 entry.

Position of equipment -

1. Nine-car trip in No. 6 entry between 89 and 90 crosscuts.

2. Goodman 400 miner located approximately 30 feet from face of the upper radius.

3. Auxiliary fan located on 91 crosscut between Nos. 3 and 4 entries with tubing extended to normal position near operator.

4. Auxiliary fan located in 91 crosscut between Nos. 7 and 8 entries with 18-inch tubing to within 16 feet of slant entry face.

5. Nip station on No. 6 entry just outby 90 crosscut.

Construction changes - Close off upper radius by means of a tight check in line with the left rib of No. 6 entry; close off No. 5 entry with loose check at upper radius.

Air-measuring stations -

1. Measuring stations as shown by number, air readings simultaneous.

2. Ventilation control measures as shown. Stoppings made of metal; canvas checks and line canvas tight and well installed.

__Physical conditions__ - Similar to test A-7 except:

1. No. 6 entry was practically open at its connection with upper radius.

2. Left ventilating fan running.

__Comment__ - This condition shows that the air volume was increased in the upper radius with excess above fan capacity returning to the right split.

Test A-9

__Purpose__ - To determine conditions with left ventilating fan not operating; conditions assumed to exist at the time of the explosion.

__Physical conditions__ - Same as test A-8 except:

1. Left ventilating fan not operating.

2. The line brattice in No. 7 entry was removed to a line of spads believed to indicate the location where it had been installed previously.

__Comment__ - This shows reversed airflow with:

1. 5,000 cfm returning down No. 6 entry from face of upper radius.

2. 7,600 cfm toward the nip station from 91 crosscut.

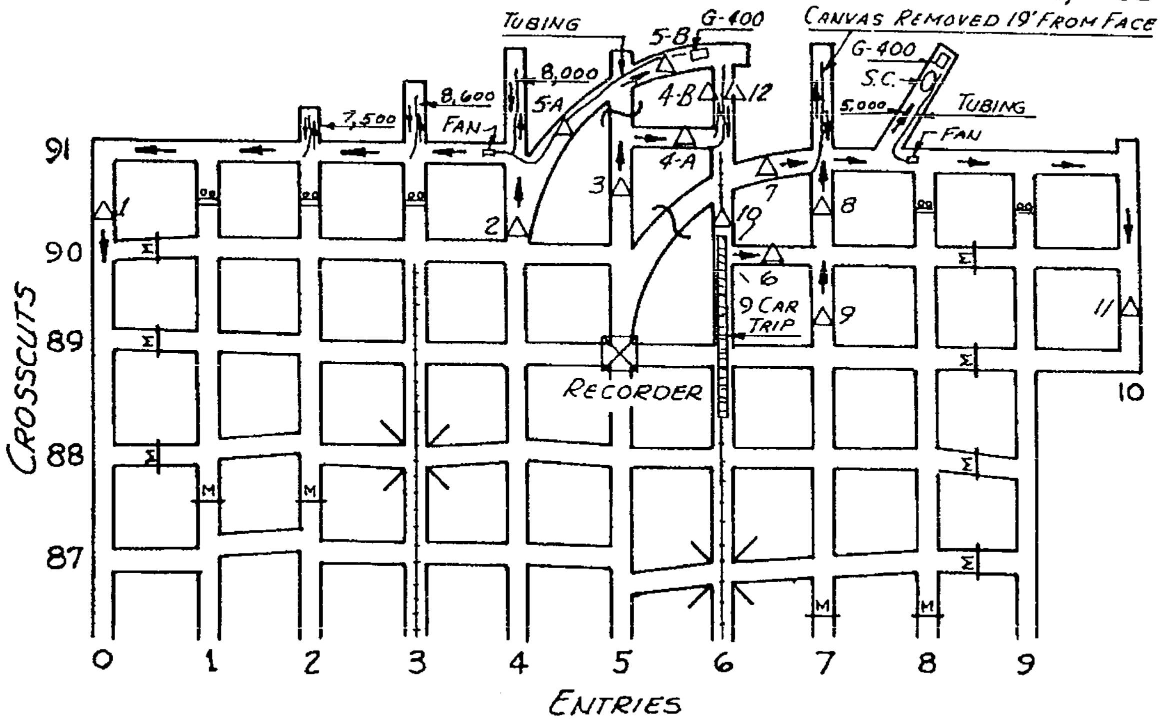
3. A flow through the upper radius of 4,500 cfm from ventilation pressure without the auxiliary fan.

VENTILATION STUDY

FACE AREA - 4 MAIN BUTTS - 8 FLATS LT. SECTION

ROBENA NO. 3 MINE

CONDITIONS ASSUMED PRIOR TO EXPLOSION ON DECEMBER 6, 1962



TEST A-3 DATA SHOWING AIR QUANTITIES CU. FT./MIN.

TESTS TAKEN JAN. 15, 1963

CONDITIONS

RIGHT FAN RUNNING

LEFT FAN DOWN

PLASTIC STOPPING REMOVED IN INBY RADIUS

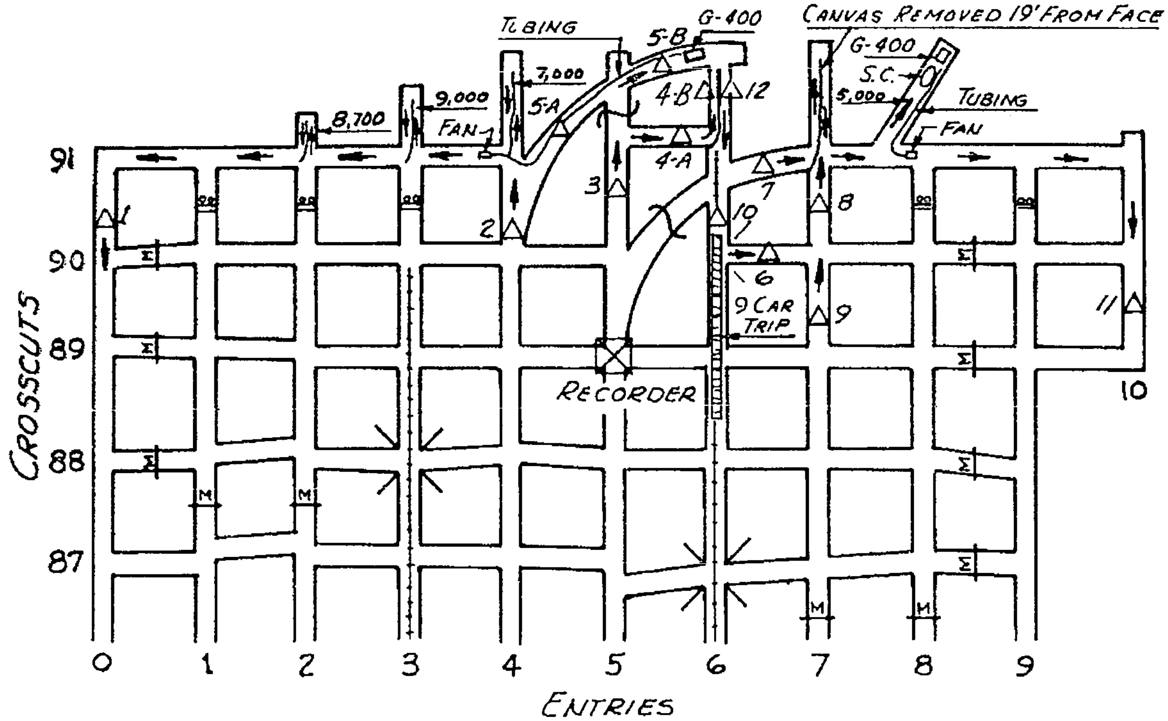
STA. 1	25,500	STA. 6	10,500
2	25,200	7	5,700
3	3,550	8	35,800
4-A	3,400	9	25,000
4-B	3,000	10	SLIGHT SMOKE MOVEMENT
5-A	NO MOVEMENT	11	41,500
5-B	SMOKE MOVEMENT	12	2,900

VENTILATION STUDY

FACE AREA - 4 MAIN BUTTS - 8 FLATS LT. SECTION

ROBENA NO 3 MINE

CONDITIONS ASSUMED PRIOR TO EXPLOSION ON DECEMBER 6, 1962



TEST A-2 DATA SHOWING AIR QUANTITIES CU. FT./MIN.

TESTS TAKEN JAN. 15, 1963

CONDITIONS

RIGHT FAN RUNNING

LEFT FAN RUNNING

PLASTIC STOPPING REMOVED IN INBY RADIUS

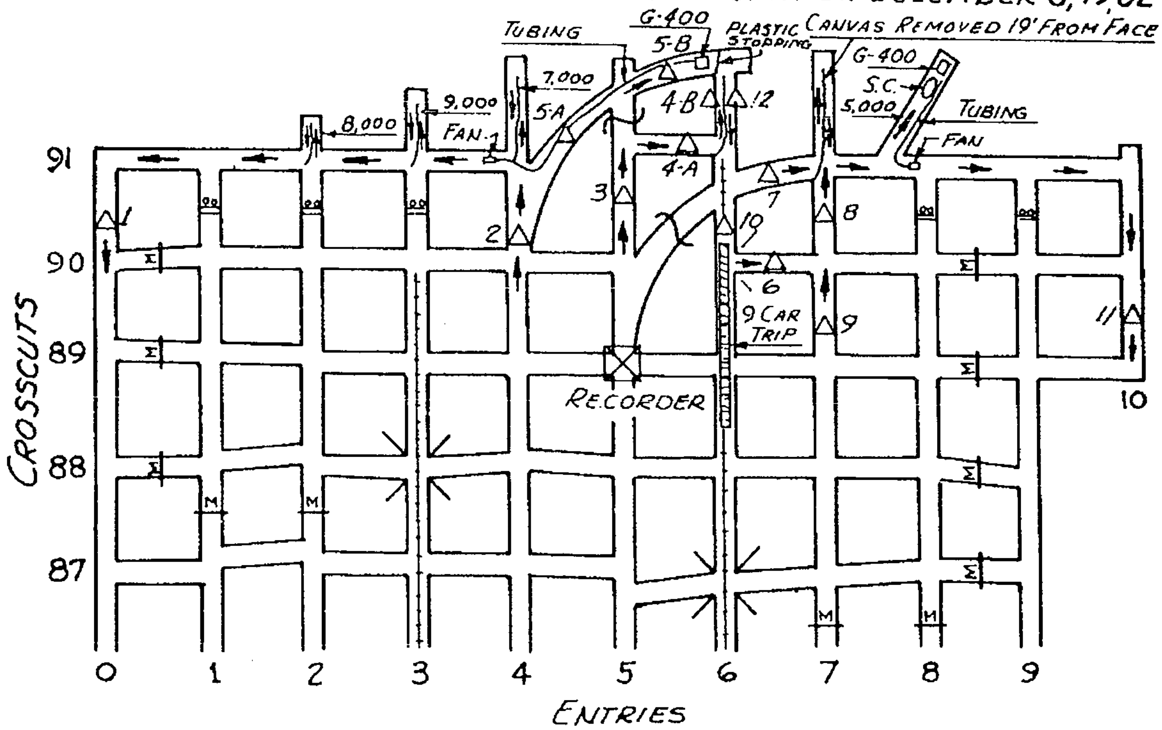
STA.		STA.	
1	26,100	6	10,200
2	26,200	7	3,500
3	4,700	8	38,000
4-A	4,000	9	27,800
4-B	3,500	10	NO MOVEMENT
5-A	SMOKE MOVEMENT	11	41,000
5-B	SMOKE MOVEMENT	12	3,000

VENTILATION STUDY

FACE AREA - 4 MAIN BUTTS - 8 FLATS LT. SECTION

ROBENA NO. 3 MINE

CONDITIONS ASSUMED PRIOR TO EXPLOSION ON DECEMBER 6, 1962



TEST A-1 DATA SHOWING AIR QUANTITIES CU. FT./MIN.

TESTS TAKEN JAN. 15, 1963

CONDITIONS

RIGHT FAN RUNNING

LEFT FAN RUNNING

PLASTIC STOPPING IN INBY RADIUS JUST OUTBY NO. 6 ENTRY

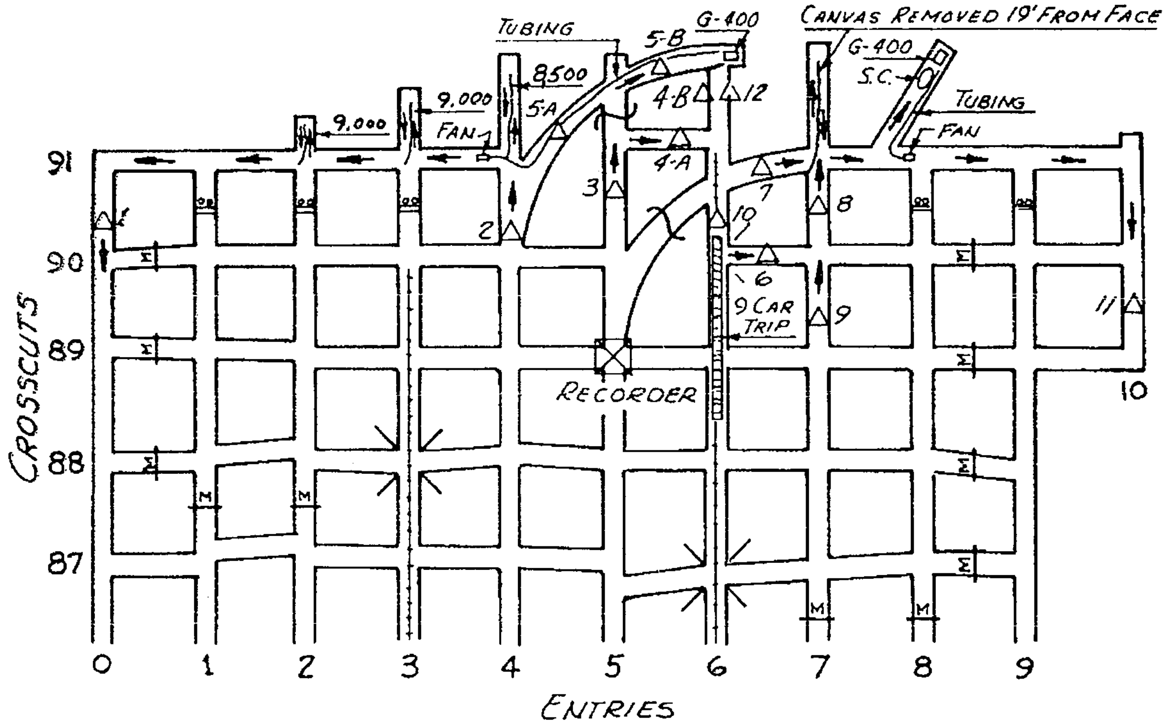
STA. 1	26,800	STA. 6	10,100
2	25,200	7	2,700
3	4,750	8	37,500
4-A	3,800	9	27,400
4-B	3,000	10	NO MOVEMENT
5-A	SMOKE MOVEMENT	11	39,700
5-B	SMOKE MOVEMENT	12	2,700

VENTILATION STUDY

FACE AREA - 4 MAIN BUTTS - 8 FLATS LT. SECTION

ROBENA NO. 3 MINE

CONDITIONS ASSUMED PRIOR TO EXPLOSION ON DECEMBER 6, 1962



TEST A-4 DATA SHOWING AIR QUANTITIES CU. FT./MIN.

TESTS TAKEN JAN. 15, 1963

CONDITIONS

RIGHT FAN RUNNING

LEFT FAN RUNNING

LINE CANVAS IN #6 ENTRY

AT INBY RADIUS OPEN 1-FOOT

STA. 1	23,400	STA. 6	12,700
2	24,500	7	10,700
3	10,400	8	30,000
4-A	10,000	9	17,600
4-B	NO MOVEMENT	10	SLIGHT SMOKE MOVEMENT
5-A	SLIGHT SMOKE MOVEMENT	11	40,900
5-B	SLIGHT SMOKE MOVEMENT	12	DISCONTINUED

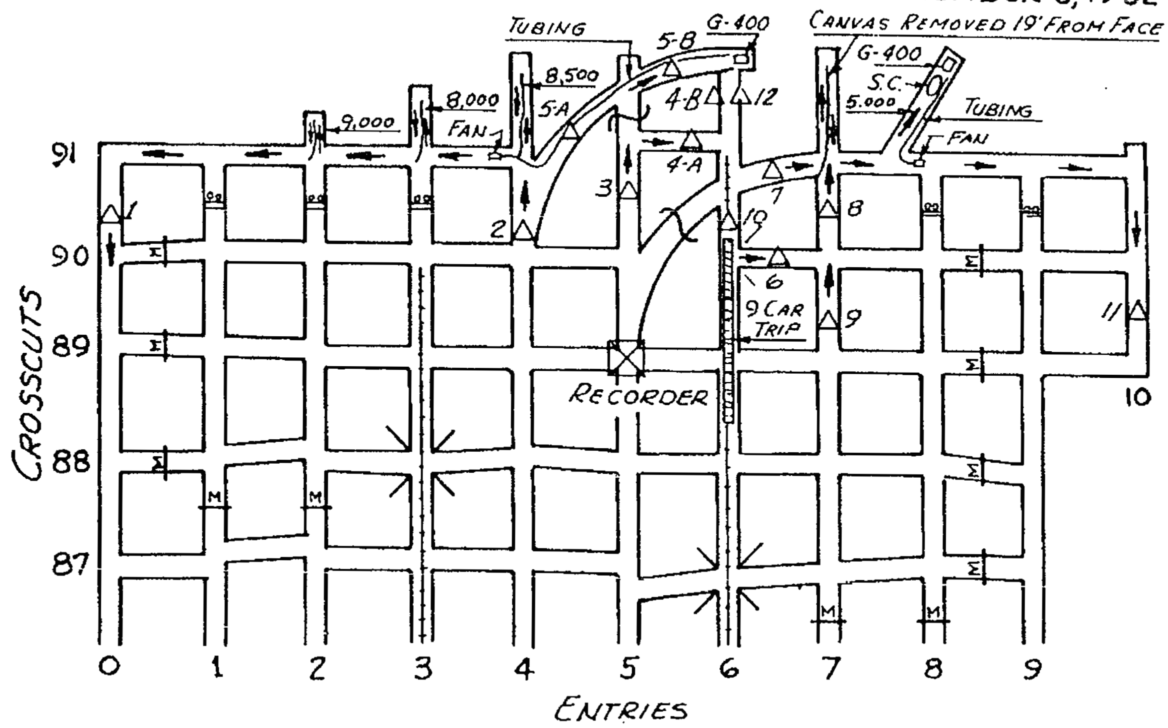
APPENDIX I

VENTILATION STUDY

FACE AREA - 4 MAIN BUTTS - 8 FLATS LT. SECTION

ROBENA NO. 3 MINE

CONDITIONS ASSUMED PRIOR TO EXPLOSION ON DECEMBER 6, 1962



TEST A-5 DATA SHOWING AIR QUANTITIES CU. FT./MIN.

TESTS TAKEN JAN. 15, 1963

CONDITIONS

RIGHT FAN RUNNING

LEFT FAN DOWN

LINE CANVAS IN #6 ENTRY

AT INBY RADIUS OPEN 1-FOOT

STA.		STA.	
1	26,100	6	12,800
2	25,900	7	9,700
3	10,000	8	30,000
4-A	10,000	9	18,400
4-B	SLIGHT SMOKE MOVEMENT	10	SMOKE MOVEMENT
5-A	NO MOVEMENT	11	40,300
5-B	SLIGHT SMOKE MOVEMENT	12	DISCONTINUED

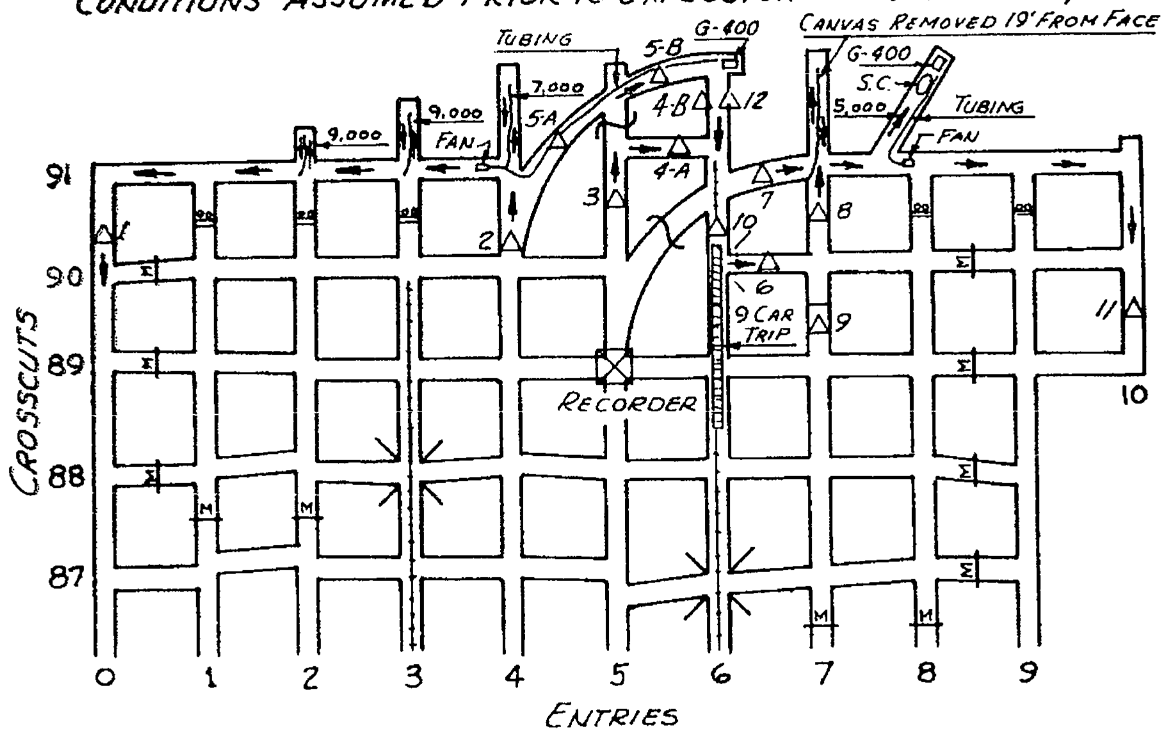
APPENDIX I

VENTILATION STUDY

FACE AREA - 4 MAIN BUTTS - 8 FLATS LT. SECTION

ROBENA NO. 3 MINE

CONDITIONS ASSUMED PRIOR TO EXPLOSION ON DECEMBER 6, 1962



TEST A-8 DATA SHOWING AIR QUANTITIES CU. FT./MIN.

TESTS TAKEN JAN. 15, 1963

CONDITIONS

RIGHT FAN RUNNING

LEFT FAN RUNNING

PLASTIC STOPPING IN # 7 ENTRY

BETWEEN 89 & 90

LINE CANVAS IN #6 ENTRY AT

INBY RADIUS TAKEN OUT

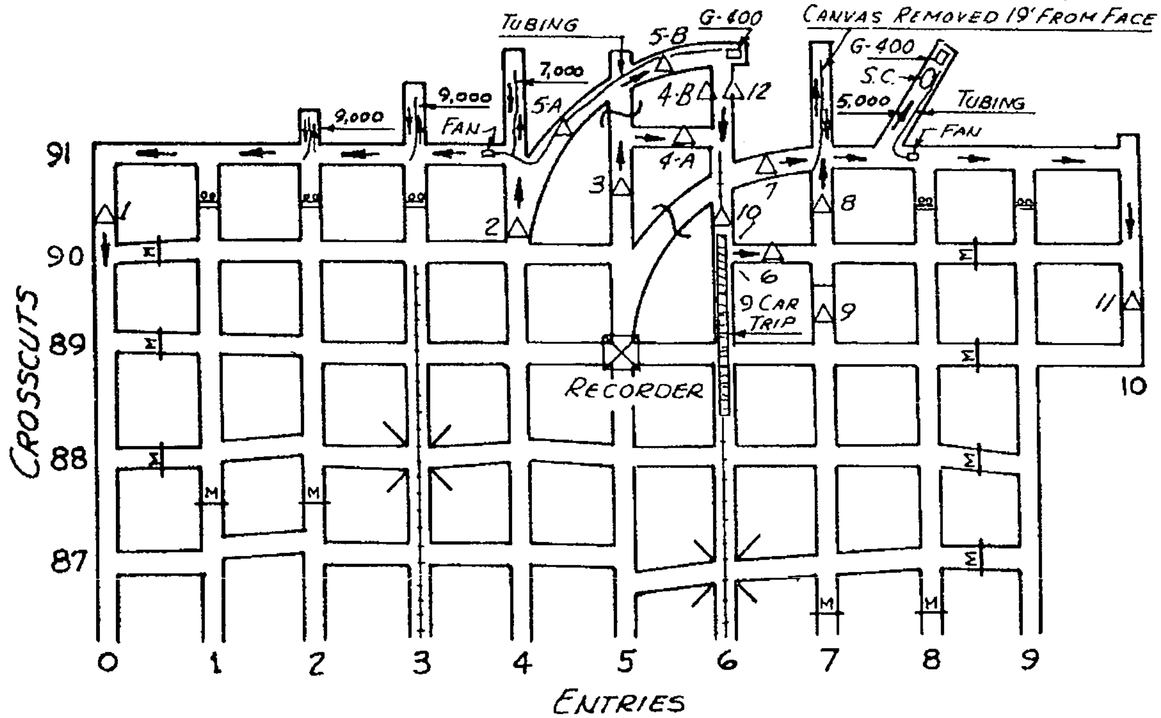
STA. 1	25,400	STA. 6	27,600
2	29,700	7	10,400
3	14,900	8	28,500
4-A	15,000	9	DISCONTINUED
4-B	3,300	10	7,200
5-A	7,700	11	39,700
5-B	7,400	12	DISCONTINUED

VENTILATION STUDY

FACE AREA - 4 MAIN BUTTS - 8 FLATS LT. SECTION

ROBENA NO. 3 MINE

CONDITIONS ASSUMED PRIOR TO EXPLOSION ON DECEMBER 6, 1962



TEST A-9 DATA SHOWING AIR QUANTITIES CU. FT./MIN.
TESTS TAKEN JAN. 15, 1963

CONDITIONS

RIGHT FAN RUNNING
LEFT FAN DOWN

PLASTIC STOPPING IN #7 ENTRY BETWEEN 89 & 90
LINE CANVAS IN #6 ENTRY AT INBY RADIUS TAKEN OUT

STA. 1	26,100	STA. 6	28,300
2	29,700	7	12,000
3	15,700	8	29,100
4-A	12,400	9	DISCONTINUED
4-B	5,000	10	7,600
5-A	2,800	11	41,600
5-B	4,500	12	DISCONTINUED

Appendix J

Sample Analyses and Results of Gas-Emission Tests Conducted by Members of Investigating Committee, December 19, 1962

On December 19, 1962, during the investigation of the disaster, a group composed of a representative from the United States Steel Corporation, the Pennsylvania Department of Mines and Mineral Industries, the United Mine Workers of America, and the Bureau of Mines conducted a gas-emission survey in the 8 left faces and return airways outby 8 left. The results are summarized as follows:

Table 1 shows the sample analyses and liberation from specific face areas, and the attached map shows sampling and measuring points at which samples were collected and air measurements taken.

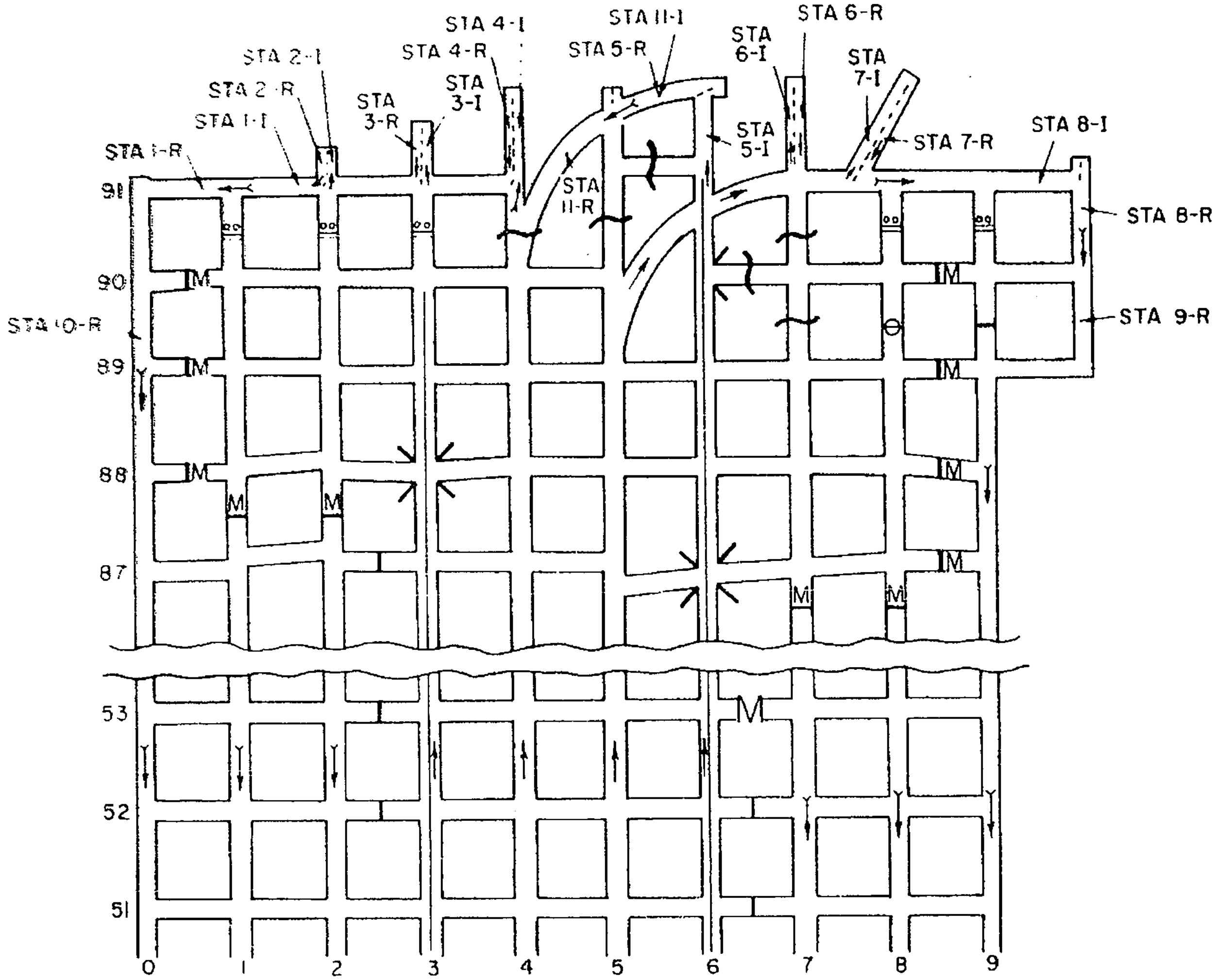
Table 2 shows the analyses of samples collected in the return airways outby the face, which include the methane liberated at the faces. The analyses indicated that the total methane liberation from the faces and entry surfaces from the face of 8 left section outby to 52 crosscut was 467.41 cubic feet a minute when the samples were collected.

TABLE 1. - Sample analyses and results of gas-emission test - face area, December 19, 1962

Bottle No.	Location in mine or station No.	Percent in volume: Carbon dioxide	Percent in volume: Oxygen	Percent in volume: Methane	Percent in volume: Nitrogen	Quantity air and gas (cfm)	Quantity methane liberated (cfm)	Quantity methane liberated from a specific area (cfm)
Y-7546	1R	0.08	20.82	0.16	78.94	27,840	44.54	
X-5378	1I	.05	20.84	.14	78.97	26,975	37.76	6.78
Y-9437	2R	.03	20.80	.17	79.00	11,390	19.36	
X-4713	2I	.07	20.88	.14	78.91	11,220	15.71	3.65
X-4768	3R	.06	20.84	.13	78.97	11,849	15.40	
X-4767	3I	.07	20.88	.13	78.92	11,233	14.60	0.80
Y-8079	4R	.09	20.85	.16	78.90	6,327	10.14	
Y-8083	4I	.07	20.84	.12	78.97	6,567	7.88	2.26
X-4728	5R	.03	20.85	.11	79.01	26,550	29.21	
X-4729	5I	.05	20.88	.09	78.98	25,600	23.04	6.17
X-4813	6R	.16	20.83	.16	78.85	7,332	11.73	
Y-7370	6I	.07	20.88	.08	78.97	7,314	5.85	5.88
Y-8065	7R	.15	20.86	.13	78.86	8,880	11.54	
Y-8894	7I	.03	20.88	.11	78.98	8,922	9.81	1.73
Y-8478	8R	.08	20.89	.13	78.90	25,500	33.15	
Y-9944	8I	.10	20.84	.11	78.95	25,481	28.03	5.12
X-4811	9R	.07	20.86	.13	78.94	28,210	36.67	36.67
Y-8032	10R	.05	20.77	.24	78.94	28,21[illegible]	67.70	67.70
X-4748	11R	.08	20.88	.11	78.93	28,600	31.46	
X-4747	11I	.06	20.88	.11	78.95	26,550	29.21	2.25

I - Intake to place
R - Return from place

Liberation of place or area = R-I



LEGEND

↘↙ ↗↖	LOADING RAMP	⊖	MASONRY STOPPING WITH MANDOOR
▬	CONCRETE-BLOCK STOPPING	------	LINE BRATTICE
M▌	PREFABRICATED METAL "	←——	INTAKE AIR
⊤⊤	DOUBLE BRATTICE CLOTH WITH POSTS	←——≺	RETURN AIR
~	PLASTIC CHECK	M	MANDOOR

APPENDIX J - METHANE TEST, 8 LEFT, ROBENA NO. 3 MINE DISASTER, DEC. 19, 1962

Appendix J (Con.)

TABLE 2. - Sample analyses and methane liberation from face and a portion of area outby the face, December 19, 1962

Bottle No.	Location in mine or station No.	Percent in volume: Carbon dioxide	Oxygen	Methane	Nitrogen	Quantity air and gas (cfm)	Quantity methane liberated (cfm)
U-5129	0 entry 53 crosscut	0.19	20.56	1.17	78.08	7,000	81.90
U-5134	1 entry 53 crosscut	.21	20.71	0.79	78.29	14,000	110.60
R-5977	2 entry 53 crosscut	.17	20.73	.53	78.57	21,350	113.16
W-9921	7 entry 52 crosscut	.12	20.82	.31	78.75	14,000	43.40
X-4699	8 entry 52 crosscut	.13	20.75	.56	78.56	14,350	80.36
Y-7442	9 entry 52 crosscut	.10	20.75	.71	78.44	5,350	37.99
	Total 8 left faces and entries outby to 52 crosscut						467.41

Appendix K

Gas-Emission Tests, December 18, 1962

The results of air samples collected by a Bureau of Mines inspector on December 18, 1962, to ascertain the methane liberation from the face area of 8 left and entry surfaces outby the face are shown in the following tables. For sampling locations refer to the map which is included in appendix J.

TABLE 1. - Liberation of methane from a portion of the face area and the returns of the face splits

Bottle No.	Location in mine	Percent in volume: Carbon dioxide	Oxygen	Methane	Nitrogen	Quantity air and gas (cfm)	Quantity methane liberated (cfm)
X-4891	90 feet outby face of radius off No. 4 entry, 8 left (includes methane from entries 5 and 6)	0.07	20.88	0.10	78.95	22,800	22.80
X-5360	No. 0 entry 75 feet outby 91 crosscut, 8 left (return of left split)	.10	20.78	.19	78.93	29,400	55.86
X-4892	No. 10 entry 75 feet outby 91 crosscut, 8 left (return of right split)	.07	20.85	.15	78.93	23,400	35.10

Appendix K (Con.)

TABLE 2. - Liberation of methane from the faces and the entry surfaces outby the face to 51 crosscut

Bottle No.	Location in mine	Percent in volume: Carbon dioxide	Oxygen	Methane	Nitrogen	Quantity air and gas (cfm)	Quantity methane liberated (cfm)
X-5351	No. 0 entry between 50 and 51 crosscuts	0.25	20.67	0.98	78.10	16,800	164.64
Y-7431	No. 1 entry between 50 and 51 crosscuts	.20	20.72	.77	78.31	5,600	43.12
X-5350	No. 2 entry between 50 and 51 crosscuts	.13	20.80	.53	78.54	15,400	81.62
X-5473	No. 7 entry between 50 and 51 crosscuts	.15	20.80	.21	78.84	16,800	35.28
X-5474	No. 8 entry between 50 and 51 crosscuts	.13	20.80	.41	78.66	17,500	71.75
X-5377	No. 9 entry between 50 and 51 crosscuts	.20	20.74	.61	78.45	8,000	48.80
				Total methane liberated from faces and entry surfaces outby to 51 crosscut			445.21

A sample of air (bottle No. X-4553) collected ahead of ventilation at 81 crosscut No. 4 entry during the recovery operations (December 10, 1962) showed the following analysis in percent of volume: Carbon dioxide, 6.8; oxygen, 10.6; hydrogen, 1.8; carbon monoxide, 1.3; methane, 28.0; and nitrogen, 51.5.