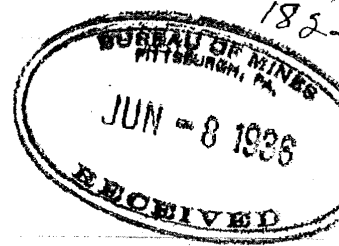


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REPORT OF EXPLOSION  
MONARCH NO. 2 MINE  
NATIONAL FUEL COMPANY  
BROOMFIELD, BOULDER COUNTY, COLORADO



About 6.20 a.m. January 20, 1936, an explosion of gas and coal dust or of coal dust occurred in the Monarch No. 2 mine of the National Fuel Company. Eight of the ten men in the mine at the time were killed; two escaped uninjured by traveling up the main air shaft stairway to the surface. The explosion extended over about one-half of the mine workings wrecking numerous stoppings, doors, and an undercast and overcasts. There were many extensive caves of roof due to the explosion knocking out supporting timbers. The Monarch No. 2 mine is operated in a subbituminous coal field the coal produced being locally known as "lignite". No explosions other than local gas ignitions have occurred in an operating mine in this field for about 50 years; the coal dust is generally considered by the mine operators to be nonexplosive and neither rock-dust nor water are used to any extent to lessen any coal-dust hazard.

Vice-President Jenkins of the National Fuel Company called E. H. Denny of the U. S. Bureau of Mines about 7 a.m. and Messrs. Denny, Forbes, and Bird of the Bureau arrived at the mine by auto truck about 8.30 a.m. with oxygen breathing apparatus, gas masks, and accessories. Chief Mine Inspector Allen and Deputy Mine Inspector Graham arrived at the mine about the same time.

About 30 minutes after the explosion Nick Delprizio and Wm. Jenkins, Jr., miners who had been working cleaning up a roof fall in the section of the mine adjacent to the air shaft, climbed up the air shaft

stairway through a brownish smoke to safety. Mine Foreman Ward, Assistant Foreman Davitt, and Joseph Stevens shortly afterwards climbed down the air shaft stairway in the mine return air in an attempt to rescue men: they were overcome a short distance down the 280-foot shaft but were able to call for help and miners, including the two who had just escaped, rescued them using tire chains and fence wire to get them back up the stairway.

The main fan, located at the top of a shaft a short distance from the hoisting shaft, had been shut down following the explosion. Afterdamp was coming up the main hoisting shaft. Attempt to lower the auxiliary cage at the fan shaft failed as the cage would not go down the shaft. This fan was started operating exhausting (contrary to its usual operation blowing) resulting in air going down the main shaft, and up the nearby fan shaft by a short course due to doors and stoppings having been blown out near the shaft bottom. With stoppings out the direction of air circulation by the fan had no influence so far as the mine workings were concerned.

The cages were impeded by debris near the shaft bottom and the first two parties to enter the mine had to climb down about 15 feet to the shaft bottom. The first exploration near the shaft bottom disclosed much mine wreckage and seven mules alive near the mule stable despite evidence of violence on the stable walls.

Although the air circulated by the fan was short circuiting nevertheless there was a natural circulation into the mine from the

main shaft apparently induced by the chimney or stack effect of the main air shaft almost a mile distant. This natural circulation was followed by parties along 7 and 8 west entries to the underground shaft between the two coal seams and also along the main south entries to 13 and 14 west entries. The explosion had not extended any great distance into the 7 and 8 west entries but there were numerous caves on the main south entries, the roof was still caving, and bad air was found at the mouth of 14 south entry. Also, there was a sealed off mine fire on 1 and 2 north room entries off the main west entries which had been causing trouble for several months, two men had been working on the seals at the time of the explosion, and this fire was suspected as the point of explosion origin and as a probable hazard to men engaged in recovery work. Accordingly, the fan was started blowing (its normal direction), the hoisting shaft curtained off, and blown-out stoppings replaced with canvas and boards, and air directed into 7 and 8 west entries. It was kept away from the fire seals and the fire seal area explored by a gas mask crew. The fire seals were found intact and the bodies of Lester Novinger and Leland Ward located and carried out of the mine. These bodies were located about 4 a.m. January 21. Air was carried past the fire seals and at about 11 a.m. January 21 the body of Thomas Stevens, night boss, was found on a locomotive on the main west entry haulage road just outby 2 north entry. Three dead mules were lying near the mouth of 2nd north entry. Exploration of the main west entries beyond 2nd north entry disclosed large falls and stoppings blown out and three more dead mules. A gas mask exploration to the entrance of 5th south entry disclosed bad air in the 5th south entry.

Exploration was then re-directed down the main south entries into 13 and 14 west entries; the extensive falls of rock were leveled so that men could get over them readily and three bodies were located about a locomotive on the 13 west entry about 1200 feet in by the main south entries. These bodies of Tony De Santis, Shot firer, Ray Bailey, and Oscar Hgird were found early in the evening of January 21 and carried to the surface early on the morning of January 22. The locomotive had been on the way to the hoisting shaft with 7 cars of rock and 25 cars of coal. All of these cars were buried under rock falls which could not be traveled over.

Two bodies remained to be recovered. Louis Jaramillo, stable boss, had been driving 8 mules before him down the 14 west entry supposedly with a locomotive. His location and that of two mules was narrowed down by further exploration to a rock fall about 300 feet long on the main west entry out by 2nd north entry toward and in the slope connecting the lower seam with the upper seam and 14 west entry. Brattice crews restored stoppings on the main west entries and about midnight January 22 the body of Steve Davis, fire boss, was found a short distance off of 5 south entry on 3rd east entry. He had traveled some distance as evidenced by his tracks and had died of carbon monoxide poisoning. His flame safety lamp, extinguished, was sitting upright by him; his electric cap lamp was not burning. After 11 days of moving rock the attempt to recover the body of Louis Jaramillo was abandoned; The bodies of the two mules were uncovered from the cave but no locomotive or car was found. A careful search of all open territory nearby was fruitless.

#### GENERAL MINE DATA:

The Monarch No. 2 mine is located about 3 miles northwest of Broomfield, Colorado, and about 20 miles north of Denver. It is in Boulder County on a branch of the Colorado and Southern railroad. Its officials are:

F. E. Jenkins, Vice-President and General Manager  
Colorado Building, Denver, Colorado.  
Roy Williams, Superintendent, Lafayette, Colo.  
A. Ward, Mine Foreman  
Wm. Davitt, Assistant Foreman.

The mine had been operated for about 28 years. 105 men were employed on the day shift and 94 men on the night shift. The mine was producing about 800 tons of coal daily.

The mine is opened by three shafts, a two-compartment hoisting shaft and fan shaft about 270 feet in depth and an air shaft about 280 feet in depth. The air shaft is a two-compartment shaft with a stairway in one compartment; it had no hoist.

#### CHARACTER OF COAL:

The coal mined from the Monarch mine is a subbituminous averaging about 5 feet 9 inches in thickness. The coal bed is overlain by a hard shale which deteriorates on exposure to air and caves to a considerable height unless supported by roof coal or timber. The floor is a soft shale. The coal bed is practically flat. Two beds of coal have been worked in parts of this mine; the lower of the two beds was being worked at the time of the explosion; a rock interval of 8 to 90 feet separates the two beds. In general only one of the beds has been worked in any one section.

The Monarch No. 2 mine was sampled in June, 1934, by E. A. Anundsen of the U. S. Bureau of Mines and coal analysed at Pittsburgh, Pennsylvania, under the direction of E. M. Cooper. The composite analysis of the four samples taken underground on an as received basis is as follows:

Proximate Analysis

Moisture	19.6%	Sulphur	0.3
Volatile matter	30.6	B.t.u.	10,130
Fixed carbon	45.9		
Ash	<u>3.9</u>		
	100.0		

METHOD OF MINING:

The mine is worked on a double entry room and pillar system rooms being driven about 25 feet wide on 50-foot centers and 150 feet in length. Pillars are extracted. Pairs of room entries are turned at approximately 300-foot intervals. Usually rooms driven from one entry connect with the caved territory left from mining operations off the adjacent room entry. Goodman shaker conveyors with duckbills are used in one section of the mine to which the explosion did not penetrate. Hand loading methods are used in other parts of the mine. Extensive timbering is necessary on entries.

VENTILATION AND GASES:

The Monarch No. 2 mine is rated by the Colorado State Mine Inspection Department as a gassy mine. The mine is ventilated by a steam fan size 4½ feet by 16 feet operated blowing and circulating normally about 45,000 cubic feet of air per minute according to the

State Coal Mine Inspector's report; it is reversible. Doors near the hoisting shaft made the main air shaft the principal air outlet. Some air turned up the main shaft after ventilating the stable and a small north section. The mine was examined before the shift by a fire boss; two night foremen and a shot firer also carried flame safety lamps, permissible type, on their rounds before the day shift entered. The fire boss also had an electric cap lamp.

The course of the mine ventilation before the explosion as shown by the mine map was as follows:

The air split at the foot of the fan shaft. A small portion ventilated the mule stable on the north side of the main shaft, the main pump south of the hoisting shaft, and open territory to the east of the main shaft and then returned up the hoisting shaft. The main supply of air traveled along the main south entries with west entries blocked off by stoppings until it reached 7 and 8 west entries, where it split. The portion continuing down the main south entries was split by an undercast at 14 west entry. The air passing through the undercast continued down the south entries, ventilated open nonworking territory, returned up one of the main south entries and into 14 south entry. Air intaking in 14 south entry passed 4 pairs of sealed off room entry areas. Two pair of these seals were said to have methane behind them and the other 2 pair black damp. The air on 13 west entry passed near 4 seals in the upper seam said to have black damp behind them and thence down an air shaft to the lower seam on the main west entries and thence up 1st north entry. The air on 14 west entry passed through a rock tunnel or slope to the lower workings and the main west entries.

A little of the air entering the main west entries went into the first south entry section and thence by overcast up the 1st north entry, through the 5th and 6th east entries, back across the 1st north entry to the 2nd north entry and thence out 7 west entry to the air shaft. The larger portion of the air entering the main west entries passed along the haulage entry and into 5th south entry, across 5th west entry, out 10th south entry, to the faces of the main west entries, back through 7 and 8 north entries, out the main west entry aircourse and up 4th north entry to the main air shaft.

Air in the split previously referred to off the main south entries at 7 and 8 west entries passed along these west entries, down an underground shaft to the lower seam, then ventilated the new conveyor section workings to the north of 7 and 8 west entries before it reached the main air shaft.

ANALYSES OF AIR SAMPLES COLLECTED:

Eight air samples were collected in the Monarch mine following the explosion and analysed in the laboratory of the U. S. Bureau of Mines at Pittsburgh, Pennsylvania, under the direction of W. P. Yant, chemist and supervising engineer there. These samples were collected under the abnormal ventilation conditions prevailing after the explosion. Analyses were as follows:

# ANALYSES OF MINE AIR SAMPLES, MONARCH #2 MINE, BROOMFIELD, COLORADO

Laboratory: Number	Location in Mine	Date of Sampling	Percentage					Air Quantity Cubic Feet Per Minute
			Carbon Dioxide	Oxygen	Carbon Monoxide	Methane	Nitrogen	
60108	Main west entry 50 ft. inby 2nd south entry	1/27/36	0.29	20.38	0.00	0.08	79.25	4800
60109	Same	1/27/36	0.27	20.42	0.00	0.07	79.24	4800
60113	8 south entry 20 ft. off 14 west entry	1/27/36	2.2	16.0	0.00	8.3	73.5	
60114	Same	1/27/36	2.0	13.8	0.00	11.1	73.1	
60127	Main south entry 250 ft. inby 14 west entry	1/30/36	0.33	20.58	0.00	0.04	79.05	
60128	Same	1/30/36	0.12	20.90	0.00	0.01	78.97	
60129	1st main south stub entry 85 ft. inby 14 west under- cast	1/30/36	0.42	20.37	0.00	0.04	79.17	
60130	Same	1/30/36	0.40	20.33	0.00	0.01	79.26	

All of the air samples taken contained methane; the percentage found in moving air currents was small considering the generally deranged ventilation. Samples 60113 and 60114 containing 8.3% and 11.1% methane respectively, however, show that in all probability that a very considerable body of methane existed behind the 8 south entry seals before the explosion and the approximately 2% carbon dioxide naturally mixed with it was by far insufficient to affect the gas mixture explosibility if mixed with air and subjected to an ignition source.

#### HAULAGE:

Haulage is by trolley locomotive and mule. Five locomotives are used underground of which three were or had been in use in the mine workings shortly before the explosion. 250-volt direct current is used for trolley haulage. About 15 mules were in the mine at the time of the explosion; eight of these were on their way into the mine workings at the time of the explosion and were killed; the remainder were about the underground stable near the hoisting shaft and were uninjured. Track gage is 36 inches; 20- to 40-pound rail is generally used in the mine but heavy rail has recently been installed in the newer work. Wood cars of 1-ton capacity are used; some had steel end gates and some wood end gates. Evidently there was much coal spillage from them.

#### LIGHTING:

Edison portable electric lamps, permissible type, are used exclusively by miners and mine officials.

#### MACHINERY UNDERGROUND:

440-volt alternating current Sullivan coal cutting machines, not of the permissible type, are used to undercut the coal. Some compressed

air punchers were also in the mine. The Goodman shaking conveyors are also electrically driven. 5 electrically operated and 5 compressed air operated pumps are used in the mine. Power lines are brought into the mine by drill holes, one at the main shaft and one 1000 feet south and east of the main shaft. One power line also comes in the air shaft. There are two motor-generator sets, one located 1000 feet from the main shaft and the other on 4th north entry at the 7th west entry, 300 feet from the air shaft. Electrically driven blower fans were used in the conveyor section; they were not operated 24 hours daily.

#### EXPLOSIVES:

40 per cent Dupont Gelatin is used for brushing work in entries. Pellet powder is used on hand loading work. Dupont Monobel "B" permissible explosive is used in conveyor work. All shot firing is done by shot firers for hand loading work after the shift is out of the mine. Shot firing is done by shot firers on conveyor work at any time during the shift. Pull wire igniters are used to fire the pellet powder; electric detonators are used to fire the other explosive.

#### DUST:

Following the explosion much dry fine dust was noted in the mine. The locomotive main haulage road is known to have been dry and dusty before the explosion and dry dust was noted on the 7 west roadway following the explosion in a part of the mine not travelled by the explosion.

Mine dust samples were collected by W. H. Forbes and J. H. Bird of the Bureau of Mines following the explosion. Results of tests made by the Pittsburgh laboratory of the Bureau on these samples follow:

ANALYSES AND SIZING TESTS OF DUST SAMPLES  
COLLECTED IN THE MONARCH #2 MINE BY W. E. FORGES AND J. H. BIRD  
FEBRUARY 4, 1936.

Sample: Number:	Location in Mine	Road or Rib	Mois- ture	Combus- tible	Ash	Sizing/test of under 20-mesh dust Thru 48 Mesh: Thru 100 Mesh: Thru 200 Mesh:	Ignition Tempera- ture of Dust	Incombustible Content To Prevent Inflammation
	:Outer end of first parting:						: 520° C	
B11154:	on main south	Rib	: 5.9	: 74.8	: 19.3	: No sizing test made	: 970° F	: 89%
							: 560° C	
B11155:	Same	Road	: 6.3	: 76.6	: 17.1	: 60.6 : 39.0 : 29.0	: 1040° F	: 83%
	:Between 11 and 13 crosscut:						: 560° C	
B11156:	west on 8 west main entry	Rib	: 7.4	: 73.6	: 19.0	: No sizing test made	: 1040° F	: 83%
							: 580° C	
B11157:	Same	Road	: 6.6	: 65.7	: 27.7	: No sizing test made	: 1075° F	: 79%
	:Main south entry at 10						: 540° C	
B11158:	east entry neck	Rib	: 6.0	: 79.4	: 14.6	: No sizing test made	: 1005° F	: 84%
							: 580° C	
B11159:	Same	Road	: 7.2	: 81.1	: 11.8	: 38.3 : 24.4 : 15.6	: 1075° F	: 72%
	:14 west off main south 300:						: 540° C	
B11160:	ft. west of undercast	Rib	: 6.3	: 75.4	: 18.3	: No sizing test made	: 1005° F	: 85%
							: 560° C	
B11161:	Same	Road	: 6.0	: 69.6	: 24.4	: 73.7 : 55.3 : 41.1	: 1040° F	: 84%

It will be noted that all dust samples readily ignited in the laboratory tests and that these tests showed between 72% and 89% of total incombustible content required to prevent dust inflammation. The incombustible (moisture + ash) content of the dust samples ranged from 18.9% to 34.3%; the dust contained about 12% less moisture and an average of 15% more ash than the original coal and shows, even considering the added ash, a large loss of moisture by the coal. Two of the three road dust samples on which sizing tests were made after material over 20 mesh was rejected showed a large amount of very fine (under 200 mesh) dust.

Mr. Greenwald, Senior Physicist of the Bureau at Pittsburgh, comments in part on his tests of these samples as follows:

"Tests in the Bureau's laboratory apparatus indicated that 72 to 89 percent total incombustible material (including moisture and ash of the dust samples themselves) was required to prevent inflammation. Individual values have been typed on the analysis reports. Subbituminous coals always have given high inflammabilities in laboratory testing and it has not been possible as yet to check the matter fully by making tests in the Experimental Mine. Whatever may be said concerning the strict quantitative value of the laboratory tests, there can be no doubt of the qualitative fact that these dusts are decidedly dangerous and that mines containing them should be rock-dusted at least to the minimum set forth in the standard specifications for rock-dusting.

"In connection with laboratory tests it is customary to determine the minimum temperature at which a dust, as received, will ignite. The ignition temperature of the present eight samples ranged from 520 to 580° C.

(970 to 1075° F.). Individual values appear on the analysis sheets.

These temperatures are much less than those present in open flames, gas explosion, burning or detonation of explosives and electric arcs.

The only laboratory test now available for determining relative ease of ignition of different dusts involves use of an induction coil spark. Fine Pittsburgh bed coal dust is ignited readily by such a spark, but none of the present eight samples could be so ignited."

The mine was not rock-dusted but the National Fuel Company before the explosion had secured a number of tons of rock dust to be used in dusting haulage roads.

#### EXPLOSION DETAILS:

The explosion occurred about 6.20 a.m. on Monday morning, January 20, 1936. No abnormal conditions were reported in the mine preceding the disaster. Records of the U. S. Weather Bureau at Denver 20 miles distant show the barometer to have been 24.60 inches at 6 a.m. (slightly under the normal of 24.71 inches) and to have been rising and continued to rise until noon. There had been a slight dip (24.50) at 4 a.m. but for two days previously the barometer had been about normal with little variation. The weather was clear and warm for the season. The mine had not worked on the day previous since it was Sunday but the usual inspections had been and were being made. The main fan operated continuously. Neither the mine nor the district has any previous record of explosions with men in the mine. The only other case of an explosion known to the writer in a northern subbituminous Colorado mine was that of Satanic or Bluebird mine near Morrison, Colorado, which had been sealed

at the shafts because of a mine fire; it blew up several weeks after sealing; there were numerous surface breaks over the mine. Another similar case is said to be on record in which a mine in which a fire existed blew up about 1885 with no men in the mine.

The force of the explosion at the Monarch mine was manifest through a considerable portion of the working parts of the mine and at the top of the main shaft and fan shaft by slight damage to the headframe and the fan shaft housing. An employee standing a few feet from the hoisting shaft observed sparks and a "Roman candle" effect in a dense cloud of smoke issuing from the hoisting shaft, indication that flame traveled to the top of this shaft. Debris was piled in the shaft sump. Stoppings were blown out along the main south entries to 13 and 14 west entries. There were numerous caves of rock in both entry and aircourse on the main south entries. The wooden undercast at the junction of the main south entries with 14 west entry was completely demolished. Stoppings between 13 and 14 west entries were blown out; the 13 west entry was caved just inby the 8 north entry for 150 feet or more; there was also about 300 feet of entry completely caved from the 1st north entry outby through and beyond the rock tunnel or the slope. Inby the 1st north entry on the main west entries there were occasional caves and stoppings out to just beyond 5 south entry. Beyond this point on the main west entries there was little disturbance. Occasional large falls continued on 5 and 6 south entries to 4 east entry these entries not being traveled beyond this point. Violence with gradually diminishing intensity was manifest on 1 and 2 north entries to a point about 100 feet past the fire seals which were intact except that <sup>a</sup> 1-inch valve was broken off. On 3 and 4 north entries the force similarly diminished.

The wood plastered fire seals were slightly broken and pushed inward by force from without and a small amount of blackdamp was issuing from the seals. On the main south entries beyond 14 west entry there were falls and violence with direction of movement of debris outward. At the locomotive found on 13 west entry the direction of the explosion forces was apparently inward. At the pump located off of 1st north entry dust had been blown inward indicating that force had gone from the lower seam toward the underground shaft connecting to the upper seam. At the main pump near the hoisting shaft some dirt and debris had been blown into the pump motor indicating that forces had come from the main south entries and not from the open workings below the pump.

#### CAUSE OF THE EXPLOSION:

The large amount of territory caved by the explosion and the consequent impracticability of a complete and detailed examination of the mine workings and particularly of open abandoned workings makes it impossible to definitely fix the origin point of the explosion or to state the exact cause. It is evident that an explosion of considerable and wide-spread violence took place and it seems inconceivable that an accumulation of explosive gas in sufficient quantity could have occurred to cause the wide-spread damage found. The wide distribution of the explosion forces and the dense clouds of smoke and dust evolved indicate that coal dust was ignited and, in the opinion of the writer, played the major part in the force developed.

Following the explosion the only explosive gas found was outby the blown-out seals in 7 and 8 south entries off 14 west entry. Explosive gas may have leaked from these seals into the ventilating current and

thence passed into 13 and 14 west entries and into the main west entries. Or explosives gas may have been forced out by a fall of rock from open territory off the main south entries inby 14 west entry, or from the open territory off 1st and 2nd south entries off the main west entries, or from behind the broken seals in the upper seam off the underground air shaft near 1st north entry off the main west entries. Or gases may have issued from sealed areas along 13 and 14 west entries, such as 5 and 6 or 9 and 10 south entry seals, these gases perhaps consisting in part of methane masked by a high carbon dioxide and nitrogen content. The ventilating current may have been partly short circuited by the propping open of doors near the main shaft to facilitate quick handling of the 32 car trip about to come out.

Assuming that methane in explosive proportions was in the air current in some part of 13 and 14 west entries or the main west entries another point not definitely determined is the place of ignition. Two or probably three locomotives were on the 13 and 14 west and main west entries at the time of the explosion. One on 13 west entry was traveling toward the shaft and outby the sealed area known to contain methane; the air current was moving in the opposite direction. The forces of the explosion extended somewhat equally from this locomotive in all directions. It is possible that an arc from the trolley pole of this locomotive may have lit gas coming from the main south entry region inby 14 west entry. A second locomotive was outby 2nd north entry on the main west haulage. Six mules were inby it and two outby it probably filling the air with dust as they traveled in. The air current here may have contained a body of explosive gas from any one of the outby seals which was lit by a trolley arc.

A locomotive used by the stable boss, Louis Jaramillo, was not found nor was Jaramillo's body found. The latter is almost certainly in the rock cave behind the last mules outby 1st north entry in or near the slope to 14 west entry and the locomotive may be under this fall too. This locomotive is also a possible source of gas ignition.

A heavy cave on 14 west entry might have brought the trolley wire down with arcing and at the same time stirred up a heavy coal dust cloud with consequent ignition of dust. Whether eight mules, some of them possibly running and kicking, could have stirred up enough coal dust to be lit by a trolley arc seems unlikely but perhaps possible.

The theory of the release of explosive gas from old workings is given some support from a statement by a one-time official in the Monarch mine who says that some 12 or more years ago when he was a boss in this mine bodies of explosive gas were unexpectedly found in open workings. If the door near the foot of the man shaft had been left open there would have been an almost complete short circuiting of the ventilation which might have facilitated the accumulation of an explosive mixture of gases.

The explosion died out as it traveled toward the new work and the coal faces. There was noticeably less coal dust in these sections and that present was probably coarser and of higher natural moisture content. There was much dry dust of long standing in 5 west entry but the explosion died out in this entry; possibly room for expansion at the junction of the main south and 5 west entries accounted for this. The explosion traveled the main south entries through dry, old, dust to the hoisting shaft.

The State Coal Mine Inspector concluded in his monthly report of fatalities that the eight men "came to their death by being caught in a gas explosion with fine dust playing a part."

RECOMMENDATIONS:

The following recommendations are offered as a result of this explosion:

1. Consider subbituminous coal dust as a potential explosion hazard. Keep roadways clean as practicable of coal dust and coal spillage. Particularly keep ribs and timbers free of fine coal dust. It is believed that such fine dust could be washed down from ribs and timbers by the judicious use of hose and water without wetting the bottom to such an extent as to cause heaving.
2. Combat the formation of coal dust through spillage by maintenance of track in good shape, use of tight cars, and limitation of car topping.
3. After roadways and ribs and timbers have been cleaned of dust so far as practicable begin rock-dusting of ribs, timbering, and roadways particularly along trolley locomotive haulageways, and adjacent to sealed areas. Eventually extend such dusting to all open parts of the mine that are in coal and not naturally wet.
4. Where it is necessary to control the main course of the ventilating current by doors on haulage roads have such doors installed in pairs with room between them for a trip of cars and require that such doors be kept closed except when men or haulage are passing through them.
5. Instead of ventilating open non-working areas with air which passes afterwards over a main haulage road seal off such areas with tight substantial stoppings of non-combustible material.

6. The use of trolley locomotives in entries adjoining which there are sealed areas which contain or may contain explosive gas is dangerous practice particularly unless such entries are ventilated by a large volume of fresh air which is not subject to interruption by opening of doors or by shutting down of fan without warning. Permissible type storage battery locomotives are the safest means of electrical haulage under such circumstances.

7. Have cages at shafts other than main hoisting shafts which are held only for emergency transportation of men and material tested frequently to make sure that they can be operated.

8. Insist that officials and men do not attempt to enter return air shafts or openings in event of fire or explosion.

9. Require that all persons when examining for methane or other gases have electric cap lamps turned out or light hidden so as to not interfere with visual examination of safety lamp flame.

10. Install pipes and valves in seals and have samples of gases from these seals analysed occasionally for methane, carbon dioxide, carbon monoxide, and oxygen content.

APPENDIX

SUMMARY OF CORONER'S INQUEST

The coroner's inquest was held at Boulder, Colorado, January 30, 1936, with George W. Howe, Coroner, James D. Lewis, deputy district attorney, and Thomas Allen, state coal mine inspector, examining witnesses.

The coroner's verdict was as follows:

**CORONER'S VERDICT:**

That said deceased bodies came to their deaths in the Monarch mine, Boulder County, Colorado, at about 6.15 a.m., January 20, 1936. That deaths were caused by an explosion occurring inside of said mine

We further find that one Joe Jaramillo was in the mine at the time and that his body has not been discovered but will be removed as soon as found

We further find that the said deceased came to their deaths as a result of an explosion, the origin of which the jury cannot determine

We further find that dust was allowed to accumulate along the motor track, which was a hazard, that the operators of said mine had been notified by the state mine inspector to remove said hazard prior to date of said explosion, and that operators were negligent in failing to remove said dust hazard and complying with said order

Various witnesses testified and important points brought out in their testimony are summarized herewith.

G. R. HENNING - Mortician.

The condition of the bodies was as follows:

(1). John Novinger - body charred from shoulders up and head charred and burned; upper part of breast crushed, left foot off at ankle, clothing stripped and body perforated with coal dust and dirt.

- (2). Leland Ward - body burned a little on each hand, slight bruises on forehead and chin, no broken bones. Death due to gas or shock.
- (3). Thomas Stevens - body burned, no bones broken, body charred from shoulders up.
- (4). Anthony De Santas - body burned all over in big blotches, lower jaw broken, and skull fractured.
- (5). Raymond Bailey - body burned from chest up and skull fractured at base. Apparently no bones broken.
- (6). Oscar Baird - body charred from shoulders up, no bones broken.
- (7). Stephen Davis - body not burned but putrefaction had set in; death came from shock or gas.

**JOHN NEISH - Night Boss**

He left the mine between 2 and 3 a.m. the morning of the explosion having remained in the mine for a while after the night boss, Mr. Stevens, came to work at 12.30 a.m. His duties were to supervise the men working. Ventilation was apparently all right on the night of the explosion. He had been employed for 6 months at the Monarch mine. He came out the rock tunnel and along 13 and 14 west entries to the shaft on the locomotive about 3.30 a.m. (i see above). He met Stevens at the fire walls and traveled with him on the locomotive along 2 north entry to the junction and thence to the shaft bottom. The violence of the explosion seemed to come from 2nd north entry.

NICK DELPRIZZIO -- company man.

He was engaged in timbering and loading rock in the mechanical loading section of the mine into which the explosion did not penetrate. He went with Tom Stevens, the night boss, into 11 west entry with a locomotive to get timber about 20 minutes before the explosion. At the time of the explosion he was working with a Mr. Jenkins about half way along 11 and 12 west entry in the 2nd north section. After the explosion he proceeded with Jenkins to the air shaft; he came out the 2nd north entry, the back entry being caved, up the main entry to 14 entry then back to the 4th north entry and to the air shaft.

MILTON HOBBS -- Pump and pipe man, holds foreman's certificate.

He was outside of the mine at the time of the explosion. As he stepped out of his house near the tippie he saw a puff of smoke come out of the air shaft and saw the smoke flash out. He went down on the cage with Mr. Graham, Jim Tapp, and one other on the first trip after the explosion.

He had examined the main south section many times and found black damp but no explosive gas. The 3rd and 4th south entries off 14 west entry were sealed and contained black damp but no explosive gas. The 5th and 6th south and 5th and 6th north sealed areas contained black damp but no explosive gas. He occasionally found small quantities of methane when he opened the valves in the seals in 7 and 8 south entry. He sometimes also found methane behind the stoppings which were about 65 feet off of 14 west entry in 9 and 10 south entries.

There were stoppings in 13 and 14 west entries in the upper seam, these being located about 150 feet from the 1st north entry in the lower seam. He had found depleted air but no explosive gas at these seals. There was an electrically operated pump in first south entry near an air shaft to the upper seam pumping from first south entry; the air was always good at this pump. Explosive gas to cause the explosion could not have come from the 9 and 10 south section because the seals there were intact after the explosion. Explosive gas might have come from the 7 and 8 south entries where the seals were blown out by the explosion or from 3 and 4 south entries. He knew of some cleaning and sprinkling done in the mine from time to time; he used to sprinkle.

A. C. WARD - mine foreman.

He was in the Monarch mine from 3.30 p.m. to midnight on the Sunday immediately preceding the explosion.

He tried to enter the air shaft shortly after the explosion and was overcome by afterdamp after proceeding 12 steps down the stairway.

He believes that the explosion was caused by a fall in the old works forcing out explosive gas to be ignited by a trolley locomotive.

In 9 and 10, 11 and 12, and 13 west entries (the mechanical section of the mine) mice were alive after the explosion showing that the explosion did not penetrate this section.

The fire boss, Stephen Davis, entered the mine between 3 and 3.30 a.m.

The 7 and 8 and 9 and 10 south entries were the only places where methane had been found in the mine.

Mr. Davis had about 50 places to examine in two mine territories; Mr. Davis examined the old works once a week, the last time as he recalls it on January 13.

Mr. Jaramillo at the time of the explosion was taking stock from the shaft bottom into 14 west entry and would leave some mules in 5th south entry, 3 mules in the 2nd north entry or 3 mules in by 2nd north entry on the main west entry between 2nd north entry and 3rd north entry.

J. W. GRAHAM - deputy state mine inspector.

He last examined the mine on November 20, 21, and 22, 1935. He reported certain parts of the mine as being dry and dusty and that the air movement was sluggish in the south district and fair in the north district of the mine.

He arrived at the Monarch mine between 8 and 8.20 the morning of the explosion; Charles Hutton, mine foreman at the Columbine mine, was one of those who entered the mine with him on the first trip. He again entered the mine at 10 to 10.15 a.m. with Denny, Bird, and others. In one exploration after the explosion he examined the 9 and 10 south and the 7 and 8 south entries and found gas (explosive) there. Gas was encountered 20 feet off of 14 west entry in the 7th south entry.

Subbituminous dust can explode if there is a fire or similar cause. He thinks that a low barometer may have something to do with this explosion. He believes that if the roadway in 14 west entry had been moistened there would have been no extension of the explosion by the dust. He does not think that coal dust stirred up by mules could be ignited.

Mr. Graham's report of the November, 1935, inspection of the Monarch mine gave the following air measurement readings:

<u>Location</u>	<u>Area Sq. Ft.</u>	<u>Vel. Ft./Min.</u>	<u>R.P.M. Fan</u>	<u>Quantity Cu. Ft./Min</u>
Main intake	60	860	96	48,160
8 west split	36	285		10,260
1st north	40	110		4,440
Return at air shaft	56	540		30,240

Mr. Graham stated that Mr. Jenkins of the National Fuel Company had written him in response to his request stating that he was cleaning roadways as fast as men could work on them, but that he could not accept the recommendation of spraying or sprinkling.

**JURORS:**

Members of the jury added briefly to the inquest testimony. One stated that he loaded Monarch mine dust in a car and threw it on the mine dump and when it hit the fire in the dump it exploded and injured the man. A juror stated that he had followed mules in the Monarch mine with a locomotive and that the dust kicked up carried ahead of the locomotive.

A juror stated that northern Colorado dust will explode in a stove.

**HUGO MACHIN** - deputy state mine inspector

He considers that the explosion originated somewhere along 14 west entry. At the locomotive near 5th and 6th south entry there was violence manifested in both directions along the haulage road;

there was soot close to this locomotive where 3 bodies were found. Mr. Machine stated that Mr. Bird reported the stopping in 8 entry blown outward by the explosion.

ROBERT DALRYMPLE - Inspector Employers Mutual Insurance Company.

He had made 3 examinations of the Monarch mine for this insurance company, the last inspection in October, 1935. He believes that a gas explosion occurred but he has no knowledge of where the gas might have come from. He only found explosive gas once in very small quantity.

JAMES LORD - district official United Mine Workers of America.

Mr. Lord examined a part of the Monarch mine following the explosion. He thinks that a gas explosion occurred followed possibly by a dust explosion.

THOMAS ALLEN - chief coal mine inspector.

Mr. Allen believes the explosion due to explosive gas and perhaps dust and that the gas came from abandoned workings.

The stoppings on 13 and 14 west were cracked by (roof) pressure.

LEWIS ROSSER - Miner formerly at Monarch mine.

The dust in the Monarch mine was pretty thick along the main haulage prior to November 22, 1935, especially if there were a bunch of mules in front.

WILLIAM HARRIS - miner.

Mr. Harris was working at the Monarch mine at the time of the explosion. He stated that there had been a man cleaning the mine road but that this man had worked at the shaft bottom for 10 days before the explosion, up to Tuesday or Wednesday when one place got so full of dust

that he was called back to clean part of it out so the locomotive could go through. He considered that the company should have kept 14 west entry and the main south entry free from dust and that the rock dust which the company had on the surface should have been distributed in the mine.

On the Saturday night before the explosion Mr. Harris worked at the fire wall on 2 north entry. The door in 2 north entry about 100 feet inside was open on Saturday and Sunday. Inspector Graham questioned at this point said that the opening of this door would not affect the ventilation a great deal - the air current intaking through the main shaft passes down through an air shaft that connects the two seams (the 1st north underground shaft) and passes through the first north entry and would go into 2nd north entry by this door. The air current up the 8th west entry passes down another underground shaft that connects both seams. A portion of this 8th west air current is deflected into what we call the current shaft entrance and ventilates the portion of the mine Harris speaks about. The air current goes in by that door to the 2nd north.

Harris resumed his testimony to state that there was rock dust near the fire wall Saturday night before the explosion - he didn't know what it was going to be used for.

JOHN LA SALLE - miner

There was plenty of dust on the haulage. He rode the man trip. He inspected the mine with Inspector Graham in November. The company did a little bit of cleaning but didn't follow it up systematically. A fire boss, Lee Smith, told him that one time gas was clean out on the motor line.