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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 NO. 77-37-413

GATES RUBBER COMPANY
DENVER, COLORADO

AUGUST 1977

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) on February 9 and March 1, 1977, at the Gates Rubber Company, Denver, Colorado. At the time of this evaluation, breathing zone samples were taken for zinc oxide, resorcinol, formaldehyde, sodium hydroxide, and ammonia. One out of ten sodium hydroxide samples was found to exceed the most recent evaluation criteria. Trace concentrations of formaldehyde, zinc oxide, and ammonia were found. Resorcinol samples were all below the NIOSH detection limits. Confidential employee interview forms were completed on all workers in this area. Based on these interviews and the highly irritating properties of the above-mentioned chemicals, it is concluded that a health hazard existed from a combination of low exposures to zinc oxide, resorcinol, formaldehyde, ammonia and rayon fibers, and exposures to sodium hydroxide.

II. DISTRIBUTION AND AVAILABILITY

Copies of this determination report are currently available upon request from NIOSH, Division of Technical Services, Information 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 NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

Gates Rubber Company
U.S. Department of Labor - Region VIII
NIOSH - Region VIII

For the purpose of informing the 40 affected employees, copies of the report shall be posted in a prominent place 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, 29 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.

NIOSH received such a request from plant management at the Gates Rubber Company in Denver, Colorado, to evaluate the potential hazards associated with exposures to zinc oxide, resorcinol, formaldehyde, sodium hydroxide, and ammonia during the manufacture of high pressure hose.

IV. HEALTH HAZARD EVALUATION

A. Process Evaluated

The Gates Rubber Company of Denver, Colorado, produces high pressure hose which is used by the automobile, oil, farming, and many other types of industries. The process evaluated during this evaluation was the hose braiding department.

Braiding--during this process rubber hose is fed into a braiding machine, and the hose is reinforced with rayon cord. This cord is braided around the rubber hose. The rayon cord has been pre-treated in another area of the plant by a rewinder. During the process of rewinding, the cord is dipped into a solution containing zinc oxide, resorcinol, formaldehyde, sodium hydroxide, and ammonia. Later when the braider is braiding the hose with the treated rayon, small fibers come loose from the cord. This entire braiding and rewinding area was monitored for all chemicals that were being used during the entire hose braiding process.

B. Evaluation Design and Methods

Breathing zone air samples to determine the concentrations of the above-named contaminants were taken on all workers in the braided hose department using a variety of sampling and analytical methods recommended by NIOSH.

Zinc oxide samples were analyzed by atomic absorption spectroscopy. Ammonia samples were analyzed colorimetrically using Nessler reagent. Formaldehyde samples were analyzed colorimetrically. Resorcinol samples were analyzed by high pressure liquid chromatography. Sodium hydroxide samples were analyzed by atomic emission spectroscopy. All 40 workers were interviewed. Most of the workers complained of upper respiratory irritation, burning and itching skin, eye irritation, and coughing and sneezing. Most identified this as occurring on the day of the study. Dermatitis was evident on five of the workers.

C. Criteria for Assessing Workroom Concentrations of Air Contaminants

The two sources of criteria used to assess workroom concentrations of air contaminants in this evaluation are: (1) NIOSH recommended criteria for occupational exposures and (2) recommended threshold limit values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH)(1976).

Substances	Permissible Exposures 8-Hour Time-Weighted Exposure Basis (mg/M^3) 1976 TLV's	NIOSH Criteria
Zinc Oxide	5	5
Resorcinol	45	---
Formaldehyde	"C" 3	0.6
Sodium Hydroxide	"C" 2	2
Ammonia	18	50

mg/M^3 = approximate milligrams of substance per cubic meter of air

"C" = ceiling concentration which should never be exceeded

Occupational health standards and criteria for standards are established at levels designed to protect individuals occupationally exposed to individual toxic substances on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

D. Toxicology

Zinc Oxide--when high concentrations of zinc oxide are inhaled, a delayed form of mild pneumonitis may occur.[1] This may be found among workers in galvanizing plants and brass foundries and in other industries using zinc oxide such as the braided hose industry.

Occupational exposure to zinc oxide should be controlled so that workers are not exposed to concentrations greater than 5 mg/M^3 as a time-weighted average exposure for up to a 10-hour work day, 40-hour work week, with a ceiling of 15 mg/M^3 as determined by sampling time of 15 minutes.[2]

Resorcinol and Formaldehyde--the term "phenolic resins" encompasses a variety of similar products made by reacting a phenol-like compound with an aldehyde. Commercial "phenols" include phenol, cresol, xylenol, and ammonia and various other amines. Important industrial effects are mainly dermatitis and upper respiratory irritation. Resorcinol and formaldehyde are irritants and sensitizers.[3] Maintaining worker exposure to formaldehyde below 0.6 mg/M^3 and resorcinol below 45 mg/M^3 may not protect workers when combined exposures occur.

Sodium Hydroxide--excessive exposures to sodium hydroxide may produce contact dermatitis as well as upper respiratory tract irritation. Occupational exposures to sodium hydroxide should be controlled so that no worker is exposed to sodium hydroxide at a concentration greater than 2.0 mg/M^3 for any 15-minute sampling period.[4]

Ammonia--is a primary irritant with good warning properties and only a remote probability of sensitization. The TLV of 18 mg/M^3 was selected to protect against respiratory tract and eye irritations.[5]

E. Evaluation Results and Conclusions

As the company had recently measured total particulate levels, these levels were not again measured by NIOSH. The company found levels in the range of 1-2 mg/M^3.

In this study one out of ten sodium hydroxide samples exceeded the most recent evaluation criteria. Zinc oxide, formaldehyde, ammonia, and resorcinol were all below the most recent evaluation criteria. However, combined exposures to all of these compounds in trace quantities, as shown in Tables I through V, could cause employee complaints and symptoms such as upper respiratory tract irritation and burning eyes and skin, particularly in combination with the rayon fibers.

The article mentioned in reference 5 is an example of almost the same situation that was evaluated during this study. Levels of resorcinol, formaldehyde, and ammonia were very near the same as those found in this hazard evaluation. Worker complaints and medical findings were also very similar, which included upper respiratory tract irritation and burning eyes and skin. In that study pulmonary function changes correlated with respirable particulate levels rather than air levels of the individual substances. It was felt that the particles could carry the irritating substances into the lungs on the surface of the particle.

Therefore, it is concluded that a health hazard existed from a combination of low exposures to zinc oxide, resorcinol, formaldehyde, ammonia and rayon fibers, and exposures to sodium hydroxide.

F. Recommendations

1. Ventilation should be installed in department 21 (braided hose department) to eliminate employee exposure to lint and dust containing zinc oxide, resorcinol, formaldehyde, sodium hydroxide, and ammonia. Ventilation has been effective in another area of this plant that uses the same product but has no worker illness experienced by workers evaluated during this survey. Ventilation is the only difference in the two departments.

2. Until the area is ventilated, workers should be provided with barrier creams to protect them from fibers and dust containing the irritating chemicals.

3. Physicians treating the employees should be informed of what the worker is exposed to and, if possible, the physician should tour this area to become acquainted with what the worker is doing.

V. REFERENCES

1. Casarett, Louis J., Ph.D., and Doull, John, M.D., Ph.D.: Toxicology--The Basic Science of Poisons, Macmillan Publishing Company, 1975, pp 221-222.

2. NIOSH recommended standard for zinc oxide, 1975.

3. Hamilton, Alice, M.D., and Hardy, Harriet L., M.D., F.A.C.P.: Industrial Toxicology, Publishing Sciences Group, Inc., 1974, pp 333-334.

4. NIOSH recommended standard for sodium hydroxide, 1975.

5. American Industrial Hygiene Association Journal, Vol. 37, No. 9, September 1976: pages 499-513.

VI. AUTHORSHIP

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Table I

ATMOSPHERIC CONCENTRATIONS OF
ZINC OXIDE

Gates Rubber Company
February 9, 1977

Sample Number	Location	Job Classification	Time of Sample	Zinc Oxide mg/M^3	Type of Sample
1	Braided Hose (Dept. 21)	Rewinder	7:32 AM-2:42 PM	0.001	BZ
2	Braided Hose (Dept. 21)	Braider	7:43 AM-2:37 PM	0.001	BZ
3	Braided Hose (Dept. 21)	Braider	7:41 AM-2:38 PM	*	BZ
4	Braided Hose (Dept. 21)	Braider	7:40 AM-2:40 PM	0.002	BZ
5	Braided Hose (Dept. 21)	Braider	7:35 AM-2:41 PM	0.002	BZ
6	Braided Hose (Dept. 21)	Braider	7:16 AM-2:32 PM	0.001	BZ
7	Braided Hose (Dept. 21)	Braider	7:27 AM-2:36 PM	0.001	BZ
8	Braided Hose (Dept. 21)	Fork Lift Operator	7:25 AM-2:31 PM	0.001	BZ
9	Braided Hose (Dept. 21)	Rewinder	7:22 AM-2:35 PM	0.001	BZ
10	Braided Hose (Dept. 21)	Braider	7:19 AM-2:34 PM	0.001	BZ
			EVALUATION CRITERIA	5.0 mg/M^3	
			LIMIT OF DETECTION	0.6 micrograms per sample	

mg/M^3 = approximate milligrams of substance per cubic meter of air

BZ = breathing zone

* = below limit of detection

Table II

ATMOSPHERIC CONCENTRATIONS OF
RESORCINOL

Gates Rubber Company
March 1, 1977

Sample Number	Location	Job Classification	Time of Sample	Resorcinol mg/M^3	Type of Sample
1	Braided Hose (Dept. 21)	Braider	7:21 - 8:42 A.M.	*	BZ
2	Braided Hose (Dept. 21)	Rewinder	7:25 - 8:44 A.M.	*	BZ
3	Braided Hose (Dept. 21)	Braider	7:29 - 8:48 A.M.	*	BZ
4	Braided Hose (Dept. 21)	Braider	7:18 - 8:30 A.M.	*	BZ
5	Braided Hose (Dept. 21)	Rewinder	7:56 - 9:05 A.M.	*	BZ
6	Braided Hose (Dept. 21)	Braider	7:30 - 8:50 A.M.	*	BZ
7	Braided Hose (Dept. 21)	Braider	7:50 - 8:55 A.M.	*	BZ
8	Braided Hose (Dept. 21)	Braider	7:55 - 8:50 A.M.	*	BZ
9	Braided Hose (Dept. 21)	Braider	7:53 - 9:04 A.M.	*	BZ
10	Braided Hose (Dept. 21)	Stockman	7:54 - 9:02 A.M.	*	BZ
			EVALUATION CRITERIA	45	
			LIMIT OF DETECTION	1 microgram per milliliter of sample	

mg/M^3 = approximate milligrams of substance per cubic meter of air

BZ = breathing zone

* = less than 1 microgram per milliliter of sample

Table III

ATMOSPHERIC CONCENTRATIONS OF FORMALDEHYDE

Gates Rubber Company
March 1, 1977

Sample Number	Location	Job Classification	Time of Sample	Formaldehyde mg/M^3	Type of Sample
11	Braided Hose (Dept. 21)	Braider	8:42 AM-10:06 AM	0.02	BZ
12	Braided Hose (Dept. 21)	Rewinder	8:44 AM-10:08 AM	0.03	BZ
13	Braided Hose (Dept. 21)	Braider	8:48 AM-10:10 AM	0.03	BZ
14	Braided Hose (Dept. 21)	Braider	8:30 AM-10:05 AM	0.02	BZ
15	Braided Hose (Dept. 21)	Rewinder	9:06 AM-10:25 AM	0.04	BZ
16	Braided Hose (Dept. 21)	Braider	8:50 AM-10:11 AM	0.04	BZ
17	Braided Hose (Dept. 21)	Braider	8:55 AM-10:20 AM	*	BZ
18	Braided Hose (Dept. 21)	Braider	8:50 AM-10:15 AM	0.02	BZ
19	Braided Hose (Dept. 21)	Braider	9:04 AM-10:26 AM	0.03	BZ
20	Braided Hose (Dept. 21)	Stockman	9:02 AM-10:17 AM	0.03	BZ
			EVALUATION CRITERIA	0.6 "C"	
			LIMIT OF DETECTION	0.02 micrograms per sample	

mg/M^3 = approximate milligrams of substance per cubic meter of air

BZ = breathing zone

* = below limit of detection

"C" = ceiling concentration and should never be exceeded

Table IV

ATMOSPHERIC CONCENTRATIONS OF
SODIUM HYDROXIDE

Gates Rubber Company
March 1, 1977

Sample Number	Location	Job Classification	Time of Sample	Sodium Hydroxide mg/M^3	Type of Sample
31	Braided Hose (Dept. 21)	Braider	11:20 AM-12:41 PM	0.46	BZ
32	Braided Hose (Dept. 21)	Rewinder	11:22 AM-12:38 PM	0.35	BZ
33	Braided Hose (Dept. 21)	Braider	11:21 AM-12:43 PM	0.28	BZ
34	Braided Hose (Dept. 21)	Braider	11:22 AM-12:40 PM	0.37	BZ
35	Braided Hose (Dept. 21)	Rewinder	11:40 AM-12:50 PM	0.19	BZ
36	Braided Hose (Dept. 21)	Braider	11:28 AM-12:43 PM	0.27	BZ
37	Braided Hose (Dept. 21)	Braider	11:34 AM-12:30 PM	0.69	BZ
38	Braided Hose (Dept. 21)	Braider	11:35 AM-12:51 PM	5.31	BZ
39	Braided Hose (Dept. 21)	Braider	11:39 AM-12:50 PM	0.51	BZ
40	Braided Hose (Dept. 21)	Stockman	11:38 AM-12:56 PM	0.53	BZ
			EVALUATION CRITERIA	2.0 mg/M^3	
			LIMIT OF DETECTION	1.0 microgram per milliliter	

mg/M^3 = approximate milligrams of substance per cubic meter of air

BZ = breathing zone

Table V

ATMOSPHERIC CONCENTRATIONS OF AMMONIA

Gates Rubber Company
March 1, 1977

Sample Number	Location	Job Classification	Time of Sample	Ammonia mg/M^3	Type of Sample
21	Braided Hose (Dept. 21)	Braider	10:06 AM-11:20 AM	0.16	BZ
22	Braided Hose (Dept. 21)	Rewinder	10:08 AM-11:22 AM	0.74	BZ
23	Braided Hose (Dept. 21)	Braider	10:10 AM-11:21 AM	0.99	BZ
24	Braided Hose (Dept. 21)	Braider	10:05 AM-11:24 AM	*	BZ
25	Braided Hose (Dept. 21)	Rewinder	10:25 AM-11:40 AM	*	BZ
26	Braided Hose (Dept. 21)	Braider	10:11 AM-11:28 AM	0.21	BZ
27	Braided Hose (Dept. 21)	Braider	10:22 AM-11:34 AM	*	BZ
29	Braided Hose (Dept. 21)	Braider	10:26 AM-11:39 AM	*	BZ
30	Braided Hose (Dept. 21)	Stockman	10:17 AM-11:38 AM	*	BZ
			EVALUATION CRITERIA	18.0 mg/M^3	
			LIMIT OF DETECTION	1.0 microgram per milliliter	

mg/M^3 = approximate milligrams of substance per cubic meter of air

BZ = breathing zone

* = below limit of detection