UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

REGION IV

REPORT OF MAJOR EXPLOSIVES DISASTER
SANTA RITA OPEN PIT
CHINO MINES DIVISION
KENNECOTT COPPER CORPORATION
SANTA RITA, GRANT COUNTY, NEW MEXICO

March 31, 1954

By

Allen D. Look
Mining Health & Safety Engineer

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Phoenix, Arizona
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Accident Prevention and Health Division

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INTRODUCTION

A premature detonation of about 750 pounds of explosives about 4 a.m., Wednesday, March 31, 1954, in the Santa Rita open pit of the Kennecott Copper Corporation, Santa Rita, New Mexico, resulted in the instant death of four members of a blasting crew. The fifth member of the crew was so severely injured that he died April 3, 1954. The names of the men who were killed, their ages, occupations, experience, and number of dependents are shown in Appendix A of this report.

The cause of the explosion was not clearly determined by the investigation.

GENERAL INFORMATION

The Santa Rita open pit of Chino Mines Division, Kennecott Copper Corporation, is situated at Santa Rita, Grant County, New Mexico, The mine is served by a branch line of the Atchison, Topeka and Santa Fe Railroad. The names and addresses of the principal officials were as follows:

C. R. Cox	President	New York, N. Y.
W. H. Goodrich	General Manager	Hurley, New Mexico
G. J. Ballmer	Superintendent of Mines	Santa Rita, New Mexico
W. H. Herkenhoff	Assistant Mine Superintendent	Santa Rita, New Mexico
K. V. Harris	General Mine Foreman	Santa Rita, New Mexico
Robert Shilling	General Drilling and Blasting Foreman	Santa Rita, New Mexico

Company operations at Santa Rita consist of an open-pit copper mine, a precipitating plant, necessary shops and administrative units. There were 935 men employed at the open pit and about 60,000 tons of material (ore and waste) were mined daily.

MINING METHODS, CONDITIONS, AND EQUIPMENT

The Santa Rita open pit was roughly circular in shape and the present area of mining activity had a diameter of 1 mile. Bench heights

varied at various locations in the pit from 36 to 55 feet. Broken material was loaded by nine large electric shovels and was hauled in standard gauge railroad cars pulled by electric locomotives. Some waste was hauled by trucks. Bulldozers were used to clean the areas around the shovels and to perform other related jobs in the operation.

A lookout tower located on a high point at the east end of the pit afforded a good view of all the pit operations. From this location, a dispatcher handled all train movements by means of telephone, radio, and central traffic control installed on a portion of the haulage system. The stationary radio unit was installed at this location.

Blast holes were usually drilled by churn drills and were 12 inches in diameter. Some toe holes were also drilled and the toe holes were enlarged by springing shots to provide sufficient explosive capacity prior to final loading. Churn drill holes were drilled 8 feet below grade. Churn drill holes were blasted in multiples only on day shift. On the afternoon and graveyard shifts only one hole was blasted at a time as needed.

The explosives magazine was located in the dump area west of the pit and was a large magazine conforming to recommended magazine construction. A smaller magazine was provided for storage of broken cases as no part cases of explosives were returned to the main magazine. Detonators were stored in separate magazines well separated from the explosives magazines. The main detonator magazine was used to store detonators in full cases and a smaller magazine was used for storage of cases which had been opened.

Explosives used at Santa Rita were as follows:

Description	Strength Percent	Cartridge Size and Weight	Use
LDX-705	70	Bag powder $12\frac{1}{2}$ pounds per bag	For blasting dry churn drill holes
Amogel No. 1	60	10" by 16" 50 pounds	For blasting churn drill holes where water was present
Special gel	60	$1\frac{1}{4}$" by 12" approx. 1/3 pound	For springing and blasting toe holes

Explosives were delivered in a 2-ton Chevrolet truck purchased in September 1953. This truck was reported to be in good mechanical condition and to be equipped as recommended for the transportation of explosives with the exception of fire extinguishers. The truck had a wooden deck. The front half of the body was covered by a canvas canopy and had three seat boxes

constructed of 2-inch lumber which were used for storage of detonators and blasting supplies and as seats for the members of the blasting crew. The detonators were further enclosed in 24-gauge sheet metal boxes about 8" x 8" x 14" in dimension and lined with plywood. The rear half of the body had a wooden railing of 4-inch by 4-inch material and was used for the hauling of explosives.

In normal procedure it was customary for the truck to be used at the start of the shift for transportation of the air drilling and blasting crews to the working places. Explosives were then picked up at the magazine and delivered to the various jobs where they were to be used. All explosives were left in charge of a powder foreman. Near the end of the shift, unused explosives were picked up and returned to the magazine.

In loading churn drill holes, two lengths of wire-countered Primacord from different reels were attached to rocks and dropped to the bottom of the holes. The Primacord was then cut 4 to 5 feet longer than the hole depth and the ends were secured in the clear. Explosives were then loaded into the hole. Bag powder was poured into the hole or the 50-pound cartridges were lowered with a rope. After loading was completed, the hole was stemmed by a bulldozer pushing material to the hole. Large rocks were removed by hand shovels as the stemming material was pushed into the hole.

Prior to start of loading of blast holes, the shovel was backed into the clear and turned away from the blast. After the hole or holes were loaded the powder foreman requested the shovel operator to give the blasting signal by means of the shovel whistle. After the whistle, at night a 5-minute red flare was also lit and placed on the crest of the bench at the blasting site.

When the area was cleared, the powderman taped an electric detonator to the Primacord, connected the lead wires, and carried his blasting machine to the end of the lead wires. On receiving the shooting signal, the lead wires were connected to the blasting machine then on a second signal the blast was detonated.

Blasting crews were furnished with permissible electric cap lamps for night work.

STORY OF THE EXPLOSION

Activities of Bureau of Mines Personnel

The Phoenix office, Bureau of Mines, was notified of the accident and the four fatalities by telegram from John Garcia, New Mexico Inspector of Mines, the morning of March 31, 1954. Allen D. Look, Chief, Phoenix office, was notified on his return from a field trip the same date and left for Silver City, New Mexico, the next morning, arriving at 6:30 p.m. The investigation was continued at Santa Rita, New Mexico, through April 2, 1954.

On April 8, 1954, Allen D. Look visited the office of the Apache Powder Company, Benson, Arizona, to confer with plant officials concerning the investigation and revisited the mine on April 14-16, 1954, to obtain additional information.

Activities of Blasting Crew Prior to Disaster

The drilling and blasting crew of six men started their shift at 11:30 p.m., March 30, 1954. Two of the men were pneumatic drillers and were taken to their working place at the west end of the pit at the start of the shift.

The afternoon-shift crew had left one and a part box of explosives on the explosives truck at the completion of the afternoon shift. The disposition made of these explosives was not established in the investigation. The unopened box was believed to be 10-inch by 16-inch stick size explosive used in loading churn drill holes. The part box was an explosive used in springing toe holes and was a 60-percent special gelatin (ammonia gelatine) in $1\frac{1}{4}$-inch by 12-inch sticks.

The blasting crew of four men had one 12-inch churn drill hole on the south 5900 bench to load and blast. The explosives truck was observed from the lookout tower to be driven to, and then away from, the vicinity of the blast hole about 1 a.m. Loading and blasting of the one hole was the only work scheduled for the blasting crew for the shift.

The drilling and blasting foreman visited the yard office in the vicinity of the mine shops and requested the use of a bulldozer to stem the hole shortly before 4:00 a.m. It is believed that the explosives to be used in loading the blast had been picked up at that time, and from the shop area the loaded explosives truck with the crew was driven to the blast site. The bulldozer was sent to the blasting area at about the same time. The bulldozer that was sent was a rubber-tired vehicle which would move through the pit area almost as speedily as a truck.

Description of Disaster

From the observations of the lookout, it was established that the explosives truck arrived at the hole and stopped. About 4 minutes later the bulldozer arrived and was evidently stopped about 40 feet from the explosives truck in a position where the vehicle lights would help light up the loading area. At that time the explosives detonated. Three members of the blasting crew and the bulldozer operator were killed instantly. The fourth member of the blasting crew was found on his feet and standing about 30 feet from the scene of the blast by the first man to reach the accident. It was estimated that this first man reached the scene some 12 minutes after the blast.

Recovery Operations

The bodies were removed in about 1 hour and were turned over to a mortician at the mine shops.

The area was otherwise left as found for examination during the investigation. On completion of the investigation at the scene of the accident, the debris was cleaned up April 2, 1954, and the area was opened for resumption of normal mining operations.

INVESTIGATION OF CAUSE OF EXPLOSION

Investigating Agencies

Several agencies participated in the investigation of the explosion and the primcipal participants were as follows:

New Mexico Inspector of Mines

John A. Garcia	State Inspector of Mines
Gene Galassini	Deputy Inspector of Mines

Kennecott Copper Corporation

Robert Shilling	General Drilling and Blasting Foreman
W. Howard Snell	Safety Engineer

International Union of Mine Mill & Smelter Workers

Cipriano Montoya	Secretary Local 890
Jose Roman	Vice President Local 890
Arthur Padilla	Committeeman Local 890
Charlie Martinez	Committeeman Local 890
Manuel Martinez	Committeeman Local 890
Alfredo Montoya	Special Investigator for National Headquarters

Apache Powder Company

Louis A. Towle	General Superintendent

United States Bureau of Mines

Allen D. Look	Mining Health & Safety Engineer

Investigation of Explosion Site

The area around the scene of the blast was carefully investigated following the accident. The explosives had evidently detonated in place on the truck bed as the rear axle was driven into the ground at the point where

the truck was known to have been stopped about 20 feet from the churn drill hole. The bulldozer was still in place at the point where it had stopped just prior to the blast about 40 feet from the truck and about 60 feet from the churn drill hole.

The body of the bulldozer operator was found on the seat of the bulldozer where he had been decapitated by one of the wheel rims of the explosives truck. The three badly mangled bodies of the blasting crew members were all thrown to the east of the blast and in all cases the clothing had been practically all blown from the bodies. The three bodies had been carried distances of 78, 103, and 145 feet horizontally.

Most of the remains of the truck were distributed through an area 50 feet west of the blast.

The magneto of the blasting machine was found some 75 feet east of the blast. The top of the blasting machine with the plunger in place was found about 350 feet east of the blast. There were short pieces of detonator leg wire about 3 inches long attached to the terminals of the blasting machine. Other pieces of the blasting machine were found from a distance of about 20 feet from the truck to the 350-foot point where the top was found.

A large number of detonator leg wires and some unexploded detonators were found in an area northwest of the blast. Remains of a metal covered detonator box were found in the same area.

Lead wires were found on the bench some 60 feet east of the blast.

An unexploded 50-pound box of explosives, Amogel No. 1 of the same kind that detonated in the accident, was found alongside the haulage track and about 60 feet west of the explosion center. The box showed only slight damage which was apparently from being hit by two pieces of flying debris from the blast. The box had the appearance of having been placed where found, and material had been jarred around the box by the blast sufficient to leave an impression of the box after the box was removed.

The drill hole, 50 feet in depth, was found to be plugged at a depth of 31 feet after the blast. The hole was cleaned out after the accident and was found to contain no explosives. The hole was also found to contain water which would have made the Amogel No. 1 the correct type of explosive to be used.

Other Phases of Investigation

Possibility of fire

There was no evidence of a fire in the area of the site of the explosion and no fire was reported by anyone on duty in the pit. It is felt that a fire on the truck or in the surrounding area would have been plainly visible to the lookout tower observer. It was reported by fellow workers that none of the members of the blasting crew on duty were smokers by habit.

Inventory of magazine

Following the explosion, inventory and examination of records of the main magazine disclosed 15 cases of Amogel No. 1 in 10-inch by 16-inch stick size were involved in the blast. The explosives were part of a lot manufactured January 15, 1954.

Extraneous electricity

In any consideration of extraneous electricity as a cause of detonation of the explosives it should be remembered that in the normal procedure of loading at the Santa Rita open pit, detonators should still have been in the storage box at a time of 4 minutes after arrival of the explosives truck at the loading site.

There were no electrical storms in progress in the area and there was little if any wind blowing on the night of the accident.

The nearest radio equipment was about 1400 to 1800 feet away and consisted of transmitters on locomotives. The Federal licenses for the radio station lists the maximum plate power input to the final radio frequency stage of the stationary units as 60 watts and of the mobile units as 30 watts. A table is listed in part which gives the distances beyond which there would seem to be no possibility of a premature explosion by a radio transmitter.1/

Transmitter Power-Distance Guide

Power (watts)	Distance (feet)
5 - 25	100
25 - 50	150
50 - 100	220

The explosives truck was stopped near the haulage track and the trolley line over the track carried 750-volt direct current. The trolley was suspended well above the truck height.

Lack of Statement by Survivor

There was a survivor of the explosion as Magdaleno Chavez, powderman, was found alive and standing on his feet some 30 feet from the blast at the time the first man reached the accident scene about 12 minutes after the explosion. He was removed to the Santa Rita hospital and remained in a critical condition until his death in the early morning of April 3, 1954. Due to his condition, he was allowed no visitors except the immediate members of his family.

It was reported by a deputy of the Grand County Sheriff's office that at one time Chavez did make an apparently lucid inquiry to his brother

1/ Blaster's Handbook: E. I. DuPont de Nemours & Company, 1952, p. 230.

as to the condition of other members of the blasting crew and then lapsed into a less conscious state with the cry, "¡Esperate, esperate! ¡Dejalo!" (You wait, you wait! Leave it alone!)

Discussion of Evidence

It was established that the truck was stopped at the time of the blast. Assuming that the blasting crew was gathered near the rear of the truck at the time of the accident, with the exception of the blasting machine, the debris and bodies were all found in an expected pattern. In normal procedure, the blasting machine would have been in the front of the truck and should have been blown to the west. However, the parts were found to the east and on the same side of the blast as the bodies. Furthermore, there was a short piece of detonator leg wire still attached to each terminal on the top of the blasting machine. There was no time in the normal blasting procedure of the Santa Rita operation where the detonator would be connected directly to the blasting machine.

The unexplcded box of powder was probably left in violation of the printed safety rules either by a preceding shift or at the time of the 1 a.m. trip to the blasting site by the explosives truck. It was not believed from the appearance of the box that it could have been thrown from the truck at the time of the accident without exploding.

The presence of lead wires in the area was explained to be common practice where blasting of drill holes was being done one at a time. Following a blast, the lead wires would be disconnected and possibly pulled back for use in the next blast.

Cause of Explosion

Due to the meager evidence remaining after the blast and lack of any witnesses it was not possible to arrive at a definite conclusion as to the accident.

From the presence of the detonator leg wires on the blasting machine terminals and the location of the remains of the blasting machine in the opposite direction from that which would be expected, it may be assumed that some use was being made of the blasting machine contrary to usual practice. Such use may have been the cause of this accident.

RECOMMENDATIONS

Since no cause was determined it is not possible to make specific recommendations to prevent a similar accident. The following recommendations are offered for consideration for the general improvement of the explosives handling practice as observed:

1. Persons permitted to ride on vehicles transporting explosives should be limited to the driver and a helper.

2. All unused explosives from blasting should be returned to the magazine.

3. Vehicles carrying explosives should not be brought into the shop area.

4. If not feasible to transport detonators on a separate vehicle from that carrying the explosives, it is recommended the present wooden storage box have walls 4 inches in thickness.

5. Consideration should be given to furnishing of suitable stemming material and stemming by manual means.

ACKNOWLEDGMENT

The cooperation received from John A. Garcia, New Mexico Inspector of Mines, officials of the Kennecott Copper Corporation, Apache Powder Company and International Union of Mine Mill and Smelter Workers is gratefully acknowledged.

Respectfully submitted,

Allen D. Look

ALLEN D. LOOK
Mining Health & Safety Engineer

Approved by:

J. H. East Jr

J. H. East, Jr.
Regional Director
Region IV

APPENDIX A

VICTIMS OF PREMATURE EXPLOSION

SANTA RITA OPEN PIT

March 31, 1954

Name	Age	Occupation	Years of experience at Santa Rita	Dependents
Jose S. Portillo	48	Powder Foreman	4	2
Enrique C. Pedraza	27	Truck Driver	10	5
Chesley Chappell	35	Bulldozer Operator	1	3
Andres R. Gonzales	47	Powderman	29	6
Magdeleno M.Chavez	43	Powderman	27	None

Average age of victims - - - - - 40

Total number of dependents - - - 16

APPENDIX B

VERDICT OF CORONER'S JURY

Following the accident at the Santa Rita open pit of Kennecott Copper Corporation, an inquest was held in Santa Rita, Grant County, New Mexico, March 31, 1954, by Justice of the Peace Howard Snell, ex-officio coroner, to determine the cause of death of the men. The verdict of the coroner's jury in each case was: "Deceased came to his death by reasons of a premature explosion of dynamite, cause unknown."

APPENDIX C

REPORT OF FATAL ACCIDENT-MARCH 31, 1954 AT CHINO PIT, KENNECOTT COPPER CORPORATION SANTA RITA, NEW MEXICO

STATISTICS OF THE ACCIDENT:

(1) Jose S. Portillo, age 48, occupation powderman foreman. Deceased was married. Survivors are a wife and one child.

Deceased was employed by Kennecott Copper Corporation for 3 years, 8 months, 27 days, and was reported efficient and temperate in his work.

(2) Andres R. Gonzales, age 48, occupation powderman. Deceased was married. Survivors are a wife and five children.

Deceased was employed by Kennecott Copper Corporation for 35 years, 7 months, and was reported efficient and temperate in his work.

(3) Enrique C. Pedraza, age 27, occupation truck driver. Deceased was married. Survivors are a wife and three children.

Deceased was employed by Kennecott Copper Corporation for 9 years, 10 months, 8 days, and was reported efficient and temperate.

(4) Chesley Chappell, age 35, occupation bulldozer operator. Deceased was married. Survivors are a wife and two children.

Deceased was employed by Kennecott Copper Corporation for 1 year, 21 days, and was reported to be efficient and temperate in his work.

All above mentioned were severely mangled and instantly killed when 15 fifty-pound cases of explosives loaded on a truck exploded on the South 5900 bench at approximately 4:00 a.m. March 31, 1954.

The following named man died in the Santa Rita Hospital at 1:15 a.m. April 3, 1954, from injuries sustained in the same mishap.

(5) Magdeleno M. Chavez, age 43, occupation powderman. Deceased was single.

Deceased was employed by Kennecott Copper Corporation for 26 years, 11 months, 28 days, and was reported to have been efficient and temperate in his work.

EXTENT OF INVESTIGATION:

Mr. Howard Snell, Safety Engineer for the above-named operation, telephoned me at 5:25 a.m. March 31, 1954. I telephoned Mr. John A. Garcia, State Inspector of Mines, immediately after talking to Mr. Snell. Mr. Garcia informed me that he would arrive in Santa Rita as soon as possible. I proceeded to the Pit, arriving there at 5:50 a.m. Accompanied by Ken Harris, General Mine Foreman, we went to the scene of the accident. Guards were then placed at the several roadways leading into the area. These guards were instructed to keep out all unauthorized personnel. An intensive search of the area for a possible clue to the cause of the explosion was made. Mr. John A. Garcia arrived at 1:00 p.m. Mr. Louis Towle, Technical Representative, and his assistant, Mr. Phil Morey, of the Apache Powder Company, Mr. Walter Herkenhoff, Assistant Mine Superintendent, Mr. Bob Schilling, General Drilling and Blasting Foreman, Mr. John A. Garcia, State Inspector of Mines, and myself continued the investigation until time of the inquest.

The inquest was held at 3:30 p.m. March 31, 1954, in the District Court Room in Silver City, New Mexico. Verdict of the Coroner's Jury was "Death by reason of a premature explosion of dynamite, cause unknown."

Mr. John A. Garcia, State Inspector of Mines, was accorded the privilege of asking any questions he wished. This served as our formal hearing.

We returned to the Pit at 8:00 p.m. March 31, 1954. The afternoon shift powder crew was questioned as to their actions during said shift. They gave a full account of the mechanical condition of the powder truck, materials, and supplies left by them on the truck at the completion of the shift.

After talking to Mr. Rue M. Spruill, lookout man on duty at the time of the accident, we left the Pit at 1:00 a.m. April 1, 1954.

April 1, 1954, was spent in and about the Pit viewing the scene of the accident and interrogating the drill crew of the same department on shift at the time of the accident.

During this investigation the top of the blasting machine was found. Both terminal posts were still in place. Attached to each terminal post was a fragment of twenty-two gauge wire. This is the same size wire as the electric blasting cap leg wires. Each fragment of wire was about three inches in length. All phases of the blasting procedure for different types of blasts were discussed with the powder men, foremen, and supervisors. The electric blasting cap leg wires on the blasting machine terminal posts could not be accounted for by anyone. In all blasts at this operation, it is necessary to use extension wires. Eighteen gauge annunciator wire is used for these extensions.

DESCRIPTION OF THE ACCIDENT:

The powder crew consisting of Jose S. Portillo, Foreman, Enrique C. Pedraza, Truck Driver, and Andres R. Gonzales, Powderman, were to blast a churn drill hole, which was twelve inches in diameter and approximately fifty feet deep on the South 5900 bench directly above electric shovel No. 14.

Chesley Chappell, Bulldozer Operator, had been summoned to stem the churn drill hole. He was operating a Caterpillar DW-10. He stopped on the side of the tracks opposite and facing the churn drill hole, about thirty-five feet from the powder truck. The powder truck was the length of the truck forward and between the bulldozer and the churn drill hole.

A 1953 Chevrolet two-ton truck was being used to transport explosives. The bed of this truck had a wooden deck over the manufacturer's bed. Blasting caps were also transported on this truck. Blasting caps were placed in containers constructed of twenty-four gauge sheet metal which were lined with plywood. These containers were then placed in stationary boxes on the truck. These boxes were constructed of 2"X12" material. It was estimated that at the time of the accident approximately 70 blasting caps and 15 cases (750 pounds) of Amogel 10"X16", 60-percent blasting powder were on the truck along with the blasting machine and prima cord.

Mr. Rue Spruill, Lookout Man, saw the powder truck drive onto the bench and stop. He said that he could see the powder crew moving about. Powder crew members were equipped with miner's hat lamps. Mr. Spruill said that approximately five minutes after the truck stopped at the churn drill hole, the explosion occurred.

It was evident that the powder had not been unloaded from the truck. No craters were visible. The differential housing, rear axles, and the inside wheels of the duals had been embedded in the ground. One outside wheel of the duals was next to Chesley Chappell's body, which was in the bulldozer. The bodies of the other victims were blown in an easterly direction from the truck. Magdeleno M. Chavez was found thirty feet from the truck. The body of Jose S. Portillo was one hundred and three feet from the truck. The bodies of Andres R. Gonzales and Enrique C. Pedraza had been blown over the bank and were lying on the 5858 bench, a horizontal distance of one hundred and forty-five feet and seventy-eight feet respectively from the same fix. This would indicate that all members of the powder crew were to the rear of the truck.

One case of powder was found at the scene of the accident. Because of its location and lack of damage to the box, it was presumed that this case of powder had been placed there sometime prior to the accident.

RESPONSIBILITY FOR THE ACCIDENT:

Industrial accident investigation has failed to reveal the actual cause of the accident. I am unable to offer any criticism in regard to the blasting procedure. Failure to follow this procedure could have been the cause. This was the first fatal accident suffered by this department since 1928. Good records do not make anyone immuned to accidents, but it is evident that necessary precautions are taken.

RECOMMENDATIONS:

(1) Blasting procedures shall be thoroughly reviewed by management and personnel, and steps shall be taken to correct any existing carelessness.

(2) The least number of men shall be allowed in and around the area to be blasted and when transporting explosives.

(3) The cap boxes on the powder truck shall be kept locked.

Report prepared by Gene Galassini, Deputy State Inspector of Mines.

Approved:

/s/ John A. Garcia
John A. Garcia
State Inspector of Mines

/s/ Gene Galassini
Gene Galassini
Deputy State Inspector
of Mines