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UNITED STATES  
DEPARTMENT OF THE INTERIOR

MINING ENFORCEMENT AND SAFETY ADMINISTRATION

M/NM FATAL



## HEALTH AND SAFETY REPORT

REPORT OF MULTIPLE FATAL HYDROGEN SULFIDE GAS POISONINGS  
BONNIE LAKE MINE AND MILL  
W. R. GRACE AND COMPANY  
BARTOW, POLK COUNTY, FLORIDA

June 4, 1975

by

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### INTRODUCTION

This report is based on an investigation made pursuant to Clause (1) of Section 4 of the Federal Metal and Nonmetallic Mine Safety Act (80 Stat. 772).

Reference numbers used in the report identify mine safety standards promulgated in the Federal Register, Vol. 34, No. 145, Thursday, July 31, 1969; Vol. 35, No. 38, Wednesday, February 25, 1970; Vol. 35, No. 237, Tuesday, December 8, 1970; Vol. 37, No. 139, Wednesday, July 19, 1972; Vo. 37, No. 220, Tuesday, November 14, 1972; Vol. 38, No. 167, Wednesday, August 29, 1973; Vol. 39, No. 127, Monday, July 1, 1974; Vol. 39, No. 153, Wednesday, August 7, 1974. Mandatory standards are indicated by (M) after the reference number.

Warren A. Haddock, dams maintenance supervisor, age 29, and Clifford Bowers, mines utility man, age 20, were killed at about 2:30 p.m. on June 4, 1975, when they were overcome by hydrogen sulfide gas while placing flashboards near the bottom of a spillway decant tower. Haddock was survived by his widow and two dependent children. He had been employed by the company for 8-1/2 years, the last three months as a dams maintenance supervisor. This was believed to be his total mining experience. Bowers was survived by his widow and one dependent child. He had been employed by the company for 11 months, the last 18 days as mines utility man.

Keith Simmons, age 38, mining supervisor, and Brant Chewning, age 21, rodman, were overcome during recovery operations and were hospitalized. Prior to the submission of this report, both men had been released and were expected to return to work.

The Bartow, Florida, field office of the Mining Enforcement and Safety Administration was notified of the accident by a telephone call from the company's safety director at about 8:45 a.m. on June 5, 1975. An investigation was started immediately.

Information for this report was obtained by visiting the scene of the accident, interviewing company personnel and witnesses, and by testing air and water samples with field test equipment.

### GENERAL INFORMATION

The Bonnie Lake Mine and Plant, an open-pit phosphate operation, owned and operated by W. R. Grace and Company, was located about four miles west of Bartow, Polk County, Florida, along State Highway 60. Operating officials were: J. R. Terry, general manager; M. P. McArthur, production manager; A. L. Holmes, plant manager of mining; and E. J. Hargaden, industrial relations manager.

The mine and plant were normally operated three shifts a day, seven days a week. A total of 133 persons was employed.

Excavation of the phosphate was essentially a strip mining operation in which the overburden was stripped and placed in adjacent mined-out areas and the underlying matrix mined. The matrix varied from 10 to 30 feet in thickness and consisted of approximately one-third recoverable phosphate, one-third silica sand, and one-third clay. Draglines were used to remove and deposit the matrix into shallow sumps or wells, located within the swing radius of the draglines, where hydraulic guns broke up the material. The resulting slurry, consisting of about 40 percent solids, was pumped through large pipelines to the beneficiation plant for washing, screening, sizing, and flotation. About three-fourths of the phosphate production from the beneficiation plant was used in an adjacent company-owned phosphoric acid producing plant. The two facilities were connected by belt conveyors.

Process water for the plant was supplied from deep wells and reclaimed from large slime settling ponds. These slimes consisted of phosphatic, clay-bearing wastes generated in the beneficiation process. The settling ponds were created by building retaining dams in mined-out areas. Virtually all of the residual reagents from the beneficiation plant including ammonia, fatty acid, amine, fuel oil, sulfuric acid, petroleum distillate and occasionally caustic soda, were also discharged into these settling ponds.

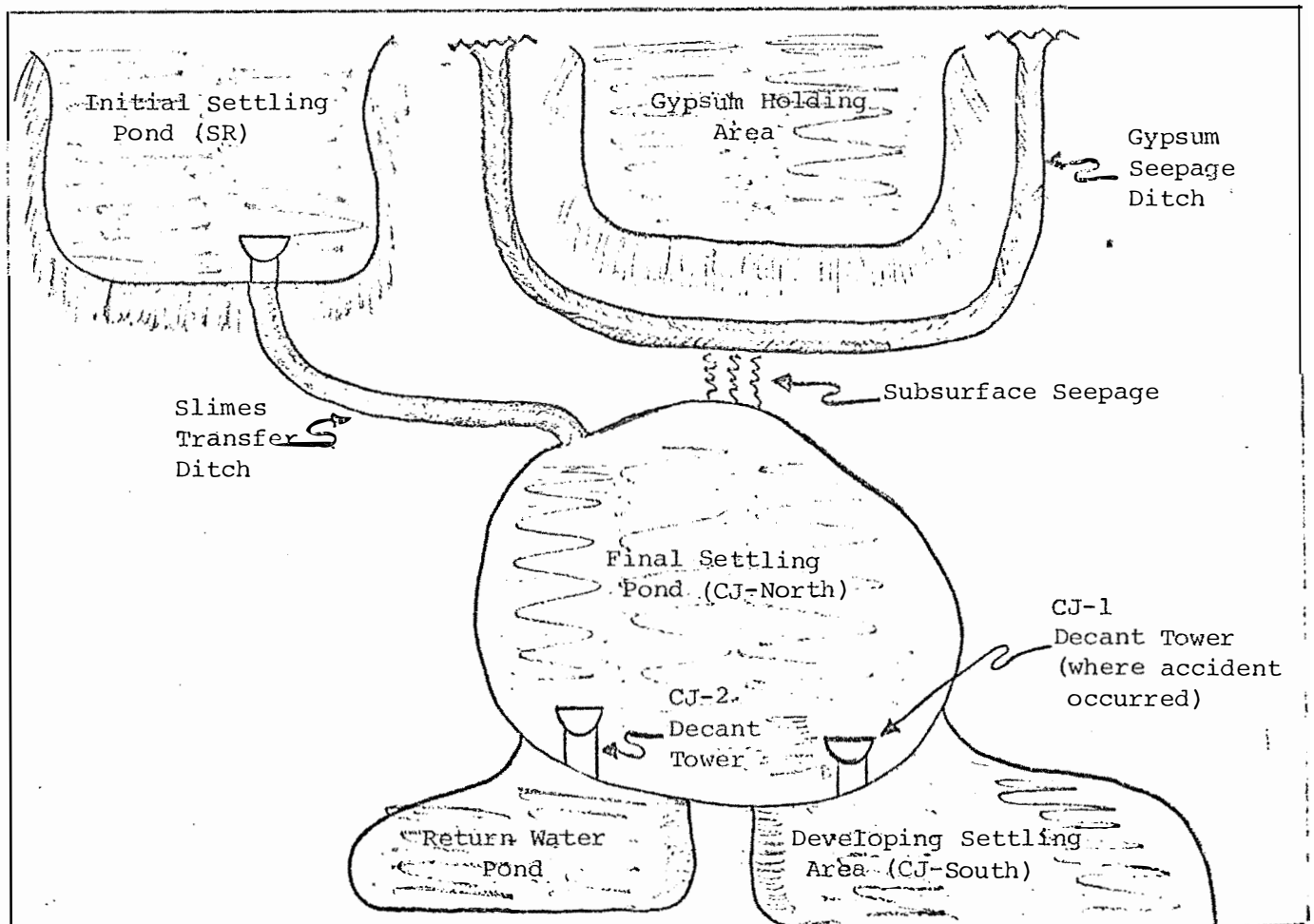
The water recovery system involved in the accident consisted essentially of two settling ponds. Water was decanted from the first pond and flowed through an open ditch into the second pond known as CJ-North. Two decant towers were located at opposite corners of the lower end of CJ-North. One tower discharged into a relatively small pond for clear water return to the plant. The other, known as CJ-1 and where the accident occurred, discharged into a larger, 600-acre area that was to be used later as part of another recovery system. Both discharges were submerged which prevented natural ventilation. In this system, the first settling pond was comparatively ineffective as the slimes passed from one end to the other in channels and did not broadcast over the 350-acre settling area. CJ-North was almost entirely covered by water hyacinth and other vegetation.

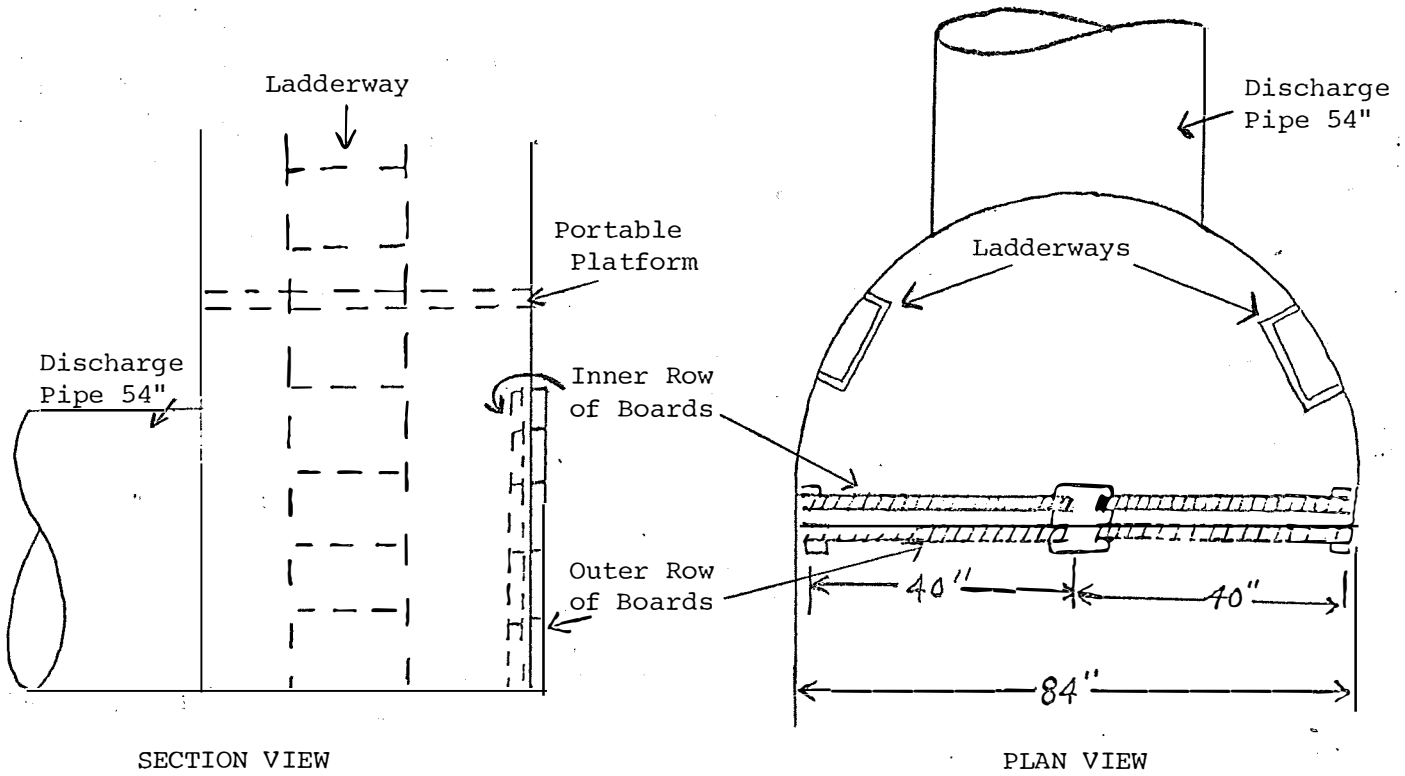
Chemically produced gypsum, a waste by-product from the acid plant, was stored aboveground in large holding areas adjacent to the slimes settling pond and at a slightly higher elevation. An open seepage ditch had been cut around the lower perimeter of the gypsum dikes to catch the acid water leached from the gypsum. At times the solution was pumped back into the gypsum to promote evaporation as local environmental controls would not allow its release. Scrubber wastes from the driers and acid waste water from the chemical plant were also discharged into the gypsum area. Inspection of the CJ-North settling pond revealed subsurface seepage of the acid solution from the gypsum dikes or ditch into the upper end of the pond.

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NOT TO SCALE





SECTION VIEW

PLAN VIEW

SECTION AND PLAN VIEW  
 OF  
 BOTTOM OF DECANT TOWER

NOT TO SCALE

The retaining dam at the accident site was approximately 20 feet high. An expanded-metal walkway extended from the top of the dam to the top of the decant tower. The tower was of steel construction, 20 feet high, semi-circular in cross section and 84 inches across the diameter. The water level in the pond was raised by inserting flashboards across the diameter of the riser. Two boards, 8 inches by 2 inches by 40 inches, fitted end-to-end into channel-iron slots would raise the water level 8 inches. Two sets of these flashboards were frequently used. The second, or back-up, set provided additional strength when the water reached greater depths of 12 to 14 feet and pressure against the outer set of boards increased. Two fixed ladders were attached on opposite sides inside the tower and extended to the metal bottom. A portable, expanded-metal platform installed through the rungs of both ladders was used to stand on while placing or removing boards. Water from the tower was discharged by means of a 54-inch diameter tube extending from near the bottom of the tower, through the dam and into the pond on the other side. At the time of this investigation, approximately 5 feet of water was in the CJ-North pond at this location.

The following persons participated in this investigation:

W. R. Grace and Company

Dick Risley	central services superintendent
Jackie Purcell	waste disposal superintendent
Bob Johnson	safety director
Alex McDonald	survey crew party chief
William Lovett	mines utility man and witness

CNA Insurance Company

Ed Hall and John Pierce	safety representatives
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State of Florida-Division of Occupational Health

Glynn McKinnon	industrial hygienist
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Polk County, Florida-Health Department

Donald R. Guthrie	sanitary engineer
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U. S. Department of Interior-M.E.S.A.

Charles Paterson	metal and nonmetal mine inspector
C. N. Narramore	supervisory inspector

The last regular inspection of this operation was completed January 23, 1975.

DESCRIPTION OF ACCIDENT

On the day of the accident Haddock and Bowers reported for work at 7:00 a.m., their regular starting time. During the course of routine inspection and maintenance of retaining dams that day, it was decided that there was sufficient time to install a back-up set of flashboards in the CJ-1 decant tower, a job that they had intended to do for some

time. Haddock and Bowers proceeded to the site accompanied by William Lovett, mines utility man. Haddock and Bowers climbed down the ladders and stood in about six inches of water at the bottom of the tower. Water was not flowing over the top of the flashboards but a moderate amount was leaking between them. Reportedly, no one had been to the bottom of the tower for quite some time. Lovett remained on the expanded metal platform that was positioned just above the outside water level.

Haddock and Bowers worked from the floor of the tower for about 10 minutes removing water hyacinth caught between the boards while Lovett jumped on the top of the boards to press them closer together. Lovett was sent for more boards and was halfway up the ladder when he heard Bowers moan and saw him fall. Haddock called for Lovett to assist him, but he too fell as he leaned over to help Bowers. Lovett returned to the platform but could not get any response from the two men or reach them from where he stood, so he returned to Haddock's pick-up truck and called for help on the radio.

Assistance came within minutes, and two of the rescuers, Simmons and Chewning, who entered the tower were soon overcome to the point of unconsciousness. A short time later the safety director arrived with an ambulance. One oxygen-breathing apparatus was available on the ambulance but was rendered inoperative when a control valve was broken in the haste to reach the victims. By this time a welding truck and a compressor truck had arrived and the riser was purged to some extent with oxygen and air.

The victims were recovered by pulling them over the top of the flashboards and wading to shore with them. Artificial respiration was started immediately and resuscitators were put into service. Two county ambulances had also arrived with additional equipment.

Haddock and Bowers were pronounced dead on arrival at a local hospital. Simmons and Chewning were unconscious and remained in critical condition for several days.

Testing of the air quality at the bottom of the two spillway risers during the days following the accident indicated concentrations of  $H_2S$  ranging from 500 to 2000 ppm. The concentrations became progressively higher as the water flow into the spillway increased. The threshold limit for  $H_2S$  is 10 ppm, and the allowable excursion limit is 20 ppm.

Air sampling of spillways at other similar mining operations in the area did not reveal significant amounts of  $H_2S$ .

#### CAUSE OF ACCIDENT

It was the consensus opinion of the investigators that a general anaerobic state existed in the CJ-North pond which allowed hydrogen sulfide gas to form. The anaerobic condition was apparently brought on by the following:

1. The rapid transfer of slimes through the first settling pond which reduced its effectiveness in initial clarification of the water.

2. The proximity of the gypsum holding area and the seepage of the acid solution into the CJ-North pond.
3. The presence of dense hyacinth cover over the CJ-North pond which prevented sunlight penetration and exposure to open air.
4. The presence of sufficient sulfur from various sources which promoted the growth of sulfur utilizing bacteria which acted in conjunction with the high acidity of the pond to create optimum conditions for the production of  $H_2S$ .

The accident was caused by the unawareness of company officials and workmen that this anaerobic condition could allow hydrogen sulfide to form and that high concentrations of the gas had collected at the bottom of the decant tower.

#### ORDERS ISSUED

55.5-1(a), Order No. 1 Excessive hydrogen sulfide concentration and/or oxygen deficiency at lower level of CJ-1 spillway riser.

55.5-1(a), Order No. 2 Excessive hydrogen sulfide concentration and/or oxygen deficiency at lower level of CJ-2 spillway riser.

#### RECOMMENDATIONS

Compliance with the following recommendations should prevent recurrence of similar accidents:

1. The level of slimes in the first settling pond should be raised and maintained at a level that will allow the removal of some of the solids prior to discharge into the CJ-North area.
2. Seepage from the gypsum area should be prevented from entering the slime ponds.
3. The hyacinth growth covering the ponds should be eliminated and future growth should be controlled to provide exposure of the water to sunlight and open air.
4. The CJ-North pond should be drained to a level as low as the spillways will allow and an improved water management program established that will insure the aerobic state of the water system during future use.

55.5-1(a) MANDATORY. The exposure to airborne contaminants of a person working in a mine shall not exceed, on the basis of a time-weighted average, the threshold limit values adopted by the American Conference of Governmental Industrial Hygienists, as set forth and explained in the most recent edition of the Conference's publication entitled "Threshold Limit Values of Airborne Contaminants Excursions above the listed threshold limit values shall not be of a greater



magnitude than is characterized as permissible by the Conference. This paragraph does not apply to airborne contaminants given a "C" designation by the Conference--for example, nitrogen dioxide. The permissible excursion limit for hydrogen sulfide is 20 ppm.

55.5-2 MANDATORY. Gas and fume surveys shall be conducted as frequently as necessary to determine the adequacy of control measures.

#### ACKNOWLEDGMENTS

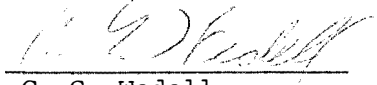
The courtesy and cooperation of company officials and employees during this investigation are gratefully acknowledged.

The cooperation and technical expertise provided by Mr. McKinnon of the Florida Division of Occupational Health, and Mr. Guthrie of the Polk County Health Department are especially acknowledged. Their technical input provided the basis for the findings and corrective recommendations contained in this report.

/s/Charles Paterson  
Charles Paterson  
Metal and Nonmetal Mine Inspector

/s/ C. N. Narramore  
C. N. Narramore  
Supervisory Inspector

Approved by:

  
C. G. Wedell  
Subdistrict Manager