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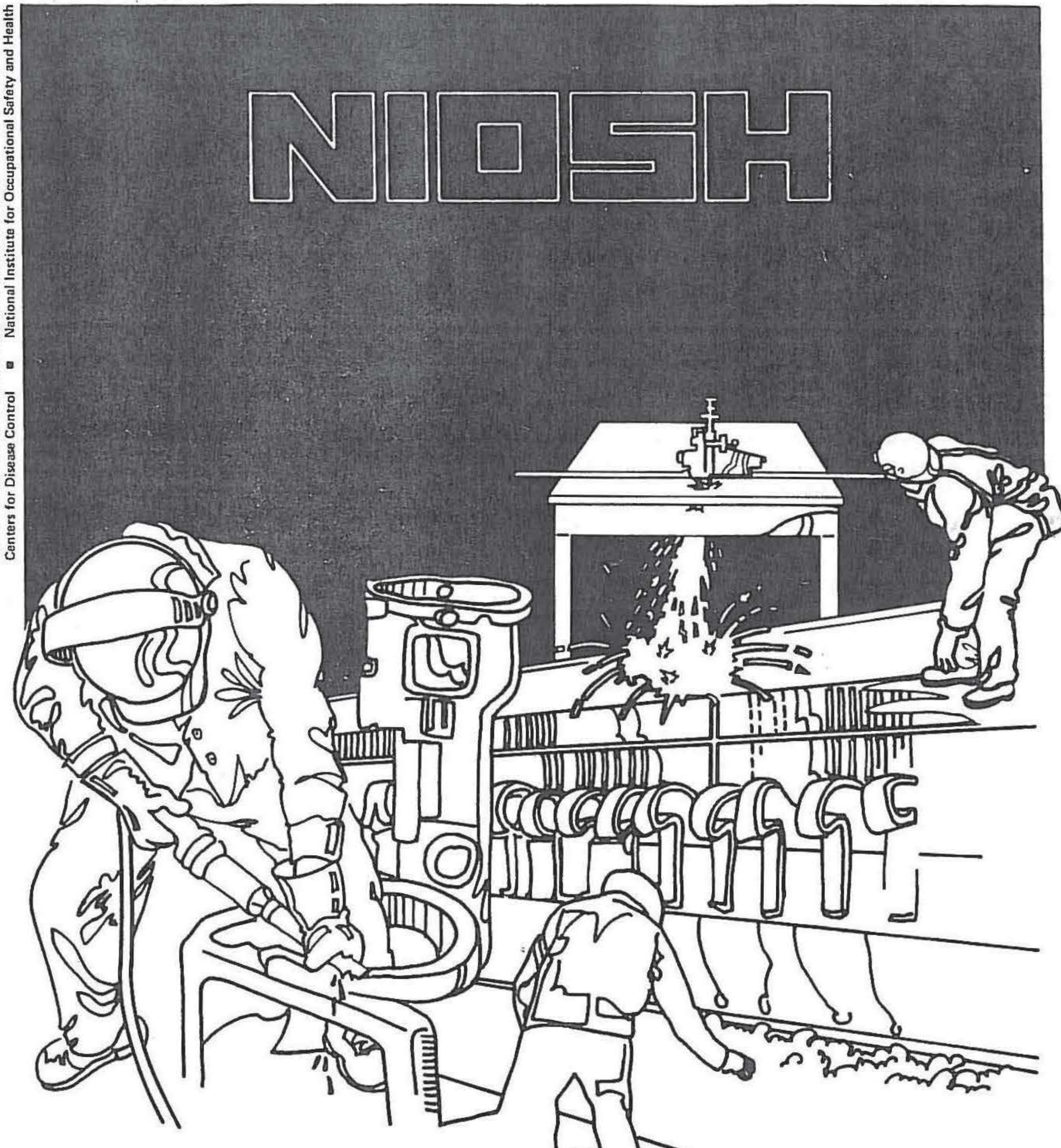

Health Hazard Evaluation Report

HHE 80-036-922
LITHIUM CORPORATION OF AMERICA
BESSEMER CITY, NORTH CAROLINA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from 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 Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HHE 80-036-922
JULY 1981
LITHIUM CORPORATION OF AMERICA
BESSEMER CITY, NORTH CAROLINA

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I. SUMMARY

On November 28, 1979, NIOSH received a Health Hazard Evaluation request from the Oil, Chemical, and Atomic Workers (OCAW) Union, Local 3-802, to investigate potential chemical exposures in production of lithium compounds at the Lithium Corporation of America (LithCOA), Bessemer City, North Carolina. LithCOA produces lithium compounds from spodumene ore (lithium aluminum silicate). NIOSH conducted an initial survey on February 4-7, 1980 and a follow-up medical and industrial hygiene investigation on August 25-27, 1980.

Personal and area samples were collected on pre-weighed filters for measurement of total and respirable dust with specific analysis for lithium content by atomic absorption. The pH of bulk dust samples was measured to determine alkalinity. Total and respirable dust samples taken in the ball mill building were analyzed for percent free silica by x-ray diffraction. The Butyl Lithium and Special Products R and D areas were sampled for n-hexane.

A medical questionnaire was administered to 21 exposed and 23 less exposed workers (workers with jobs outside the main plant) regarding symptoms or adverse health effects. Blood specimens were obtained from 21 exposed and 6 less exposed workers to determine blood lithium levels.

The total dust concentration in three of 28 personal samples exceeded 10 mg/M^3, the recommended exposure limit for nuisance dust. Two of these samples were taken in the lithium carbonate ($LiCO_3$) grinding room (19.3 and 42.3 mg/M^3) and one during $LiCO_3$ packing (18.9 mg/M^3). The highest lithium exposure (as lithium) was found in the carbonate grinding room (3.5 mg/M^3). The highest lithium hydroxide (LiOH) exposure measured was 171 micrograms (μg)/M^3 (as LiOH). The silica content of spodumene ore dust ranged from 1.3 to 2.3 percent for respirable dust and 3.8 to 6.3 percent for total dust. Exposure to respirable free silica was below 50 $\mu g/M^3$, the NIOSH recommended limit. All n-hexane exposures were below 50 ppm.

Lithium level in blood samples were below the limit of detection in all but two samples which were 2.1 and 1.0 mg/liter, a level below the level of recognized therapeutic effects (2.8 to 8.3 mg/liter). Results of questionnaires showed a higher prevalence of upper respiratory tract irritation in workers exposed to LiOH and $LiCO_3$.

Based on the data obtained during this study, NIOSH determined that certain bagging and packing operations resulted in excessive exposures to $LiCO_3$ dusts (as nuisance dust). However, considering the high alkalinity of lithium compound and lithium hydride and the higher prevalence of upper respiratory symptoms and skin irritation reported by exposed workers, the current standard for nuisance dust seems inappropriate for these lithium salts.

KEY WORDS: SIC 2819, lithium, silica, alkaline dusts, hexane, respiratory irritation, blood lithium levels

II. INTRODUCTION

On November 28, 1979, NIOSH received a request from the officers of Local 3-802 of the Oil, Chemical, and Atomic Workers Union (OCAW), for a health hazard evaluation at The Lithium Corporation of America (LithCOA), Bessemer City, North Carolina. The union had expressed concern about a number of potential workplace health hazards. The OCAW international union had also requested a medical evaluation of workers who had worked at LithCOA prior to the shut down of beryllium compound production in 1970.

NIOSH investigators conducted an initial survey at the plant on February 4-7, 1980. At that time it was noted that some locations, especially bagging and packing areas, were heavily contaminated with dust on the floor and surrounding work surfaces. There was considerable dust in the ball mill area. An interim report was submitted to management and union representatives on June 30, 1980. A follow-up medical and environmental investigation was completed August 25-27, 1980. The main purpose of this study was to evaluate current exposures to lithium compounds and to document any adverse health effects these exposures had on the current work force, particularly effects from exposure to alkaline lithium compounds.

III. BACKGROUND

LithCOA is the world's largest producer and marketer of lithium compounds. Since 1941 the company has extracted lithium metal and its salts from spodumene ore (lithium aluminum silicate) which is mined locally in North Carolina.

The ore is brought by trucks from the mine, dumped in a hopper, and conveyed to a storage silo. Ore from the silo is fed through a long rotary kiln in which it is heated to 2000°F. This "decrepitation" process makes the ore more susceptible to extraction, thereby increasing the yield. After cooling, the ore is ground in a ball mill and then a pug mill and passed under a spray of concentrated sulfuric acid (H_2SO_4). The ore is then roasted in a rotary kiln at 500° F and the lithium oxide (LiO) is converted to lithium sulfate ($LiSO_4$). $LiSO_4$ is then dissolved in water, neutralized, purified, filtered, and concentrated as a $LiSO_4/NaSO_4$ solution. Soda ash is added to precipitate the $LiCO_3$, and the $NaSO_4$ (glaubers salt) is dried and sold as a by-product. A portion of the $LiCO_3$ is treated with calcium hydroxide (CaOH) to form LiOH which is dried and packaged as the monohydrated crystal. The remainder is dried and packaged in drums as $LiCO_3$ powder.

LiOH and $LiCO_3$ are used as feed stocks for producing other lithium compounds. These are produced in various circuits in Production Area 2 (e.g. lithium chloride, lithium bromide, lithium hypochlorite, lithium fluoride) by batch type processes.

In the Metals Building, lithium metal is produced from a solution of lithium chloride and sodium chloride in eight electrolytic cells. The LiCl is converted to Li metal which floats to the surface of the liquid. Operators (Cell Dippers) ladle the molten metal periodically into a set of molds. Chlorine gas, a byproduct of the reaction, is locally exhausted from the interior of the cells and recovered by passing the gas through a packed tower scrubber. Lithium hydride is produced by reacting lithium metal with hydrogen gas in pressurized chambers. Organic lithium compounds, (e.g., butyl lithium) are produced in a small building adjacent to the main production plant.

Approximately sixty percent of the workers at the plant have direct contact with lithium dust in areas where the salts are extracted, processed and packaged. Young, recently employed workers are commonly assigned as "production helpers" or clean-up crews in dusty areas. The workers with the heaviest dust exposure are those who bag and pack lithium carbonate, hydroxide and chloride. Special products such as lithium amide and hydride are produced irregularly in batches. In the pelletizer area lithium carbonate is compressed into pellet form and there is potential for heavy dust exposure. Fork lift truck drivers carry goods between the bagging and warehouse areas and are probably less exposed than production helpers. During a given week, production helpers may be rotated through several jobs as the need arises and day to day levels of exposure may be variable. Also after a period, production helpers with seniority may be transferred to less dusty jobs.

Forty percent of the work force are employed in jobs not directly related to the production process and therefore have a lower exposure to lithium dust. These are outside maintenance workers, electricians, storeroom, and warehouse personnel. Workers in these "less-exposed" jobs were studied as a comparison group.

IV. EVALUATION DESIGN AND METHODS

A. Initial Survey (February 4-7, 1980)

Following an opening conference with management and union representatives, a walk-through survey was conducted and work practices and chemical processes were observed. Workers were interviewed and air samples were collected to characterize airborne contaminants in work areas.

1. Environmental Sampling

Air samples for qualitative analysis of airborne lithium compounds were collected, open face, on 25 mm diameter silver membrane filters and analyzed by x-ray diffraction. Samples were taken at the $LiCO_3$ and LiOH packaging operations, during lithium hydride knockout and crushing, and near the spodumene ore ball mill. Organic solvent vapors were sampled in the Butyl Lithium and Special Product R and D areas located in a small building adjacent to the main plant.

2. Personal Interviews

Seventeen production workers were interviewed and asked about symptoms associated with their work. These included: four operators of the chemical process producing lithium carbonate and chloride in tanks; two operators in the Metals Building whose duties involved "knocking out" and grinding hydride and amide, and grinding purified bicarbonate; five production helpers performing tasks such as packaging, cleanup, loading, repacking, and shipping; two operators in the special products area manufacturing inorganic and organic lithium salts; and three workers in the area outside the main plant near the ball mill area where ore is received, roasted, crushed, and treated with sulphuric acid. One maintenance electrician also was interviewed.

B. Follow-up Survey (August 25-27, 1980)

The follow-up study was designed to:

-- evaluate the effects of exposure to alkaline dust and document symptoms in relation to the levels of dust exposure and pH of the particles

-- determine blood levels of lithium in the workers and document any absorption

-- evaluate the health surveillance of LithCOA workers previously exposed to beryllium at the plant

-- determine percent respirable free silica in airborne spodumene ore dust in the ball mill area

-- evaluate hexane exposures in the Butyl Lithium and Special Products (organic) R and D areas

1. Medical Studies

Personal breathing zone air samples and blood specimens before and after a normal work shift were requested from 21 "exposed" workers. A questionnaire was administered to each inquiring about underlying symptoms and acute symptoms at work. (Two other exposed workers had only breathing zone air samples taken.) Twenty-three "less exposed" workers (outside maintenance men and waste recovery operators) were interviewed and six of these had personal breathing zone air samples and a single post shift blood specimen taken.

The union provided NIOSH with a list of names and addresses of 15 current employees who had worked at the plant during the period of beryllium production. Nine of these were interviewed or contacted by telephone and questioned about their previous exposure to beryllium, current health status and medical follow-up by their own personal physician.

Blood lithium levels were analyzed by atomic absorption spectrophotometry. The lower limit of detection of this method is 0.1 m equ/l, or 0.7 mg/liter.

2. Environmental Studies

Personal samples for airborne dust were collected on pre-weighed 5 micron (μ) pore size 37 mm diameter PVC filters mounted in 2-piece plastic cassettes attached to the workers' shirt collar. A measured air volume was pulled through the filters using battery powered air sampling pumps set at a calibrated flow rate of 1.7 liters per minute (lpm). These were obtained from workers during the majority of the work shift or for the duration of the job (in batch processes). General area air samples were collected at 2.5 lpm near packing operations and in the pelletizer area. Total particulates were determined gravimetrically. Lithium content analysis was by atomic absorption spectrophotometry using NIOSH method P and CAM No. 173. In addition, respirable dust samples (i.e. dust with particle sizes less than 10 μ in diameter) were obtained from at least one worker in each work area evaluated. Samples were collected by pulling air at 1.7 lpm through miniature cyclones designed to separate coarse dust from fine respirable dust. Bulk samples of dust were obtained for measurement of alkalinity with a pH meter.

Normal-hexane exposures to workers in the Butyl Lithium and the Special Products R and D (organic) area were measured by collecting vapors by adsorption on activated charcoal contained in small glass tubes, attached to the workers' shirt collar. A measured volume of air was drawn through the tubes using battery operated air sampling pumps set for a flow rate of approximately 150 cc/min. The tubes were analyzed for hexane by gas chromatography following a modification of NIOSH Method S-90.

High volume air samples for spodumene ore dust (one respirable and one total) were collected in the ball mill area (2nd floor) during three consecutive shifts. The samples were collected on pre-weighed PVC filters (37 mm diameter, 5μ pore size). Two filter cassettes were attached, in parallel to a motor driven pump and a constant air flow of 9 lpm was maintained using a critical orifice between the pump and each filter cassette. A small steel cyclone was used on one of the filters to collect only respirable dust. The filters were analyzed gravimetrically and by x-ray diffraction for percent free silica.

Personal exposure samples for total and respirable dust were also taken from a maintenance man working in the ball mill building. The samples were collected using battery operated equipment as described previously for collecting lithium dust samples. NIOSH Method P and CAM 259 was used to analyze the samples for free silica with the following modifications: (1) Filters were dissolved in tetrahydrofuran rather than ashed in a furnace. (2) Reference standards and samples were run concurrently and an external calibration curve was prepared from the integrated intensities rather than using the suggested normalization procedure.

Because workers expressed concern that the building used for the pelletizer process may still have some contamination with beryllium, air samples and swipe samples were collected on filter sampling media and analyzed for beryllium by atomic absorption spectrophotometry.

V. EVALUATION CRITERIA

A. Environmental Criteria

The environmental criteria described below are intended to represent airborne concentrations of substances to which workers may be exposed for eight hours a day, 40 hours per week for a working lifetime without adverse health effects. Because of wide variation in individual susceptibility, a small percentage of workers may experience discomfort from some substances at concentrations at or below the permissible limit.[1] The time-weighted average (TWA) exposure refers to the average concentration during a normal 8-hour workday. The Short-Term Exposure Limit is the maximum allowable concentration, or ceiling limit, to which workers can be exposed during a period of up to 15 minutes, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposure periods.

The primary sources of environmental evaluation criteria considered for this study were: 1) NIOSH criteria documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) Federal Occupational Health Standards. The criteria judged most appropriate for this study are as follows:

Substance	Short Term Exposure Limits (15 Min.)	8-Hour Time Weighted Average	Source
Lithium Carbonate	-	10 mg/M^3	ACGIH
	-	15 mg/M^3 (as nuisance dust)	OSHA
Lithium Hydride	-	25 μg/M^3	ACGIH
	-	25 μg/M^3	OSHA
Resp. Free Silica	-	50 μg/M^3	NIOSH
Resp. Quartz	-	10 mg/M^3 ÷ (% quartz + 2)	OSHA
Hexane (current)	125 ppm	100 ppm	ACGIH
Hexane (proposed)			
(n-hexane)		50 ppm	"
(other isomers)	1000 ppm	500 ppm	"
Hexane (n-hexane)		500 ppm	OSHA

NOTE: PPM = parts per million parts of air
mg/M^3 = milligrams per cubic meter of air
μg/M^3 = micrograms per cubic meter of air

At the present time there are no standards or recommended exposure limits for any of the lithium compounds except lithium hydride. The only guidelines available for evaluating exposure to lithium dust is the ACGIH TLV for nuisance particulates of 10 mg/M^3. The OSHA standard is 15 mg/M^3. This limit may not be appropriate for lithium compounds, especially for alkaline lithium compounds, such as $LiCO_3$ and LiOH.

B. Toxicity

The adverse health effects of overexposure to the substances measured are summarized below:

1. Alkaline Dusts

Caustic alkalies in solid or liquid form, are commonly more irritant to human tissues than most acids. Airborne caustic dusts, mists, and sprays may cause irritation of the eyes and respiratory tract, and erosion of the nasal septum. At high concentrations strong alkalies may gelatinize tissue forming soluble compounds resulting in deep and painful burns. Atmospheres slightly contaminated with alkaline dust or mist may be quite irritating when first encountered but the effects become less noticeable after a short period of exposure.[2]

2. Lithium Compounds

Lithium compounds are readily absorbed from the gastrointestinal tract (and probably from the lungs), and are uniformly distributed in body water. The largest percentage of absorbed lithium in the body is retained in the cells where it may compete with sodium at certain sites, e.g. the kidney.[3] Lithium is mostly eliminated in the urine. Reduced elimination of lithium may occur in individuals with salt (sodium chloride) depletion.

3. Lithium Carbonate

Lithium salts have been used therapeutically for over a hundred years in treatment of gout and as a salt substitute in low-sodium diets. In the last 20 years lithium has been valuable in the treatment of manic depressive psychosis. There is no evidence that small amounts of lithium may cause personality changes in normal persons. 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. The exact dose that is effective varies considerably among individuals. Therapeutic levels of lithium in the blood stream may affect the concentrating power of the kidneys.[4] Signs of lithium overdose include weight loss, poor appetite, generalized weakness, nausea, vomiting, diarrhea, shaking, incoordination, seizures, and unconsciousness. Symptoms are generally reversible if the lithium is excreted and the blood levels reduced. The dust is highly alkaline, however, and moderate exposure to airborne dusts of $LiCO_3$ (pH 11.2) may result in some upper respiratory irritation for certain individuals.

4. Lithium Hydroxide

The effects of lithium hydroxide have been observed from exposures to lithium hydride. Lithium hydride may cause severe chemical burns and is irritating to the upper respiratory tract and eyes. Lithium hydride reacts with water on these moist tissues to form hydrogen and lithium hydroxide.[5] The irritant actions of lithium hydride are attributed to the alkalinity of the hydrolysis product, lithium hydroxide. A level of 25 $\mu g/M^3$ of lithium hydride is suggested as a tolerable atmospheric level to prevent the intense nasal irritation, and sneezing. This concentration is 0.069 - 0.171 mg/M^3 as lithium hydroxide. Currently there is no OSHA standard or TLV specific for LiOH. However, 25 µg of lithium hydride when hydrolyzed will be converted to 75 µg of lithium hydroxide.

$$\text{LiH(mol. wt. = 8)} + H_2O \text{ (mol. wt. = 18)} \rightarrow$$
$$\text{LiOH(mol. wt. = 24)} + H_2 \text{ (Mol. wt. = 2)}$$

$$\frac{8}{24} = \frac{25 \text{ LiH}}{75 \text{ LiOH}}$$

Using this analogy, it would appear that an appropriate exposure limit for LiOH might be 75 $\mu g/M^3$ as LiOH or 22 $\mu g/M^3$ as lithium. After repeated exposure however, a certain degree of tolerance may be acquired.[6]

5. Crystalline Silica

The crystalline forms of silica can cause severe tissue damage when inhaled. Silicosis is a form of pulmonary fibrosis caused by the deposition of fine particles of crystalline silica in the lungs. Symptoms usually develop insidiously, with cough, shortness of breath, chest pain, weakness, and wheezing. Silicosis usually occurs after several years of exposure, but may appear in a shorter time if exposure concentrations are very high. This latter form is referred to as rapidly-developing silicosis, and its etiology and pathology are not well understood. Silicosis is usually diagnosed through chest x-rays, occupational exposure history, and pulmonary function tests. There is evidence that cristobalite and tridymite, which have a different crystalline form from that of quartz, have a greater capacity to produce silicosis.[7]

6. Hexane

Normal hexane is a mild upper respiratory irritant and causes central nervous system depression. In industry, mild symptoms of narcosis, such as dizziness, have been observed when concentrations exceed 1000 ppm but not when less than 500 ppm. Until recently, chronic health effects from exposure to hexane and similar hydrocarbons have rarely been reported. However, in 1967 17 cases of polyneuritis were reported among workers exposed to n-hexane at concentrations between 500 - 1000 ppm. Subsequent animal studies demonstrated functional disturbances of the peripheral nerves of mice at 250 ppm but not at 100 ppm.[6] Other studies reported n-hexane neuropathy among furniture workers and among workers exposed to n-hexane used as a solvent in plastic cements. It is postulated that 2,5-hexanedione, a metabolite of n-hexane, is the neurotoxic agent.[8]

VI. EVALUATION RESULTS AND DISCUSSION

A. Environmental

1. Lithium Compounds

Twenty-three exposed and six less exposed workers had personal breathing zone dust samples taken. Four of the workers studied carried out more than one task during the shift, and sampling periods for these and other jobs in batch processes were necessarily brief (e.g., grinding and bagging pharmaceutical grade carbonate [R and D] and lithium amide bagging [15 minutes]). Table 1 gives the results of this sampling including levels of total respirable and non-respirable dust, lithium content of the dust, pH of dust and duration of sampling.

The heaviest continuous dust exposures were to workers bagging lithium hydroxide (pH 12.62) and grinding and packing lithium carbonate (pH 11.24) and will be considered in more detail here. Sodium sulfate and lithium chloride are less alkaline (pH 6.24 and 6.7, respectively). Lithium amide is highly alkaline (pH 12.46), but the exposure studied was brief.

Table 2 gives the results of area dust sampling in bagging and packing areas. Area levels ranged from 0.31-14.7 mg/M^3. The lithium content of these dusts ranged from 0.01-1.31 mg/M^3 (mean 0.17). The highest dust levels of total dust were measured during the carbonate grinding and bagging operations (14.7 and 5.34 mg/M^3, respectively).

Total dust exposures in the personal breathing zone samples reflected the high area levels. The highest exposures were to workers in the lithium carbonate bagging area (18.9 mg/M^3) and the lithium carbonate grinding room (19.3 and 42.3 mg/M^3). Levels in these areas exceeded the TLV recommended by ACGIH of 10 mg/M^3 for nuisance dust and also exceeded the OSHA standard of 15 mg/M^3. The total and respirable dust concentrations in samples obtained from the 6 less-exposed workers were lower than the exposed workers and ranged from 0.19 to 6.56 mg/M3 total dust and 0.67 to 0.8 mg/M^3 for respirable dust.

Personal breathing zone exposures to total dust in the lithium hydroxide bagging area ranged from 0.64 - 2.46 mg/M^3. The lithium content of this dust ranged from 0.02 - 0.05 mg/M^3.

2. Hexane

Table 3 shows the results of 9 personal samples collected for n-hexane in the Butyl Lithium and Special Products R and D (organic) area. All sample results were below the evaluation criteria of 100 ppm. The highest concentration detected was 27.6 ppm for a DMBC operator. However, because breakthough may have occurred with this sample, the actual concentration could not be determined accurately.

3. Silica

The amount of free silica detected in airborne spodumene ore dust is presented in Table 4. The quartz content ranged from 3.8 to 6.3 percent in the total dust and from 1.3 to 2.3 percent (avg. 1.7) in the respirable dust. The maintenance man sampled was exposed to a time-weighted average respirable dust concentration of 1.5 mg/M^3 (spodumene dust), containing approximately 1.7 percent quartz (based on high-vol. area samples). No respirable free silica was detectable in the personal respirable dust sample, because of the lower volume of air sampled.

4. Beryllium

No beryllium was detected on the filters used for air and swipe sampling in the pelletizer building. The limit of detection was 0.2 micrograms of beryllium per filter.

B. Medical

Thirty-five blood specimens were obtained from 21 exposed workers. Seventeen gave blood pre and post shift; one gave a single post shift specimen. No specimens were obtained from three exposed workers studied. Single post shift specimens were obtained from 6 less exposed workers. Blood lithium levels were below the limit of detection (i.e., less than 0.1 m equ/liter or 0.7 mg/liter) in all but two of the specimens. The two specimens with detectable levels were pre-shift specimens obtained from a production helper (hydroxide bagging) and a pelletizer operator and were 0.3 and 0.14 m equ/liter (2.1 and 1.0 mg/liter) respectively . These levels were less than the level of recognized therapeutic effects (2.8 - 8.3 mg/liter).[9] and no increase was measurable over the shift. Normal plasma lithium level is approximately 0.017 mg/liter.[3]

Table 5 gives the frequency of reported symptoms among the 21 exposed and 23 less exposed workers. The 21 exposed workers who were studied were predominately production helpers. They were younger than the comparison group (30.9 yrs vs. 39.0 yrs) and had worked for fewer years at the plant (4.8 yrs vs. 8.6 yrs). A higher percentage of the exposed group were smokers (57.1 percent vs. 39.1 percent) but they had a lower frequency of chest problems as shown by cough and sputum production during the day or at night. Complaints of sinus problems, runny nose, nose bleeds, dry throat, headache and skin irritation were all more frequent among the exposed group. The irritant symptoms (especially sinus problems and runny nose) were most troublesome for those involved in hydroxide and carbonate bagging.

Workers at this plant are intermittently exposed to high concentrations of alkaline lithium salts. The most common health effects of exposure are intermittent upper respiratory symptoms. Lower respiratory tract symptoms such as shortness of breath, chest pain, wheezing, and cough were not commonly reported.

The alkaline lithium salts are highly soluble and probably dissolve readily on contact with the mucous membrane of the upper respiratory tract producing runny nose and irritation. None of the workers had elevated blood lithium levels that would indicate significant absorption from the skin, lungs, or gastro-intestinal tract.

The workers interviewed who had been exposed to beryllium 10 or more years previously had no significant respiratory complaints. All had chest x-rays free of abnormalities during the past two years. All had apparently observed good work practices during their exposure and had regular health examinations with chest x-rays at the time. The workers at the plant now have regular chest x-ray examinations under the dusty trades health surveillance program of the state of North Carolina and those interviewed seemed well informed about the potential hazards of beryllium exposure. It is very unlikely that new symptoms attributable to beryllium exposure will occur in the work force, now more than 10 years after the last exposure.

VII. RECOMMENDATIONS

1. Dust exposures of carbonate baggers should be reduced by increasing the efficiency of the existing local exhaust systems. Improved hood design, increased duct velocity or better enclosures around bags being filled would increase capture velocity of the existing system. Eye protection, gloves, and long sleeve clothing should be worn to prevent direct skin and eye contact with alkaline $LiCO_3$ dust.

2. During the survey, several workers complained of painful skin burns and irritation from exposure to lithium hydroxide at the bagging operation. Enclosing the bagging area to contain the cold air used to keep workers' skin dry and resistant to LiOH burns would reduce the potential for irritation caused by LiOH reactivity on moist skin. Face protection, gloves, and long sleeve clothing should be worn by LiOH packers to prevent direct skin contact.

3. The exhaust system in the grinding room used for grinding and packaging lithium carbonate, lithium nitrate, or lithium glycolate did not have a proper exhaust hood for capturing dust discharged into the drum. The system should be re-designed to properly control dust exposures inside the grinding room.

4. Most of the ore dust released in the ball mill area appeared to be coming from leaks in the bucket elevator and from flanges on the ore transport ducts. These systems should be repaired and sealed to prevent dust leaks. Although there does not appear to be a significant risk of exposure to respirable free silica, all personnel working in the ball mill building outside of the control room should wear NIOSH approved dust masks to prevent discomfort from exposure to airborne spodumene dust.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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IX. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati, Ohio address.

Copies of this report have been sent to:

The Lithium Corportation of America
Authorized Representatives of Employees:
Oil, Chemical and Atomic Workers, Local 3-802
Oil, Chemical and Atomic Workers, International
U.S. Department of Labor, Region IV
NIOSH Region IV
Designated State Agencies

For the purpose of informing the approximately 288 "affected employees", the employer will promptly "post" this report for a period of thirty (30) calendar days in prominent places near where the affected employees work.

X. REFERENCES

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TABLE 1
PERSONAL BREATHING ZONE DUST CONCENTRATIONS (TOTAL AND RESPIRABLE DUST)
LITHIUM CORP. OF AMERICA
BESSEMER CITY, NORTH CAROLINA
HE 80-36

August 25-27, 1980

Job Category		Sampling Time (hours)	Total Dust Total (mg/M3)	Total Dust Li (mg/M3)	Respirable Dust Total (mg/M3)	Respirable Dust Li (mg/M3)	Dust pH
Li Hydroxide Bagging							
		5.5	2.46	0.05			12.62
	*	4.5	2.04	0.05	0.61	0.01	
	*	5.0	0.64	0.02	0.12	0.001	
	*	7.0	0.77	0.02			
Li Carbonate Bagging							
		5.75	8.26	0.71			11.24
	*	7.0	6.29	0.59	0.24	0.02	
	*	2.5	18.9	1.84			
	*	5.0	5.87	0.54	0.11	0.01	
Special Products R & D							
	**	5.0	ND	ND	0.09	0.002	11.24
	**	5.0	2.40	0.17			
Li Carbonate Grinding							
	**	1.0	19.3	1.08			
	**	1.0	42.3	3.53	0.77	0.05	
Purified Li Carbonate (repacking)							
		4.25	2.18	0.13	0.27	0.01	11.24
		4.0	1.86	0.11			
Sodium Sulfate Bagging							
		5.25	3.59	0.08			6.24
		5.0	3.57	0.04	0.35	0.01	
		5.0	4.33	0.05			
Pelletizer Area							
		6.0	0.84	0.05			
		6.0	4.32	0.17	0.34	0.01	
		6.0	3.27	0.14			
		6.0	0.18	0.10			
Fork Lift Operator							
		7.0	0.88	0.04			
Amide Packing							
		8.0	0.67	0.04	0.15	0.004	12.46
		1.0	0.25	ND			
Li Chloride Bagging							
		6.0	0.29	0.01			6.7
		6.0	1.00	0.03			
		6.0	1.27	0.002	0.48	0.002	

* sampled in LiOH and $LiCO_3$ bagging
** sampled in special Products R & D and $LiCO_3$ grinding

TABLE 1 (Continued)
HE 80-36

August 25-27, 1980

Job Category	Sampling Time (hours)	Total Dust Total	Total Dust Li	Respirable Dust Total	Respirable Dust Li	Dust pH
		(mg/M3)		(mg/M3)		
Less Exposed Workers--						
Outside Maintenance	6.25	2.01	0.01			
" "	6.0	3.96	0.05	0.67	0.01	
" "	6.0	6.56	0.07	0.8	0.01	
Welder, New Fab. Shop	6.0	3.27	ND			
Maint. Man, Fab. Shop	5.5	1.48	0.002			
Waste Recovery	6.0	0.19	ND			
Limit of Detection as mg/sample		0.01	0.001			

Evaluation Criteria:
ACGIH TLV for nuisance dust = 10.0 mg/M3 (as total dust)
" " " " " = 5.0 mg/M3 (as respirable dust)

TABLE 2
AREA DUST CONCENTRATIONS (mg/M3) BY WORK AREA
LITHIUM CORPORATION OF AMERICA
BESSEMER CITY, NORTH CAROLINA
HE 80-36

August 25-27, 1980

Work Area	Hours of Sampling	Total Dust	Lithium Dust	pH of Dust
Li hydroxide bagging	4.5	2.35	0.07	12.62
	5.0	0.93	0.02	
Li carbonate bagging	7.0	5.34	0.51	11.46
	2.5	4.88	0.46	
Li carbonate grinding	<1.0	14.7	1.31	
Purified carbonate repacking	4.25	1.09	0.06	
Special products (RaD)	5.0	0.31	0.01	
Pelletizer area (carbonate)	6.0	0.18	0.10	
Amide Packing	8.0	1.89	0.16	12.46
	<1.0	1.10	0.09	

Evaluation Criteria:
ACGIH TLV for nusiance dust = 10 mg/M3 (as total dust)
" " " " " = 5 mg/M3 (as respirable dust)

TABLE 3

PERSONAL BREATHING ZONE
N-HEXANE CONCENTRATIONS

LITHIUM CORP. OF AMERICA
BESSEMER CITY, NORTH CAROLINA
HE 80-36

August 25-27, 1980

Job/Location	Sample Time (hours)	Sample Volume (liters)	Concentration (ppm)
Butyl Lithium Operators			
Working outside	5.8	5.3	4.1
" "	5.6	50.3	1.2
" "	5.6	49.0	2.4
" inside	5.8	47.6	2.0
" "	5.7	49.3	1.4
Lead Operator (inside)	5.7	49.6	0.8
Special Products R and D, Organic			
DMBC Operator	5.4	46.5	0.4
" "	5.3	50.4	27.6*
Dibutyl Mag. Opr.	4.9	45.5	0.7

Evaluation Criteria:	
NIOSH recommended exposure limit	100 ppm
ACGIH TLV	100 ppm
ACGIH TLV (proposed)	50 ppm

Limit of Detection = 0.001 mg hexane per sample

* Charcoal tube saturated - greater than 1/3 of total amount found was on the charcoal tube backup section - value reported may not be accurate.

TABLE 4
BALL MILL AREA
AIRBORNE SILICA CONCENTRATIONS IN SPODUMENE ORE DUST
LITHIUM CORP. OF AMERICA
BESSEMER CITY, NORTH CAROLINA
HE 80-36
August 25-27, 1980

Sampling Period/Type Sample (min.)	Sample Volume (liters)	Total Dust (mg/M^3)	Silica ($\mu g/M^3$)	% Quartz	OSHA Standard (mg/M^3)	Job/Location
August 26						2nd floor level
10:11am-3:46pm/area	3015	12.6		4.5	4.0	total dust
" " "	3015	2.1	ND	<1.5	>2.9	respirable dust
August 26						2nd floor level
3:49pm-10:06pm/area	3393	32.0		3.8	4.4	total dust
" " "	3393	5.6	129	2.3	2.3	respirable dust
August 27						2nd floor level
7:15am-3:10pm/area	4194	11.4		6.3	3.2	total dust
" " "	4194	1.3	17	1.3	3.0	respirable dust
August 27						Outside maint. man working in ball mill
9:33am-2:46pm/personal	517	4.0		3.9	4.3	total dust
" " "	515	1.5	ND	<3.9	>1.7	respirable dust

Evaluation Criteria:

NIOSH Recommended — 50 $\mu g/M^3$ as an 8-hour time weighted average (TWA)

OSHA Standard (8-hour TWA)

$$\frac{30\ mg/M^3}{\%\ quartz + 3}$$ (total dust)

$$\frac{10\ mg/M^3}{\%\ respirable\ quartz + 2}$$ (respirable dust)

Limits of Detection:

0.01 mg/sample total dust
0.03 mg/sample quartz

mg/M^3 = milligrams of substance per cubic meter of air
$\mu g/M^3$ = micrograms of substance per cubic meter of air

TABLE 5

FREQUENCY OF SYMPTOMS AMONG WORKERS EXPOSED AND LESS EXPOSED TO ALKALINE DUST
LITHIUM CORP. OF AMERICA
BESSEMER CITY, NORTH CAROLINA
HE 80-36

August 25-27, 1980

	Exposed (21 workers)		Less Exposed (23 workers)	
	No.	% with Symptoms	No.	% with symptoms
Lower Respiratory				
Morning cough	1	4.7	4	17.3
Cough day or night	6	28.6	6	26.1
Phlegm in morning	2	9.5	8	34.7
Phlegm day or night	3	14.3	6	23.0
Short of breath (on hill)	4	19.0	1	4.3
Short of breath (on flat)	1	4.7	0	0
Upper Respiratory				
Sinus problems	9	42.8	9	39.1
Runny Nose	8	38.0	4	17.3
Nose Bleeds	3	14.2	0	---
Dry throat	11	52.3	1	4.3
Other				
Eye	4	19.0	9	39.1
Headache	8	38.0	2	8.7
Skin	8	38.0	3	13.0
Allergy Problems	5	23.8	4	17.3
Smokers	12	57.1	9	39.1
Mean age	30.9 yrs.		39.0 yrs.	
Range	19 - 54		18 - 64	
Duration of Employment	4.8 yrs. (mean) 1 - 13 (range)		8.6 yrs. (mean) 1 - 26 (range)	