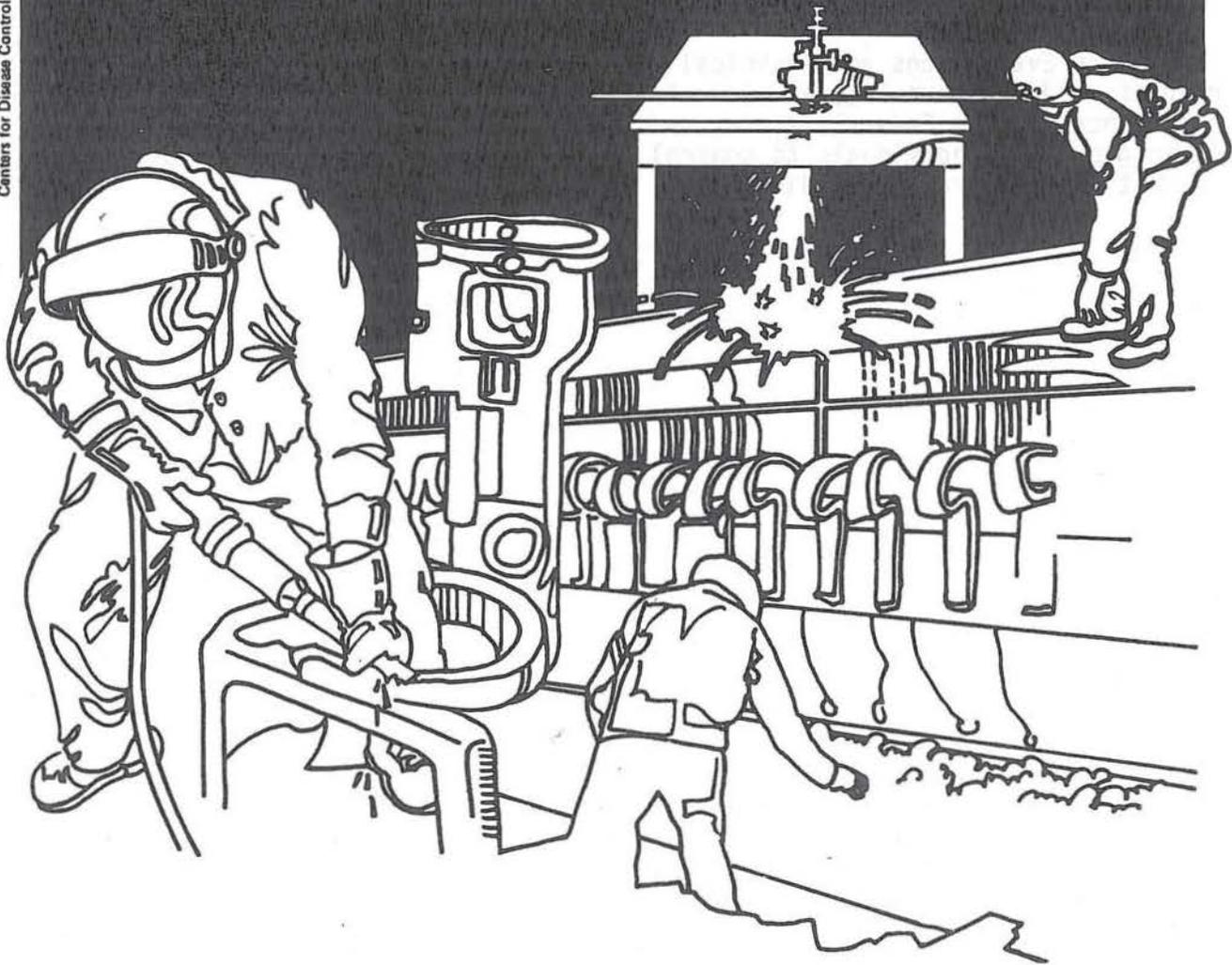


NIOSH



Health Hazard Evaluation Report

HETA 81-221-1133
KWIK KOLD KAY
LABORATORIES
MOBERLEY, MISSOURI

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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 81-221-1133
JUNE 1982
KWIK KOLD, KAY LABORATORIES
MOBERLEY, MISSOURI

NIOSH INVESTIGATORS:
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I. SUMMARY

On March 9, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a confidential request for a Health Hazard Evaluation concerning respiratory and skin symptoms reported by persons manufacturing hot and cold packs at Kwik Kold, Kay Laboratories, Moberley, Missouri. On April 15-16 and May 1, 1981, NIOSH conducted industrial hygiene and medical survey to determine health effects and airborne concentrations of dusts containing ammonium nitrate and calcium chloride, nitric oxide, nitrogen dioxide, nitrous oxide, and carbon monoxide.

The surveys demonstrated the 8-hour time-weighted average (TWA) exposures for respirable particulate concentrations ranged between 0.10 to 0.45 milligrams per cubic meter of air (mg/m^3) 8-hour TWA. The total particulate concentrations ranged from 0.2 to $4.84 \text{ mg}/\text{m}^3$ 8-hour TWA. By comparison, the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for respirable particulates is $5.0 \text{ mg}/\text{m}^3$ and that for total particulates is $10 \text{ mg}/\text{m}^3$. The Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for total particulates is $15 \text{ mg}/\text{m}^3$. Thirteen ammonium nitrate concentrations ranged from 0.24 to $0.69 \text{ mg}/\text{m}^3$. Two calcium chloride concentrations were $0.77 \text{ mg}/\text{m}^3$. There are currently no available criteria for evaluating airborne exposure concentrations of ammonium nitrate and calcium chloride. Twenty-two nitric oxide concentrations ranged from less than detectable to $2.5 \text{ mg}/\text{m}^3$ 8-hour TWA; the NIOSH recommended exposure limit is $30 \text{ mg}/\text{m}^3$ 8-hour TWA. Twenty-two nitrogen dioxide concentrations ranged from less than detectable limit ($<1 \text{ ug}/\text{sample}$) to $3.7 \text{ mg}/\text{m}^3$. The highest measured concentration ($3.7 \text{ mg}/\text{m}^3$) exceeds the NIOSH recommended exposure limit for nitrogen dioxide of $1.8 \text{ mg}/\text{m}^3$ 15-minute ceiling; all other were $<0.3 \text{ mg}/\text{m}^3$. Short- and long-term detector tubes for carbon monoxide ranged from $6 \text{ mg}/\text{m}^3$ to $29 \text{ mg}/\text{m}^3$. The NIOSH recommended standard for carbon monoxide is $40 \text{ mg}/\text{m}^3$ 8-hour TWA and $229 \text{ mg}/\text{m}^3$ expressed as a ceiling concentration. The OSHA standard is $55 \text{ mg}/\text{m}^3$.

Symptoms questionnaires were administered to 34 of 37 production line personnel and 11 of 34 non-line production workers. Personnel working on production lines involving ammonium nitrate were more likely than non-line production personnel to report at least one acute symptom (57% versus 18%) and, in particular, had a higher prevalence of skin symptoms (30% versus 0%). The apparent higher prevalences of mucous membrane irritation (29% versus 18%) and respiratory symptoms (29% versus 0%) among production line personnel were not statistically significant. There were too few workers on the calcium chloride line to draw any statistically meaningful conclusions concerning symptom prevalence. There were no significant differences in the prevalence of central nervous system symptoms between ammonium nitrate-involved production line workers and non-line production workers (22% versus 18%) or between all production line and non-line production workers (21% versus 18%).

Based on the environmental sample results, employee interviews, and available toxicological information, NIOSH concludes that while a health hazard of systemic toxicity did not exist at the time of these surveys, it appears that exposure to ammonia nitrate may cause skin and possibly mucous membrane irritation. Recommendations to aid in providing a safe and healthful working environment are presented in Section VIII of this report.

KEYWORDS: SIC 3842 (Orthopedic, Prosthetic, and Surgical Appliances and Supplies), total and respirable dusts, ammonium nitrate, calcium chloride, nitric oxide, nitrogen dioxide, nitrous oxide, and carbon monoxide.

II. INTRODUCTION

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Preliminary findings of the evaluations were reported in a letter on April 27, 1982, to the confidential requestor and management.

III. BACKGROUND

The Kwik Kold Plant at Moberley, Missouri, opened in October 1978 and has manufactured hot and cold packs since that time. These products are manufactured in an area consisting of six lines. Each line is operated by seven to eight workers. A weighed amount of binasol (an amylose starch), ammonium nitrate, and calcium chloride are added into a plastic pouch containing a liquid bubble. The pouch is sealed with a hot wire and then packaged for shipping. The plant operates one shift (7:30 a.m. to 4:00 p.m.) per day, five days per week, employing approximately 70 employees. There are six line supervisors, 15 machine and other operators, 31 line workers, and 19 non-production workers, which include quality control, supervisors, maintenance, clerks, secretarial, and janitorial personnel.

Review of OSHA 200 forms for the last 5 years revealed a total of 40 injuries, mostly trauma related, i.e. bruises, pulled muscles, scrapes, but no illnesses. There is no health care professional onsite, though three employees are Red Cross-certified first aid personnel. There are no pre-employment or annual physical examinations.

A. April 15-16, 1981, Survey

On April 15, 1981, two NIOSH industrial hygienists, a medical officer, and a medical technician visited the plant. An opening conference was held, at which company officials and an employee representative participated, and a walk-through inspection of the hot and cold pack manufacturing areas was conducted. Photographs of the processes were taken and bulk samples of binasol, ammonium nitrate, and calcium chloride were obtained.

At this time, Line 2 ran binasol plus ammonium nitrate; Lines 3 and 4 ran ammonium nitrate only; and Line 5 ran calcium chloride. Lines 1 and 6 were not operating. Twenty-five personal breathing zone samples were collected for total and respirable particulates, ammonium nitrate, and calcium chloride on Lines 2, 3, 4, and 5, the maintenance supervisor and utility operator. The filter samples,

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which had a weight gain of one milligram or greater were analyzed for ammonium nitrate and calcium chloride. Short-term length of stain colorimetric detector tubes were used to measure carbon monoxide (CO), nitric oxide (NO), and nitrogen dioxide (NO₂) in the production area. A questionnaire directed at acute symptoms was administered to 48 production line and non-production line employees.

B. May 1, 1981, Survey

NIOSH conducted an environmental follow-up survey on May 1, 1981. Airborne personal breathing zone samples were collected for nitric oxide and nitrogen dioxide. Area samples were collected for total and respirable particulate. Long- and short-term area samples were obtained for carbon monoxide on the new fork truck and the sealer machine on Line 2.

IV. METHODS

Personal and area air samples for total and respirable particulate were collected on preweighed M-5 PVC filters using MSA Model G personal sampling pumps operating at 1.7 liters per minute (LPM). Filters were set in 10 mm nylon cyclone separators to obtain respirable particulate samples. The amount of particulate was determined by weight gain on the filter.

Personal and area air samples for ammonium nitrate were collected on preweighed M-5 PVC filters using MSA Model G personal sampling pumps operating at 1.7 LPM. The filter samples, which had a weight gain of one milligram or greater, were analyzed for nitrate using the "Brucine Method".¹ The results were converted to ammonium nitrate.

Personal air samples for calcium chloride were collected on preweighed M-5 PVC filters using MSA Model G personal sampling pumps operating at 1.7 LPM. The samples were analyzed for calcium according to NIOSH P&CAM Method No. 173.² The results were converted from calcium to calcium chloride by multiplying the weight of calcium by a gravimetric conversion factor of 2.77.

Personal breathing zone air samples for nitric oxide and nitrogen dioxide were collected via a special SKC sorbent tubes using a vacuum pump operating at 0.02 LPM and analyzed according to NIOSH Method No. P&CAM 231.² A correction factor of 0.63 was used in the analysis to determine the amount of nitric oxide and nitrogen dioxide in the sorbent sections as described in the method.

Long- and short-term area air samples were obtained on the new fork lift truck and the sealer machine on Line 2. These air samples were analyzed for nitrous oxide using a Miran 103 infrared gas analyzer.

Short-term length of stain colorimetric detector tubes were used to measure nitric oxide and nitrogen dioxide. A discoloration of the sorbent in the tube indicates the presence of nitric oxide and nitrogen dioxide. These tubes are not specific for nitric oxide and nitrogen dioxide but a combination of the two.

Sampling for carbon monoxide was conducted using long-term length of stain colorimetric detector tubes. A discoloration of the sorbent in the tube indicates the presence of carbon monoxide and the length of stain corresponds to the concentration.

A questionnaire directed at acute symptoms was administered to all available production line personnel and a sample of non-line production workers.

V. EVALUATION CRITERIA

No work place exposure limit(s) for ammonium nitrate and calcium chloride have been promulgated, recommended, or proposed by NIOSH, the Occupational Safety and Health Administration (OSHA), the American Conference of Governmental Industrial Hygienists (ACGIH), or any other such group. A literature search failed to produce any documentation of health effects as a result of occupational exposures to either substance. The criteria for the other contaminants evaluated are listed in the respective tables of results (Tables I-III).

Occupational health standards and criteria for substances are usually established at levels designed to protect workers occupationally exposed for an 8-hour-per-day, 40-per-week basis over a working lifetime. NIOSH criteria are for up to a 10-hour workday, 40-hour workweek over a working lifetime. Because of a wide variation in individual susceptibility, some workers may experience ill effects at or below the designated levels. Thus, an evaluation of the work place cannot be based entirely upon comparisons made against such NIOSH criteria, ACGIH TLV, and OSHA standards, as various TLV's and standards do not represent absolute protection of all workers. Setting legal standards and enforcement is a responsibility of the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA).

VI. RESULTS

A. Environmental

1. April 15-16, 1981, Survey

Table I presents the results of the respirable and total particulate concentrations obtained in the breathing zones of the operators on Lines 2, 3, 4, and 5. Included also are the same exposure measurements for the maintenance supervisor and utility operator. The respirable particulate concentrations

ranged between 0.26 to 0.45 mg/m³. The total particulate concentrations ranged from 1.40 to 4.84 mg/m³. By comparison, the ACGIH Threshold Limit Value for respirable particulates is 5.0 mg/m³ and that for total particulates is 10 mg/m³.

Table I also presents the air concentrations of ammonium nitrate and calcium chloride particulates. Ammonium nitrate concentrations were measured in the breathing zone of the operators on Line 2 (range 0.24 to 0.57 mg/m³), Line 3 (0.25 to 0.45 mg/m³), and Line 4 (range 0.52 to 0.69 mg/m³). Calcium chloride concentrations were measured in the breathing zone of the operators on Line 5 (both samples were 0.77 mg/m³).

Seven short-term detector tube samples for nitric oxide and nitrogen dioxide were collected on Lines 2, 3, 4, and 5. The measured air concentrations were all less than 1 mg/m³ reported as total oxides of nitrogen. The source for nitric oxide and nitrogen dioxide was not determined.

Several short-term detector tube samples were collected for carbon monoxide on the production lines and aiseways near the fork trucks. The results ranged from 6 mg/m³ to 29 mg/m³ with an average of 11 mg/m³. The NIOSH recommended standard for carbon monoxide is 40 mg/m³ 8-hour TWA and 229 mg/m³ expressed as a ceiling concentration.

2. May 1, 1981

Table II presents the general area concentrations of respirable and total particulates and ammonium nitrate concentrations measured at the hypo bubble machinery, hypo packing sealers, and between the sealers on Line 2. The respirable particulate concentrations range from 0.1 to 0.3 mg/m³ and the total particulate concentrations ranged from 0.2 to 1.8 mg/m³. The 1.8 mg/m³ total particulate concentration was measured between the sealer on Line 2. This sample contained an ammonium nitrate concentration of 0.3 mg/m³. By comparison, the exposure concentrations were significantly below the 5 mg/m³ respirable particulate and 10 mg/m³ total particulate ACGIH TLV's.

Table III presents the results of 22 samples collected in the breathing zones of the shuttle, stuffer, sealer, bubble, and fork truck operators for nitric oxide and nitrogen dioxide. Nitric oxide was detected in 17 of the 22 samples at a concentration ranging from 0.4 to 2.5 mg/m³. The NIOSH recommended exposure limit is 30 mg/m³ 8-hour TWA. Nitrogen dioxide was detected in 9 of the 22 samples at a concentration

ranging from less than the detectable limit (<1 ug/sample) to 3.7 mg/m³. The highest measured concentration (3.7 mg/m³) exceeds the NIOSH recommended exposure limit for nitrogen dioxide of 1.8 mg/m³, 15-minute ceiling. No explanation is apparent as to why this sample showed a concentration that was significantly greater than the others (range 0.1 to 0.3 mg/m³). However, it does indicate a potential for increased exposure to nitrogen dioxide.

Short- and long-term detector tube samples for carbon monoxide were obtained on the production lines and aisleways near the fork trucks. The short-term samples showed concentrations ranging from 6 to 29 mg/m³. The long-term samples showed an 8-hour time-weighted average concentration of 19 mg/m³, which is below the NIOSH recommended exposure limit of 40 mg/m³ 8-hour TWA.

Short-term detector tube samples were also obtained in the same area to determine possible sources of the carbon monoxide, nitric oxide, and nitrogen dioxide. These sample results are summarized below:

a. Line 2 - Hot Wire Sealer

11 mg/m³ - carbon monoxide
1 mg/m³ - nitric oxide and nitrogen dioxide
<1 mg/m³ - nitrogen dioxide

b. Air From Compressed Air Line

11 mg/m³ - carbon monoxide
<1 mg/m³ - nitric oxide and nitrogen dioxide
<1 mg/m³ - nitrogen dioxide

c. Exhaust Air From Old Propane-Fueled Fork Lift Truck

343 mg/m³ - carbon monoxide
22 mg/m³ - nitric oxide and nitrogen dioxide
13 mg/m³ - nitrogen dioxide

d. Exhaust Air From New Propane-Fueled Fork Lift Truck

>800 mg/m³ - carbon monoxide (note, went off scale at less than 1 stroke, 2 stroke, scale is 114 to 800 mg/m³ carbon monoxide)
15 mg/m³ - nitric oxide and nitrogen dioxide
11 mg/m³ - nitrogen dioxide

Although the detector tube data are limited, they indicate that the fork trucks are significant contributors of carbon monoxide

and oxides of nitrogen. The greater concentrations of carbon monoxide emitted by the new fork truck may be attributable to the fact that the carburetor had not been tuned prior to use in the plant.

The results for analysis of nitrous oxide (N₂O) show that the shuttle machine does not produce significant amounts of nitrous oxide. The nitrous oxide which may be generated by the reaction of heat (temperature estimated at 375°F) from the hot wire machine with ammonium nitrate. Employee exposure to nitrous oxide was <1 mg/m³, which is not considered a hazard.

B. Medical

A total of 45 employees were interviewed: 34 of 37 production workers and line supervisors, and 11 of 34 non-line production workers (bubble machine operator, maintenance workers) line production workers had a higher prevalence of symptoms than non-line workers (28 years) and had a slightly longer job duration (2.9 versus 2.3 years).

Personnel working on production lines involving ammonium nitrate were more likely than non-line production personnel to report at least one acute symptom and, in particular, had a higher prevalence of skin symptoms (Table IV). The apparent higher prevalence of mucous membrane irritation and respiratory symptoms among production line personnel was not statistically significant. There were too few workers on the calcium chloride line to draw any statistically meaningful conclusions concerning symptom prevalence. There were no significant difference in the prevalence of central nervous system symptoms between ammonium nitrate-involved production line workers and non-line production workers or between all production line and non-line production workers.

The medical survey suggests that workers on production lines involving ammonium nitrate may have work-related skin (and possibly mucous membrane and respiratory tract) irritation. Since workers on the binasol plus ammonium nitrate line did not have more symptoms than the workers on the ammonium nitrate line, any symptoms attributable to working on these lines are more likely due to the ammonium nitrate rather than the binasol.

VII. CONCLUSION

Based on the environmental sample results, employee's interviews, and available toxicological information, NIOSH concludes that while a health hazard of systemic toxicity did not exist at the time of the surveys on April 15-16 and May 1, 1981, it appears that exposure to ammonium nitrate may cause skin, and possibly mucous membrane irritation.

VIII. RECOMMENDATIONS

The data from this study are not sufficient to determine the air concentration at which ammonium nitrate or calcium chloride cause skin or mucous membrane irritation. It is thus not possible to recommend a specific exposure level on the basis of this study. Good industrial hygiene practices, however, dictate that worker exposures to the chemicals be minimized to the greatest extent possible. Worker exposures could be reduced by a combination of engineering controls, good work practices, administrative controls, and personal protective equipment.

Recommendations to reduce exposures are as follows:

1. Engineering Controls - The plastic pouch for packaging binasol, ammonium nitrate and calcium chloride should be designed to minimize the generation of airborne dust and the likelihood of worker exposures. Portions of the packaging equipment, which have the potential for the release of dust into the air, should be enclosed or ventilated.
2. Work Practices - Packaging and other operations which generate dust, or result in skin contact with ammonium nitrate and calcium chloride should be avoided. Practices such as patting/slapping of the plastic pouch should be minimized.
3. Protective Clothing - When there exists the possibility of skin contact with ammonium nitrate or calcium chloride, gloves and clothing (long-sleeved) should be worn, which effectively prevents skin contact. In most cases, any type of clothing which covers potentially exposed skin areas and remains dry will provide adequate protection.
4. Vacuuming - Areas where ammonium nitrate and calcium chloride is spilled should be vacuumed rather than swept with a broom.
5. Maintenance - Periodic maintenance of the ventilation equipment should be performed to prevent malfunction. Holes in the ventilation duct should be repaired.
6. The packaging of ammonium nitrate in a plastic bag and heat sealing the bag via "hot wire" sealers should be kept at 330°F or lower. Ammonium nitrate melts at 336°F and if the melt is heated to 410°F, it will begin to decompose into nitrous oxide and water.
7. The ACGIH Industrial Ventilation Manual³ should be consulted for fuel-powered lift truck ventilation design criteria and the operating specifications of the existing system modified accordingly, if necessary. The ACGIH guidelines are summarized below.

a. Basic design ventilation rates:

5,000 CFM per propane-fueled lift truck
8,000 CFM per gasoline-fueled lift truck

b. Conditions under which the basic design rate apply:

A regular maintenance program incorporating final tuning through carbon monoxide analysis of exhaust gases must be provided. Carbon monoxide concentration of exhaust gases should be limited to 1% (or 10,000 ppm) for propane-fueled trucks and 2% for gasoline-fueled trucks.

Actual operating time of life trucks must be 50% or less of total exposure time.

Reasonably good distribution of airflow must be provided.

The volume of space must amount to 150,000 cubic feet per lift truck or more.

Corrections for conditions other than those stated above are presented in the referenced ACGIH Manual of Recommended Practice.

IX. REFERENCES

1. Standard Method for Examination of Water and Waste Water, 14th edition, 1975 APHA-AWAA-WPCF, p. 427 "Brucine Method".
2. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 1, 2nd ed. Cincinnati, OH: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) publication no. 77-157-A).
3. American Conference of Governmental Industrial Hygienists. ACGIH industrial ventilation: a manual of recommended practice. ACGIH Committee on Industrial Ventilation: Lansing, Michigan, 1982.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Manager of Kay Laboratories
2. Confidential Requestor
3. NIOSH, Region VII
4. OSHA, Region VII

For the purpose of informing the 50 affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

Personal Breathing Zone Concentrations of Respirable and Total Dust,
Ammonium Nitrate, and Calcium Chloride

Kwik Kold, Kay Laboratories
Moberley, Missouri
HETA 81-221

April 16, 1981

Job/Location	Sample Time	Sample Volume (Liters)	Respirable Particulate mg/m ³ *	Total Particulate mg/m ³	Ammonium Nitrate mg/m ³	Calcium Chloride mg/M ³
Line No. 2 operator	0710-1534	780	0.33	--	--	--
Line No. 2 operator	0717-1533	843	0.33	--	--	--
Line No. 2 operator	0750-1532	785	--	4.31	0.57	--
Line No. 2 operator	0746-1533	794	--	4.84	0.24	--
Line No. 2 operator	0744-1533	797	--	4.28	0.30	--
Line No. 2 operator	0740-1531	800	--	2.39	0.36	--
Maintenance supervisor	0643-1424	721	0.32	--	--	--
Utility operator	0650-1538	898	--	2.24	0.17	--
Line No. 3 supervisor	0704-1510	826	--	1.51	0.25	--
Line No. 3 operator	0731-1508	777	--	1.02	--	--
Line No. 3 operator	0735-1508	770	--	2.14	0.45	--
Line No. 3 operator	0736-1509	770	--	1.56	0.23	--
Line No. 3 operator	0738-1507	763	--	1.40	0.26	--
Line No. 3 operator	0733-1506	770	0.32	--	--	--
Line No. 3 operator	0714-1508	806	0.35	--	--	--
Line No. 4 operator	0720-1517	811	--	2.03	0.52	--
Line No. 4 operator	0727-1516	797	--	2.03	0.69	--
Line No. 4 operator	0755-1517	751	--	3.01	0.63	--
Line No. 4 operator	0752-1515	753	--	2.06	0.52	--
Line No. 4 operator	0730-1517	794	0.26	--	--	--
Line No. 4 operator	0707-1515	830	0.33	--	--	--

(continued)

TABLE III

Personal Breathing Zone Concentrations of
Nitric Oxide and Nitrogen DioxideKwik Kold, Kay Laboratories
Moberley, Missouri
HETA 81-221

May 1, 1981

Job/Location	Sample Time	Sample Volume (Liters)	Nitric Oxide mg/m ³ *	Nitrogen Dioxide mg/m ³
Shuttle operator line 3	0750-1302	6.0	2.6	0.2
Shuttle operator line 3	1305-1529	1.8	1.9	LD**
Shuttle operator line 2	0740-1258	5.2	0.3	LD
Shuttle operator line 2	1259-1527	3.1	LD	LD
Shuttle operator line 1	0733-1249	7.1	0.4	LD
Shuttle operator line 1	1251-1524	3.5	4.4	3.7
Stuffer operator line 3	0747-1300	6.4	2.1	0.3
Stuffer operator line 3	1302-1528	3.0	2.0	0.3
Stuffer operator line 3	0745-1306	6.1	2.3	0.3
Stuffer operator line 3	1308-1528	2.6	1.7	0.3
Sealer operator line 2	0743-1251	2.3	1.5	LD
Sealer operator line 2	1254-1527	3.2	LD	LD
Sealer operator line 1	0737-1246	5.6	0.7	LD
Sealer operator line 1	1248-1525	2.8	LD	LD
Sealer operator line 1	0735-1245	5.0	0.4	LD
Sealer operator line 1	1248-1525	2.5	0.7	LD
Fork truck operator	0756-1310	6.7	1.5	0.1
Fork truck operator	1312-1531	3.0	1.3	0.3
Fork truck operator	0753-1313	5.3	LD	LD
Fork truck operator	1316-1541	2.8	LD	LD
Bubble operator line 2	0741-1256	6.4	1.0	LD
Bubble operator line 2	1257-1526	3.0	1.7	0.3
Limit of detection			1 ug	1 ug
Environmental criteria:				
NIOSH Recommended Exposure Standard			30	1.8 (15 min. ceiling)
OSHA Standard			30	9

* mg/m³ - milligrams of dust per cubic meter of air sampled.
 ** LD - less than the analytical limit of detection.

TABLE IV
Acute Symptoms Among Employees

Kwik Kold, Kay Laboratories
Moberly, Missouri
HETA 81-221

April 1981

Job/Location	Number Interviewed	Number and (%) reporting symptoms				
		CNS ¹	MM ²	Resp ³	Skin ⁴	Any Symptom
Production Lines						
Ammonium Nitrate only	15	4 (27)	6 (40)	2 (13)	5 (33)	9 (60)
Ammonium Nitrate and Binasol	8	1 (13)	2 (25)	1 (13)	2 (25)	4 (50)
Total Ammonium Nitrate	23	5 (22)	8 (35) ^A	3 (13)	7 (30) ^D	13 (57) ^F
Calcium Chloride	5	2 (40)	2 (40)	2 (40)	0	2 (40)
Other	6	0	0	0	0	0
Total Production Lines	34	7 (21)	10 (29) ^B	5 (15) ^C	7 (21) ^E	15 (44) ^G
Non-Line Production	11	2 (18)	2 (18) ^{A,B}	0 ^C	0 ^{D,E}	2 (18) ^{F,G}

- 1 - Central nervous system: headache, lightheadedness, dizziness, or sleepiness
 2 - Mucous membrane (eye, nose, or throat) irritation
 3 - Respiratory symptoms: cough, shortness of breath, or difficulty breathing
 4 - Skin symptoms: redness, itching, irritation, or rash

Fisher's exact test, 1-tailed

- A - p=0.28
 B - p=0.38
 C - p=0.23
 D - p=0.046
 E - p=0.12
 F - p=0.039
 G - p=0.12

