U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT 77-59-496
KERR-McGEE CHEMICAL CORPORATION
TRONA, CALIFORNIA

JUNE 1978

I. TOXICITY DETERMINATION

It has been determined that at the Kerr-McGee Chemical Corporation Facility, Trona, California:

1) Dust exposures to the crystalline forms of sodium tetraborate (borax) are excessive in the Pyrobor Plant. This determination is based on the environmental samples collected on June 21-22, 1977, and the results of the medical survey conducted by NIOSH.

2) The exposures of workers to lithium carbonate at Kerr-McGee are not toxic as found during this survey. This determination is based on the medical findings, the measured air levels of lithium carbonate, the conditions of exposure, and the work practices in the lithium areas.

The above conclusions and determinations were based on on-site evaluations and the currently available scientific data. More detailed information is contained in the body of the report. Recommendations are included in Section V of this report. This report has been delayed for at least six months because of the need to develop analytical methods for lithium carbonate and anhydrous borax. Even with the extra time, a satisfactory analysis for anhydrous borax could not be developed. An interim report (October 19, 1977) was sent to Kerr-McGee and the requester which included total dust levels, some medical results, and several recommendations. This information was designed to assist Kerr-McGee and to take up the slack caused by analytical delays.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from the National Institute for Occupational Safety and Health (NIOSH), Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

(a) Kerr-McGee Chemical Corporation, Trona, California

(b) U.S. Department of Labor, Region IX

(c) CAL/OSHA

(d) NIOSH, Region IX

(e) Authorized Representative of Employees - Local #35, Chemical and Processing Workers Union, Trona, California

For the purpose of informing the approximate 50 affected employees, the employer will post the report in a prominent place(s) accessible to the employees for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 20 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from Local #35 of the Chemical and Processing Workers Union, Trona, California, to determine whether lithium carbonate and anhydrous borax were hazardous in the concentrations used or found at Kerr-McGee.

IV. HEALTH HAZARD EVALUATION

A. Description of Plant Process

On June 21-22, 1977, a NIOSH environmental and medical survey of several areas of the Kerr-McGee facility was performed. The facility is involved in the extraction of various mineral products and by-products from a natural lake brine solution. From this brine, such chemicals as borax, anhydrous borax, potash, salt cake, soda ash, and lithium carbonate are processed. The request from the union concerned two compounds (lithium carbonate and anhydrous borax) which essentially involved three areas of the facility. These areas were the Licons Plant, the Lithium Carbonate Plant, and the Pyrobor Plant.

At the Licons Plant, lithium liquor solution passes through a filter press where the lithium concentrate forms a "cake" on the filter press blades. The cake is dumped on a conveyer belt and is moved to a furnace where it is roasted at 1200°F. The lithium concentrate is then pulverized in a hammer mill and dropped into three outdoor hoppers. Only one employee operates the Licons Plant, and he spends a great deal of his time in the control room. Occasionally, a supervisor or maintenance men will rotate through the plant.

At the Lithium Carbonate Plant, the concentrate is converted into lithium carbonate. The concentrate in the hoppers at the Licons Plant is brought by a forklift and is fed into a digestor. The resulting slurry of phosphates and sulfates is heated to 280°F and cooled to 150°F. Lithium sulfate separates and is piped to a dissolver and then to a precipitator where soda ash (sodium carbonate) is added. The lithium carbonate crystals are dried and dumped. The dumping requires five to ten minutes per hour. The powder is then packed into bags. Packing takes four to five hours per day, but is not done every day. One worker does the packing, and he is required to wear respiratory protection. The lithium carbonate operator is responsible for the operation of the rest of the plant.

At the Pyrobor Plant, refined borax (sodium tetraborate with ten waters of crystallization) is calcined to remove three of the waters. The calcined material is fed to a pyrobor furnace where the remainder of the water is driven off and the material is fused. The melt is chilled on water-cooled rolls in order to form a glass 1/16 inch thick. The cooled glass is milled and screened to form the final product, anhydrous borax. The Pyrobor Plant operates for all three shifts. Two operators per shift run the controls. During the day shift only, four helpers are assigned to general clean-up duties. In all areas of the plant, there is a certain amount of dust. Where the helpers work, they are exposed to dustier conditions. The dust is a mixture of sodium tetraborate with different amounts of water.

B. Evaluation Methods

1. Environmental

Environmental samples for airborne dust were taken at the Licons, Lithium Carbonate, and Pyrobor Plants. Samples were collected with MSA Model G personal sampling pumps and pre-weighed 25 millimeter silver membrane filters. The flow rates were 1.5 liters per minute.

2. Medical

NIOSH medical personnel interviewed all available workers in the lithium and borax areas of the facility, including employees from all three shifts. In the borax area, interviews and physical examinations were performed on

nine workers (six operators and three helpers). In the lithium area, interviews and physical examinations were performed on 12 workers (nine operators, two packers, and one maintenance man). Additionally, NIOSH collected urine for routine urinalysis (including microscopic examination) and venous blood for serum blood urea nitrogen, uric acid, lithium, and creatinine levels from workers who worked near lithium. These tests were intended to evaluate kidney function in persons exposed to lithium.

C. Evaluation Criteria

1. Environmental

There are no standards or recommended limits for lithium carbonate at this time. Therefore, total dust levels in milligrams per cubic meter measured and the amount of lithium carbonate in each sample were quantitated. At the present time, the only index available for lithium carbonate is the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV) for nuisance particulates of 10 mg/m^3 based on a time-weighted average.[1] However, it must be noted that this limit may not be applicable to lithium carbonate. Further information is needed.

The ACGIH TLV's for borates (sodium tetraborate) are 1 mg/m^3, 5 mg/m^3, and 1 mg/m^3 based on a time-weighted average (TWA) for anhydrous borax, decahydrate, and pentahydrate respectively. The current CAL/OSHA standard for the borates is 10 mg/m^3 (TWA). CAL/OSHA considers borates in the nuisance dust category at this time.

2. Medical Criteria

a. Lithium Carbonate

Lithium carbonate is relatively non-toxic, unless taken into the body in large amounts. Lithium compounds have been used for over a hundred years as medicine, first in treating gout, then as a salt substitute in low-sodium diets, and in the last 20 years as a treatment for manic-depressive psychosis.[2] By mechanisms that are not well understood, lithium seems to be able to control manic episodes. There is no evidence that small amounts of lithium cause personality changes in normal persons.

Lithium is well absorbed if taken orally, and is probably also well absorbed from the lung. It is absorbed only very poorly through the skin.

Lithium is excreted mainly in the urine, although some may be excreted in sweat, diarrhea, or vomitus. It does not tend to accumulate in body tissues or in bone. A low sodium content in the body will slow down excretion of lithium and tend to make lithium toxicity worse.

When used in treating manic-depressive psychosis, lithium carbonate is typically given in doses of 0.5 to 2.0 grams a day in order to achieve the desired clinical response. This usually requires a blood level of 1.0-1.5 mg/liter, but the exact dose that is effective varies considerably among individuals. At blood levels of 1.5 to 2.0 mg/liter, the kidney may start to have trouble conserving water; excessive water drinking and urination may be observed. At higher doses the kidney may fail to put out enough urine, and kidney failure results.[3] Other signs of poisoning by large doses of lithium include weight loss, poor appetite, generalized weakness, nausea, vomiting, diarrhea, shaking and uncoordination, seizures, and unconsciousness. These serious signs of poisoning have been observed in experimental animals; cases of human poisoning of this degree usually require massive ingestion either accidentally or for suicide. Symptoms are generally reversible and non-permanent if the lithium is allowed to be excreted. One case of permanent brain damage was reported in a psychiatric patient who took large doses of lithium and halperidol, a major tranquilizer.[4]

Lithium in moderate doses is not known to cause any chronic diseases, to cause cancer, or to affect pregnant women.

In summary, lithium carbonate is a relatively non-toxic substance, but it can cause serious poisoning if taken into the body in large amounts.

b. Borax

Boron compounds are relatively non-toxic materials, except in special cases of massive overdosage. Boric acid has caused poisoning when misused as a body powder over large areas of burned skin.[5] Human poisoning has occurred when babies were chronically fed a mixture of borax and honey on pacifiers. Seizures and anemia developed in these children.[6] Borax was once used as a neutron-capture element in radiation treatment of brain tumors, which required giving up to 20 grams of borax intravenously to a patient over a short period of time. No serious toxic effects were noted due to the borax.[5] Animal studies have shown that chronic poisoning with large doses of borax can cause some testicular degeneration and sterility in rats.[5]

Anhydrous borax will pull moisture from body tissues, which can be especially irritating to wet membranes around the eyes, nose, or throat.

Small amounts of borax are not known to cause any chronic diseases, lung disorders, or cancer in humans, or to affect pregnant women.

D. Evaluation Results and Discussion

1. Lithium Carbonate

There was a great deal of difficulty in analyzing the samples for lithium carbonate (Li_2CO_3) because of baseline stability problems and sample interference. To analyze the samples, an X-ray powder diffraction method was developed by the NIOSH laboratory which relied on the sequential measurement of three phases (peaks) occurring during the analysis. The development of the method caused the analyses of the samples to be delayed until the end of November 1977.

The results of the environmental samples are contained in Table I. Two samples over a two-day period were collected in the breathing zone of the Licons (lithium concentrate) operator. The TWA dust levels were 1.90 mg/m^3 and 2.69 mg/m^3 for June 21 and 22 respectively. No lithium carbonate was detected in these samples. This was to be expected since the lithium concentrate contains no lithium carbonate at this stage. In terms of total dust, the levels were well below 10 mg/m^3, the nuisance dust TLV and CAL/OSHA standard. However, lithium concentrate dust is not officially classed as a nuisance dust.

One sample was taken on the lithium carbonate operator on June 22, 1977. The plant was not operating fully because of equipment problems on June 21 and 22. The TWA total dust level was 2.55 mg/m^3. The Li_2CO_3 concentration was 0.42 mg/m^3. Lithium carbonate was packed for two hours under an auxiliary procedure. The Li_2CO_3 is fed from drums to the packing machine where it is bagged. A two-hour run was completed. On the packer, the dust level for two hours was 4.22 mg/m^3 and the Li_2CO_3 concentration was 0.90 mg/m^3. On the feeder, the dust level was 12.79 mg/m^3 and the Li_2CO_3 concentration was 4.4 mg/m^3. Respiratory protection is mandatory. Since no standards exist for Li_2CO_3, no definite conclusions can be made about the Li_2CO_3 levels. Under current standards for nuisance dusts, the feeder can be exposed to total dust levels exceeding 10 mg/m^3 without protection if there is no other dust in the atmosphere in the Lithium Carbonate Plant.

2. Borax

The analysis for anhydrous borax was even more complex than for Li_2CO_3. The method could not be successfully developed by NIOSH, and as of April 18, 1978, the method development was terminated. Each analyte of sodium tetraborate (anhydrous, pentahydrate, and decahydrate) interferes with the X-ray diffraction profile of the other analytes. In October of 1977, it was decided to pursue development of the borax analytical method in hopes that it would succeed.

In Pyrobor, five samples were taken on helpers and four on operators over a two-day period. The results are contained in Table I. The five samples for the helpers showed TWA dust levels of 5.99, 12.7, 21.9, 27.1, and 29.9 mg/m^3. In terms of even the nuisance dust standard in California of 10 mg/m^3, these dust levels were high. The interim report pointed this fact out. The four samples for the operators showed dust levels of 2.90, 3.10, 6.54, and 7.46 mg/m^3. The dust levels were below 10 mg/m^3. The exact composition of the dust in the Pyrobor samples could not be determined, but it is assumed that the major portion of the dust contains one or more of the three crystalline forms of sodium tetraborate. A TLV for a mixture of the forms would be between 1 and 5 mg/m^3. The lowest TLV would be 1 mg/m^3. In this case, in terms of the TLV, all samples collected in Pyrobor were in excess of 1 mg/m^3 and at least three samples probably exceeded the ACGIH TLV for borates. In terms of the nuisance dust standard in California, which applies to the borates, the exposures to the helpers were too high and those of the operators were acceptable.

3. Medical Evaluation - Results

a. The OSHA Form 100 was reviewed. In the areas under study, there were no reported cases of chemical toxicity in 1974, 1976, 1977. The form from 1975 was not available on the day of the study.

b. The medical facilities available at the plant site were reviewed. There is a registered nurse assigned to the plant first-aid office during the day; a doctor also runs a clinic on weekdays at the plant medical unit, which has facilities for routine lab work, X-ray, and minor outpatient surgery. Ambulance service is available to a larger hospital in Ridgecrest, about 20 miles away.

There is a pre-employment physical examination program. Each employee has the option of a biannual physical examination thereafter.

c. Lithium Area

NIOSH medical personnel interviewed and examined 11 male and one female employees with a mean age of 28 years (range 19 to 49) and a mean duration of employment in the lithium area of 1.2 years (range one day to seven years). Turnover in this area tends to be relatively high, with a mean stay of 3.4 months among the last 13 persons employed as operators in this area. Packing is considered by most workers to be the dustiest and least desirable job in the area, so employees generally transfer to a better area after a short probationary period.

Symptoms reported by lithium area workers consisted mainly of irritation of skin and mucous membranes. Five persons reported irritated eyes; six reported dryness and chapping of the skin, but this complaint is so common in this desert area that it cannot be interpreted as directly occupational. One person reported feeling weak and nauseated on very hot days; this problem seems related mainly to heat. One person reported that his exercise tolerance seemed less since starting work in the lithium area.

Physical examinations included the mucous membranes of eyes, nose, throat; the skin; chest examination; and thyroid palpation. Results were generally negative except for five persons with slightly inflamed conjunctiva. One man had a mild folliculitis that was probably due to the oil he handled all day long as a lubrication maintenance man.

The blood chemistries used to evaluate kidney function (creatinine, uric acid, blood urea nitrogen) were all normal except for two borderline elevations of blood urea nitrogen, which are probably of little significance. No lithium was detected in any of the blood samples, using a method which can detect as little as 0.05 milliequivalents/liter of lithium.

The urinalyses were generally normal, except for one individual with a trace of blood and protein and one individual with protein only. These abnormalities are difficult to relate to lithium exposure in the absence of detectable lithium in the blood.

The specific gravities of the urines were generally high, indicating that the workers' kidneys could respond well to the hot dry climate by conserving water. Lithium poisoning would tend to impair the ability of the kidney to conserve water. The specific gravities were so high, in fact (mean 1.025, range 1.017-1.031, with five of ten values above the usual normal range of 1.005-1.025), as to indicate that some of the workers may have been getting somewhat dehydrated during the hot day shifts.

d. Pyrobor Area

NIOSH medical personnel interviewed and examined nine male employees with a mean age of 32 years (range 18-57) and a mean duration of employment in the area of four years (range two months to ten years) for operators and 1.3 months (range one week to 2.5 months) for clean-up helpers. The clean-up helper job is a starting position; employees generally transfer elsewhere after a short probationary period.

Symptoms reported in the borax area related mostly to mucous membrane irritation. Five persons reported eye irritation; three persons reported nose irritation with some bleeding after nose-blowing; three persons reported throat irritation; and four persons reported dryness and chapping of hands.

Physical examination also revealed signs of mucous membrane irritation. Five persons showed slight irritation of the conjunctiva; one person had a reddened throat; two persons showed some skin peeling on the hands, without redness or rash.

E. Conclusions

From the available information, the following conclusions are made:

1. There is no evidence of a serious medical problem in either the lithium or the borax areas of the Kerr-McGee facility. Lithium was not being absorbed by workers in detectable amounts, and kidney function was not grossly impaired as diagnosed by routine serum screening tests.

2. There was a significant number of workers who had signs or symptoms of mucous membrane irritation from dust. Several workers commented that the main problem was dust in their eyes during the frequent wind storms in the area.

3. In view of the medical findings, the lack of environmental criteria, and the work procedures, it does not appear that lithium carbonate presents a health hazard at the Kerr-McGee facility.

4. In view of the medical findings, the latest recommended criteria, and the environmental results, dust levels in the Pyrobor Plant seemed to be excessive.

5. The high urine specific gravities of several of the workers indicate that some persons may not be drinking enough fluid to keep well hydrated on hot summer days.

V. RECOMMENDATIONS

1. Kerr-McGee has shown considerable interest in employee health by maintaining plant medical and first-aid facilities and by establishing pre-employment and periodic physical examination programs. Such efforts are commendable and should be continued.

2. Personal protective equipment should be made readily available and be worn as much as possible by workers. Pyrobor helpers should wear NIOSH certified respirators whenever clean-up duties are performed. Goggles may be necessary to protect eyes from dust.

3. Good work habits such as handwashing before eating, drinking, or smoking should be emphasized to reduce ingestion of chemicals.

4. Employees should be educated about the chemicals they handle and the proper use of personal protective equipment.

5. An engineering survey of the Pyrobor Plant should be made and, where possible, equipment leaks which generate dust should be repaired.

6. Adequate water and salt intake should be encouraged.

VI. REFERENCES

1. American Conference of Governmental Industrial Hygienists (ACGIH): "Threshold Limit Value for Chemical Substances in Workroom Air," 1977.

2. Patty, F.: "Industrial Hygiene and Toxicology," Interscience Publishers, pp. 1067-1073, 1963.

3. Ramsey, T. A. et al: "Lithium Carbonate and Kidney Function," JAMA, Volume 219, Number 11, pp. 1446-1449, March 1972.

4. Cohen, W. J. and Cohen, N. H.: "Lithium Carbonate, Halperidol, and Irreversible Brain Damage," JAMA, Volume 230, Number 9, pp. 1283-1287, December 1974.

5. Weir, R. J. and Fisher, R. S.: "Toxicologic Studies on Borax and Boric Acid," Toxicology and Applied Pharmacology, Volume 23, pp. 351-364, 1972.

6. Gordon, A. S. et al: "Seizure Disorders and Anemia Associated with Chronic Borax Intoxication," C.M.A. Journal, Volume 108, pp. 719-722, March 1973.

VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:

Melvin T. Okawa
Industrial Hygienist
NIOSH, Region IX
San Francisco, California

Charles Wisseman, M.D.
Medical Officer
NIOSH
Cincinnati, Ohio

Originating Office:

Jerome P. Flesch, Chief
Hazard Evaluation and Technical
Assistance Branch
NIOSH
Cincinnati, Ohio

TABLE I. DUST CONCENTRATIONS IN THE LITHIUM CONCENTRATES, LITHIUM CARBONATE, AND THE PYROBOR AREAS OF THE KERR-MCGEE CHEMICAL CORPORATION PLANT BY JOB OPERATION FROM SAMPLES COLLECTED ON JUNE 21-22, 1977.

SAMPLE #	JOB OR OPERATION	DATE	SAMPLE TIME	SAMPLE VOLUME	WEIGHT	DUST CONC.	Li_2CO_3 CONC.
AG-1	Lithium Conc. Op.	6/21	407 min	610 liters	1.16 mg	1.90 mg/m^3	ND*
AG-10	Lithium Conc. Op.	6/22	412 min	700 liters	1.88 mg	2.69 mg/m^3	ND
AG-6	Lithium Carb. Op	6/22	415 min	706 liters	1.80 mg	2.55 mg/m^3	0.42 mg/m^3
AG-19	Lithium Carb. Packer	6/22	121 min	206 liters	0.87 mg	4.22 mg/m^3	0.90 mg/m^3
AG-20	Lithium Carb. Feeder	6/22	120 min	204 liters	2.61 mg	12.7 mg/m^3	4.40 mg/m^3
AG-7	Pyrobor Helper	6/21	407 min	610 liters	16.27 mg	27.1 mg/m^3	--
AG-9	Pyrobor Helper	6/21	411 min	616 liters	13.54 mg	21.9 mg/m^3	--
AG-4	Pyrobor Helper	6/21	399 min	598 liters	3.58 mg	5.99 mg/m^3	--
AG-12	Pyrobor Helper	6/22	378 min	643 liters	19.28 mg	29.9 mg/m^3	--
AG-17	Pyrobor Helper	6/22	362 min	615 liters	8.27 mg	13.4 mg/m^3	--
AG-8	Pyrobor Operator	6/21	397 min	596 liters	3.90 mg	6.54 mg/m^3	--
AG-5	Pyrobor Operator	6/21	396 min	594 liters	1.84 mg	3.10 mg/m^3	--
AG-2	Pyrobor Operator	6/22	376 min	639 liters	1.85 mg	2.90 mg/m^3	--
AG-3	Pyrobor Operator	6/22	375 min	638 liters	4.76 mg	7.46 mg/m^3	--

*ND - None detected; detection limit is 5.0 micrograms of lithium carbonate per sample.