U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Service
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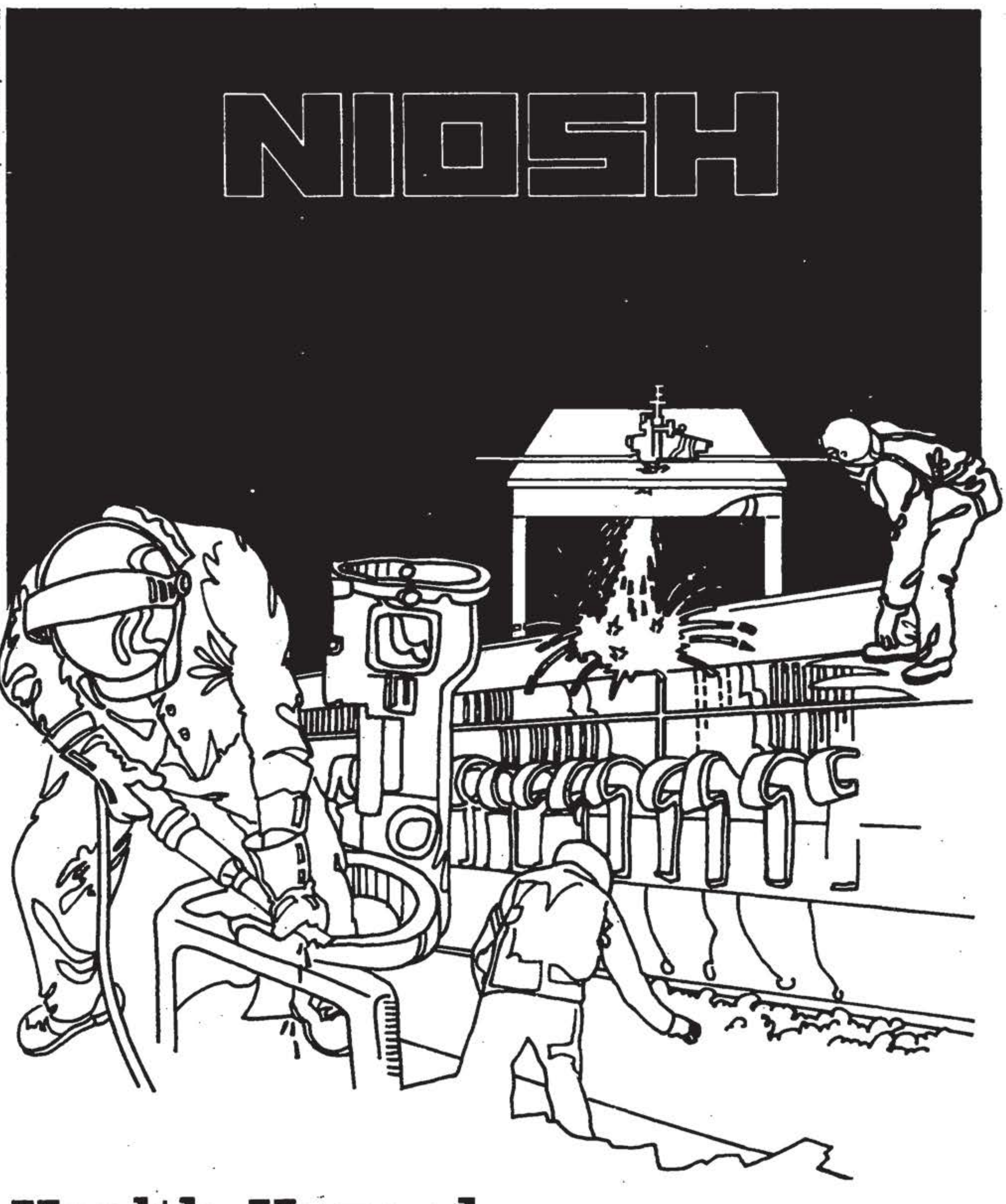

Health Hazard Evaluation Report

HETA 82-156-1231
SHELLER-GLOBE CORPORATION
KEOKUK, IOWA

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.

HETA 82-156-1231
NOVEMBER 1982
SHELLER-GLOBE CORPORATION
KEOKUK, IOWA

NIOSH INVESTIGATOR:
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I. SUMMARY

In March, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Union of the United Rubber, Cork, Linoleum and Plastic Workers to evaluate workers' exposure to nitrosamines at Sheller-Globe Inc., Keokuk, Iowa. At the time of the study, approximately 50 workers were employed at this facility in the extrusion of rubber products.

On July 13-15, 1982, NIOSH conducted environmental sampling at the plant. Fourteen personal breathing-zone air samples were collected on Thermo Sorb/N cartridges and analyzed for nitrosamines by the GC/Hall Method.

Workers were found to be exposed to nitrosodimethylamine (NDMA), nitrosodiethylamine (NDEA), nitrosodipropylamine (NDPA), and nitrosomorpholine (NMOR). NDPA was found in the highest concentrations. Exposure to total nitrosamines ranged from 2.0 to 4.4 ug/M^3 with a mean of 3.6 ug/M^3.

Capture velocities of the 21 local exhaust hoods in the extruder department ranged from <50 to 400 feet per minute. One hood was not working and three other hoods had capture velocities less than 100 feet per minute. In addition, some of the oven doors along the extruder lines were found to be poorly fitted, thereby leaking rubber decomposition products into the workroom environment.

NIOSH policy on occupational exposure to potential human carcinogens, such as nitrosamines, is to reduce exposure to the lowest feasible level.

Based on the results of this evaluation, NIOSH concluded that potential hazards due to exposure to nitrosamines existed at the time of the NIOSH investigation.

Recommendations for reducing exposure to the lowest feasible levels are presented in Section VIII of this report.

KEYWORDS: SIC 306 (Fabricated Rubber Products), nitrosamines, N-nitroso compounds, nitrosodimethylamine, nitrosodiethylamine, nitrosodipropylamine, nitrosodibutylamine, nitrosomorpholine.

II. INTRODUCTION

In March 1982, NIOSH received a request for a health hazard evaluation at Sheller-Globe Corporation, Keokuk, Iowa. The request was submitted by the United Rubber, Cork, Linoleum and Plastic Workers of America International Union who were concerned about environmental exposure to nitrosamines among extrusion workers at the plant.

Preliminary recommendations stressing the importance of more efficient process enclosures and local exhaust ventilation in the extruder area were submitted to management and union representatives at the plant following the NIOSH survey on July 13-15, 1982.

III. BACKGROUND

Sheller-Globe produces rubber parts for automobile interiors. The ECC (extruder) Department uses several elastomers to produce a variety of extruded rubber products, such as belts, gaskets, etc.

The parts are formed as they move through an automated series of extruders and ovens (approximately 400°F) to the final handling and packaging area where most of the 50 ECC workers are employed.

Volatile nitrosamines are emitted when rubber is heated, usually via the reaction of common nitrosating agents, such as oxides of nitrogen, with the secondary amine-based compounds frequently used as batch ingredients in rubber formulations.

IV. METHODS

NIOSH collected 17 personal breathing-zone and process air samples on July 13-15, 1982, to evaluate workers' exposure to nitrosamines in the ECC Department. Nitrosamines were collected on Thermo Sorb/N cartridges using calibrated personal sampling pumps operating at 0.2 liters per minute for seven hours for personal samples and 2.0 liters per minute for one hour for process air samples.

The samples were extracted with methylene chloride and analyzed by the GC/Hall Method.

Both the capture and face velocity of 21 hoods in the extrusion local exhaust ventilation system were measured using an Alnor Velometer Jr. Model 8100.

V. EVALUATION CRITERIA

Nitrosamines are ubiquitous and potent animal carcinogens which are readily formed by the interaction (nitrosation) of nitrites or oxides of nitrogen and amine precursors. They may be synthesized in the environment and in the body. Occupational exposures may occur, for example, to machinists from synthetic grinding fluids, and in industries such as leather tanneries and tire manufacturing plants (1,2). Non-occupational exposure also may occur from such sources as beer, cured meats, cosmetics, and tobacco smoke.

Nitrosamines as a class are considered to be among the most potent and widespread of animal carcinogens (3,4,5). Over 75% of tested nitrosamines are animal carcinogens (6). To date there are no occupational standards for nitrosamines except for a liquid and solid standard for N-nitrosodimethylamine (in concentrations >1%, refer to OSHA 29 CFR, 1976, 1910.1016).

Within the past year the Food and Drug Administration has put limits on the amount of nitrosamines allowed in beer (5 parts per billion). Also, the United States Department of Agriculture has limited nitrosamine concentrations in cooked bacon to 10 parts per billion.

N-nitrosodimethylamine (NDMA) has been shown to be the most potent carcinogen in the nitrosamine family. In animals, the main target organs are the liver and kidneys, depending upon the dose and length of exposure.

The acute toxic effects of animal exposure to NDMA are reported to be gastrointestinal irritation, vomiting, diarrhea, increase in body temperature, and failure of the blood coagulation mechanism (7). The lethal concentration of airborne NDMA that caused mortality in 50 percent of rats exposed to a single dose for 4 hours (LC_{50}) was 78 parts per million (ppm). In dogs the LC_{50} was less than 16 ppm. Damage to the liver after experimental exposure was the primary cause of death. Evidence of hepatotoxicity has also been reported in humans exposed to NDMA (7,9).

NDMA was shown to be carcinogenic in 1956. Addition of this compound to the normal diet of rats at a level of 50 milligrams per kilogram of food caused a high incidence of malignant liver tumors appearing between the 26th and 40th week. Also kidney tumors were reported a year or longer after exposure was stopped. These findings have since been confirmed by several other studies with varying dietary doses of NDMA (10,11,12). Animals exposed by inhalation to NDMA also have shown an increased incidence of cancer. In rats exposed daily by inhalation to 0.005 or 0.2 mg/M^3 NDMA for 25 months, those given the higher level had tumors of the lung, kidney, and liver earlier and at greater rates than controls (13).

The acute toxic and carcinogenic effects of animal exposure to the other nitrosamines found in this investigation are similar to those reported for NDMA.

NIOSH policy on human exposure to Class I animal carcinogens is to reduce potential exposure to the lowest feasible level.

VI. RESULTS

Air Sampling

The personal breathing-zone samples were found to contain nitrosodimethylamine (NDMA), nitrosodiethylamine (NDEA), nitrosodipropylamine (NDPA), and nitrosomorpholine (NMOR) (Table I). In addition to these, nitrosodibutylamine (NDBA) was detected in the process air samples. NDPA was found in the highest concentrations. Workers were exposed to NDPA at levels ranging from 1.3 to 3.3 micrograms per cubic meter (ug/M^3) with a mean of 2.3 ug/M^3. Exposure to total nitrosamines ranged from 2.0 to 4.4 ug/M^3 with a mean of 3.6 ug/M^3. Total nitrosamine concentrations found in the process samples ranged from 7.5 to 24.4 ug/M^3 with a mean of 13 ug/M^3.

Ventilation

Open spaces are present between the ovens along the extruder lines in order to observe or adjust the formation of the final product. These openings are exhausted and some are provided with curtains that can be closed to increase the efficiency of the exhaust hoods.

Face velocities of the hood systems ranged from <50 to 600 feet per minute. Capture velocities, as measured at the rubber product, ranged from <50 to 400 feet per minute. The second hood on ECC #9, the second hood on ECC #4, and the first hood on ECC #6 all had capture velocities <100 feet per minute. The second hood on ECC #2 was not working.

The oven doors on ECC #4 were poorly fitted and were emitting smoky decomposition products. It was also observed that curtains on several of the exhaust hoods frequently were left open.

VII. DISCUSSION

Airborne nitrosamine levels at this plant are consistent with those found by NIOSH in other rubber industries using this type of extrusion process. Considerably higher concentrations have been found in the tire manufacturing industry where exposure to NMOR ranging up to 27 ug/M^3 has been detected. Adherence to NIOSH recommendations for product substitution and better ventilation has helped to reduce these potentially hazardous exposures.

NIOSH policy on human exposure to Class I animal carcinogens, such as nitrosamines, is to reduce exposure to the lowest possible level, primarily by the use of engineering controls.

Total nitrosamine concentrations averaged 13 ug/M^3 in the process air samples, whereas the personal air samples averaged 3.6 ug/M^3. This difference is not very impressive, indicating that the extrusion process can and should be more efficiently enclosed and exhausted.

VIII. RECOMMENDATIONS

1. The extrusion process needs to be enclosed more tightly. Loose oven doors should be refitted or replaced. Some of the open spaces between ovens also should be enclosed if they are not necessary.

2. Several branches of the local exhaust ventilation system need to be repaired. One was not working and three others gave capture velocities less than 100 feet per minute, which should be considered the minimum ventilation requirement. Keeping the exhaust hood curtains closed should be strictly enforced.

3. Make-up air should be supplied in order to replace the large amount of air being exhausted from the Extruder Department. Not only does the negative pressure situation in this area hinder the efficiency of the local exhaust system, it also provides a means of potentially contaminated air being returned to the building. Of course, the local exhaust air should be cleaned of all toxic decomposition products, including nitrosamines, before being released outdoors.

4. Volatile nitrosamines are emitted when rubber products are heated. Those rubber parts that are still hot when they reach the finishing area are probably still emitting nitrosamines. A few of the extruders were equipped with water cooling mechanisms and it may be feasible to use the same method on more of the extruder lines. Freshly formed rubber products should be as cool as possible before workers handle them.

5. Elastomer chemists at Sheller-Globe should determine to what extent the secondary amine-based accelerators and other batch ingredients used in rubber formulations contribute to nitrosamine formation, and then take steps to reduce, remove, or substitute for these materials where possible.

IX. REFERENCES

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X. 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. Sheller-Globe Corporation
2. United Rubber, Cork, Linoleum and Plastic Workers Union
3. NIOSH, Region VII
4. OSHA, Region VII

For the purpose of informing 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 AND PROCESS AREA AIR SAMPLES FOR NITROSAMINES

SHELLER-GLOBE CORPORATION
KEOKUK, IOWA
HETA 82-156

July 13-15, 1982

Location	Rubber Products	Sample Time	Concentrations in Micrograms per Cubic Meter (ug/M3) NDMA	NDEA	NDPA	NDBA	NMOR	Total Nitrosamines
Process-ECC#1 directly from oven	96234	819-921	2.7	0.9	1.8	N.D.*	19	24.4
Process-ECC#5 directly from oven	96613 96407	821-923	0.6	0.2	5.6	0.1	1.0	7.5
Process-ECC#6 directly from oven	96416 96613	825-925	0.7	0.3	5.1	0.2	1.4	7.7
		average =	1.3	0.5	4.2	0.1	7.1	13
Personal-ECC#1&2 windup operator	96234 96241	1538-2229	0.4	0.3	2.4	N.D.	0.8	3.9
Personal-ECC#9 windup operator	96613 96407	1601-2233	0.2	N.D.	1.9	N.D.	0.4	2.5
Personal-ECC#4 finish operator	96613 96407	1559-2030	0.4	0.2	3.0	N.D.	0.5	4.1
Personal-ECC#4 windup operator	96613 96407	1542-2030	0.4	0.4	2.7	N.D.	0.7	4.2
Personal-ECC#6 finish operator	96416 96613	1548-2032	0.4	0.2	3.1	N.D.	0.5	4.2
Personal-ECC#5 finish operator	96613 96407	1545-2030	0.4	0.3	3.3	N.D.	0.4	4.4
Personal-ECC#7 finish operator	96410 96613	1552-2032	0.3	0.2	2.8	N.D.	0.4	3.7
Personal-ECC#4 finish operator	96417	716-1430	0.4	N.D.	2.1	N.D.	1.2	3.7
Personal-ECC#2 finish operator	96234	715-1429	0.4	N.D.	1.7	N.D.	0.8	2.9
Personal-ECC#5 finish operator	96613 96407	719-1430	0.4	0.2	2.3	N.D.	1.1	4.0
Personal-ECC#9 finish operator	96613 96407	723-1434	0.4	N.D.	1.6	N.D.	1.1	3.1
Personal-ECC#7 finish operator	96416 96613	721-1434	0.2	N.D.	1.3	N.D.	0.5	2.0
Personal-ECC#1 finish operator	96234	728-1429	0.5	0.4	1.8	N.D.	1.0	3.7
Area-ECC#6 at work station	96416 96613	730-1435	0.4	0.2	2.2	N.D.	0.8	3.6
		average =	0.4	0.2	2.3	-	0.7	3.6

*N.D. = below detectable limits

KEY:
NDMA = nitrosodimethylamine
NDEA = nitrosodiethylamine
NDPA = nitrosodipropylamine
NDBA = nitrosodibutylamine
NMOR = nitrosomorpholine

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