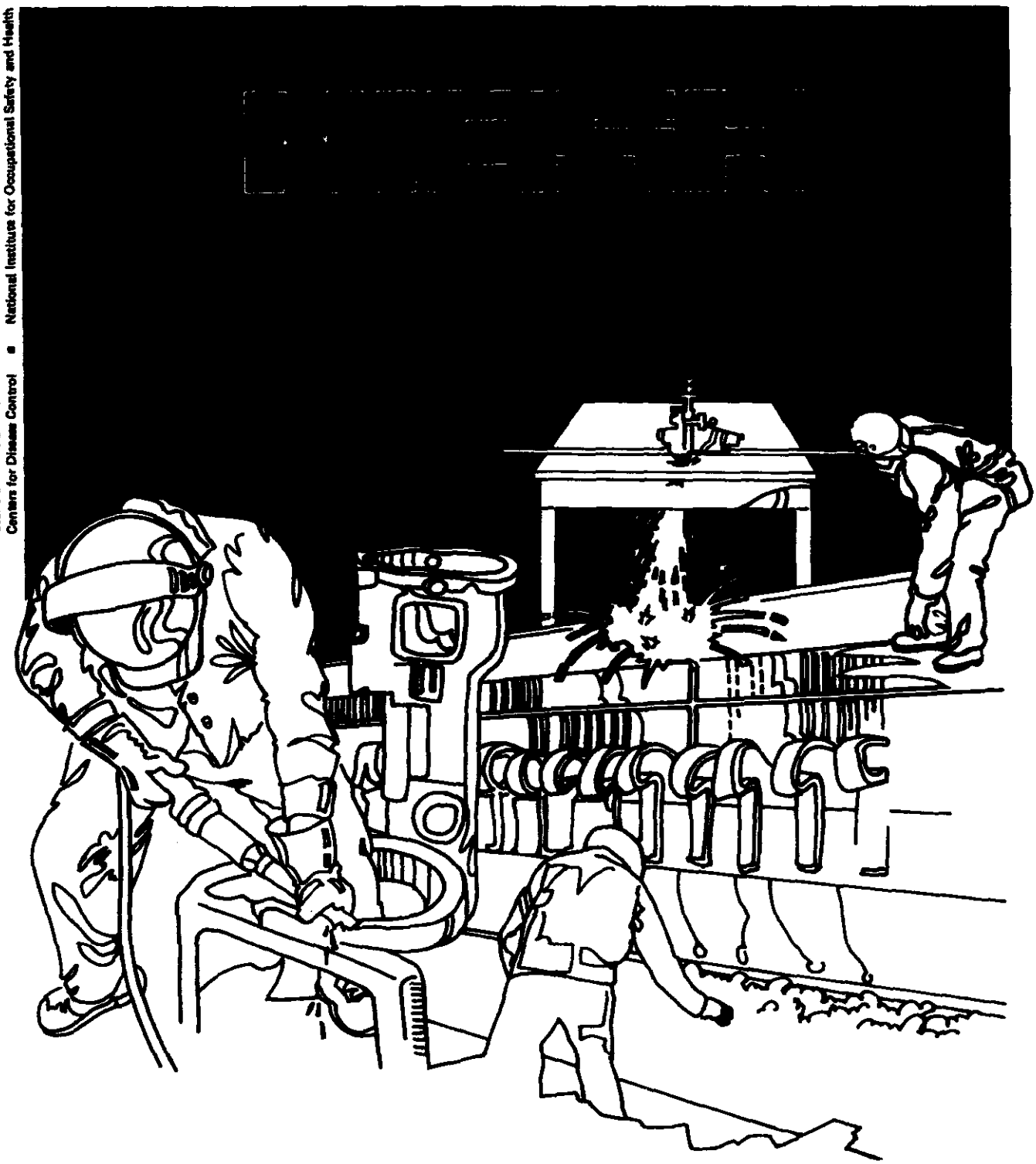
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 87-121-1968
RILEY BROTHERS, INC.
BURLINGTON, 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 nygiene 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 87-121-1968
MAY 1989
RILEY BROTHERS, INC.
BURLINGTON, IOWA

NIOSH INVESTIGATORS:
Suresh Gupta, M.D.
Richard Kramkowski,I.H.
Stan Salisbury, C.I.H.

I. SUMMARY

In January 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request from the owner of Riley Brothers, Incorporated, in Burlington, Iowa, for a health hazard evaluation (HHE). The request was prompted by two Riley Brothers employees who reportedly became sick as a consequence of their exposures to paint solvents. In May 1987, environmental and medical surveys were conducted.

Although ten different solvent vapors were detected in bulk air samples collected during the survey, the most noteworthy exposures detected were to VM & P naptha and xylene. The highest exposures to solvent vapors were for those working in the poorly ventilated basement of Plant No. 1, and for two workers at Plant No. 2 who were stripping paint from parts left soaking in a tank of xylene. Results from the five personal air samples collected in Plant No. 1 showed one paint maker's (paint formulator) combined exposure to VM & P naptha and xylene was 1.7 times the American Conference of Governmental Industrial Hygienists (ACGIH) recommended exposure limit. In Plant No. 2., short term exposures to xylene for the two workers stripping paint were 157 and 173 ppm, which exceeded the 150 ppm short-term (15 minutes) exposure limit recommended by the American Conference of Governmental Industrial Hygienists (ACGIH).

Pre- and post-shift urinary methyl-hippuric acid (a metabolite of xylene) concentrations were determined from specimens collected from 21 participants on May 13, 1987. A cross-shift change in urinary methyl-hippuric acid greater than 1500 mg/g creatinine corresponds to an air level of xylene in excess of 100 PPM (the OSHA permissible exposure limit). Two paint makers had a cross-shift change in urinary methyl-hippuric acid greater than 1500 mg/g creatinine, and two others, one paint maker and one paint filler, had levels between 500 and 1000 mg/g of creatinine. This correlates well with the environmental monitoring results, since the paint makers and fillers had the highest exposures to paint solvent vapors. The two paint strippers had an average cross-shift change in methyl-hippuric acid of 387.3 mg/g creatinine.

From the results presented in this report, the investigators concluded that Riley Brothers employees, especially Plant No. 1 paint makers and fillers, and workers stripping paint from parts soaked in xylene at Plant No. 2, are at risk for developing adverse health effects. The elevated levels of methyl-hippuric acid over a normal work shift and corresponding results of personal and area sampling indicate that some workers are exposed to xylene and other solvents at levels exceeding ACGIH threshold limit values. Recommendations to lower the exposure to these solvents and reduce the risk of health effects are presented in section X.

KEYWORDS: SIC 2851 (Paints, Varnishes, Lacquers, Enamels, and Allied Products), VM & P Naptha, xylene, solvent vapors, neurological effects, methyl hippuric acid

II. INTRODUCTION

In January 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the owner of Riley Brothers, Incorporated, of Burlington, Iowa. The request stated that certain production employees were exposed to various solvents and that the solvent levels measured in their blood were "varying in nature."

In March 1987, a NIOSH physician and an industrial hygienist visited Riley Brothers. An introductory meeting was held with representatives of the employees (there was no union) and management to explain the reason for our visit and to ascertain what the perceived health problems were. Following the meeting, NIOSH investigators toured the two plants. Later that day, 16 production area employees were interviewed.

On May 12-13, 1987, NIOSH investigators conducted a follow-up survey which consisted of:

1. Collection of personal and area air samples to evaluate worker exposures to solvent vapors.

2. Collection of pre- and post-shift urine for determination of methyl-hippuric acid concentration.

3. Administration of a neurologic symptom questionnaire.

Participants were notified of their urine test results on August 4, 1987. Results of air monitoring were sent to the company on August 24, 1987.

III. BACKGROUND

Riley Brothers, Inc., manufactures paint for various uses according to customer specifications. Major products include the formulation of solvent-based paints, and spray painting or dip painting of metal parts. They also manufacture roof waterproofing materials composed of coal tar pitch. Paint formulating is a manually operated batch process. The company operates in two separate facilities (Plant No. 1 and No. 2), located a few blocks from each other. At the time of the NIOSH investigation, a maximum of 35-40 people were employed at the company in two shifts, with only 21 people working in production. The job categories for production workers are paint makers, sprayers, labelers, filler and packers, laboratory workers, truck drivers, and supervisors.

About six months before the requested HHE, two employees became sick, allegedly from exposures to solvents at work. This led the owner of the company to perform an in-house investigation, which included personal interviews with the workers. A consultant was hired to collect blood samples for determination of blood solvent concentration (volatile aromatic hydrocarbons) and an insurance company performed environmental sampling. The two ill workers were evaluated by physicians, including internists, neurologists and psychiatrists, and were later seen at an occupational health clinic.

Eight employees had their blood tested for solvent concentrations by the company consultant. These workers were employed in paint making, the spray and dipping process, and parts cleaning. The blood solvent concentrations were in the following ranges: xylene: 128.5 to 708.0 parts per billion (ppb); toluene: 29.3 to 48.6 ppb; and ethylbenzene: 59.6 to 152.0 ppb. These solvent levels indicate an environmental exposure but are below the levels that would correspond to airborne exposures at or over their respective OSHA Permissible Exposure Limits (PELs).[1] Since these solvents are metabolized in the body, and also excreted unchanged through the lungs, blood levels reflect actual body burden only if the samples were collected at the end of the work shift. Environmental sampling did not reveal levels of xylene or toluene in excess of the 100 parts per million (ppm) PEL for xylene or the 200 ppm PEL for toluene.

After the company's consultant completed the blood tests and the environmental sampling, the company instituted the use of half-face cartridge respirators for spray painters, and cleaned the spray booths to reduce exposures. At the time of the initial NIOSH visit, only spray painters wore respirators.

Since investigations by the consultants were inconclusive, the owner decided to request a NIOSH health hazard evaluation.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

On the follow-up visit in May 1987, five personal air samples and one area air sample were collected to determine the average full-shift exposures to solvent vapors in Plant No. 1. To monitor exposures for Paint Makers and Fillers working in the basement, NIOSH industrial hygienists sampled day-shift workers from 5:00 am to 1:00 pm. Workers on the first floor spraying epoxy paint were sampled from 7:00 am to 1:00 pm. Two short-term area samples (70 minutes) were also taken in the paint making and filling areas. In Plant No. 2, three workers involved with spraying mine caps with primer, followed by a green finish coat, were sampled from 7:00 am to 2:00 pm. One area sample was also taken near a drying oven.

Two workers removing paint from parts that had soaked overnight in a tank of xylene were sampled for the duration of the job, lasting about one hour for one worker, and about 30 minutes for the other worker.

The personal air samples were collected near the workers' breathing zones by attaching vapor absorbing charcoal tubes to the shirt collar. The tubes were attached via plastic tubing to battery powered air sampling pumps that had been calibrated to pull a measured volume of air through the tubes at a flow rate of about 50 cubic centimeter (cc) of air per minute. Short term samples were collected at a flow rate of 100 cc per minute.

Based on information obtained from Material Safety Data Sheets, and the results from one bulk air sample collected in Plant No. 2, the samples collected were analyzed by gas chromatography for the following organic vapors: xylene, toluene, VM & P naptha, mineral spirits, n-butyl acetate, 2-ethoxyethane, butoxyethanol, ethyl acetate, isopropyl acetate, and isopropyl alcohol.

B. Medical

During the follow-up visit, a questionnaire was administered to all 21 employees in the production areas. The questionnaire was a modification of the "Swedish 16" neurotoxic questionnaire[2] and has been used in a number of studies.[3] Pre- and post-shift urine samples were collected for determination of methyl-hippuric acid (MHA) concentration. MHA is a specific indicator of xylene absorption and metabolism in the human body. Since the half-life of xylene in the human body is only a few hours,[1] the urine level of MHA at the beginning of the work shift would be lower than the level at the end of the work shift.

Forty-five urine samples were collected from 21 production workers and three presumably unexposed, office employees. The production workers gave a pre- and post-shift urine sample, whereas only one sample was obtained from office workers. These samples were immediately frozen on dry ice and sent to the NIOSH laboratory in Cincinnati, Ohio. They were kept frozen until the day of analysis. An aliquot of the urine sample was saturated with sodium chloride and subsequently isolated from interfering compounds by extraction into ethyl acetate. A portion of the extract was then dried under a stream of nitrogen and redissolved in an equal volume of water. Resolution and quantitation was then accomplished by high performance liquid chromatography using a reverse phase column and a mobile phase consisting of water/acetonitrile/acetic acid, 90/10/.02% (v/v). The concentration of meta-methylhippuric acid was determined by utilizing NIOSH analytical method #8301.[4] The urine creatinine was also measured and the methyl-hippuric acid levels were then expressed as milligrams of methyl-hippuric acid per gram of creatinine.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (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) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that employers are legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

B. Substances Identified Above the Limit of Quantitation

1. VM & P Naptha

VM & P naphtha (Varnish Makers' & Printers' Naphtha) is a clear, mobil, flammable liquid with a boiling point ranging from 118° to 179° C. It has a fast evaporation rate and a narrow distillation range. It is composed of C_5 to C_{11} organic compounds. Typical formulations are composed of 55.4% paraffins, 30.3% napthens, 11.7% alkyl benzene, 2.4% dicycloparaffins, and less than 1% benzene.

VM & P naphtha has been reported to have an acute toxicity four times greater for rats and other species than rubber solvent[15], a solvent similar to VM & P, but containing a greater percentage of lower molecular weight C_5 to C_7 organic compounds. In addition, there has been one report of unspecified chronic effects from exposure to 800 ppm of VM & P naphtha, while the same author did not report any complaints from considerably higher exposures to rubber solvent.[16] For these reasons the TLV for VM & P naphtha was set lower than that for rubber solvent. A TLV of 300 ppm, as a time-weighted average, and a STEL of 400 ppm are recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). On the other hand, NIOSH recommends, on a weight-basis, an identical limit for all common petroleum solvents; 350 mg/M^3, or about 75 ppm for VM & P naphtha and 90 ppm for rubber solvent.

2. Xylene

Xylene vapor may cause irritation of the eyes, nose, and throat. Repeated or prolonged skin contact with xylene may cause drying and defatting of the skin, which may lead to dermatitis. Liquid xylene is irritating to the eyes and mucous membranes, and aspiration of few milliliters may cause chemical pneumonitis, pulmonary edema, and hemorrhage. Repeated exposure to the eyes to high concentrations of xylene vapor may cause reversible eye damage. Acute exposure to xylene vapor may cause central nervous system depression and minor reversible effects upon the liver and kidneys. At high concentrations xylene vapor may cause dizziness, staggering, drowsiness, and unconsciousness.[6] Workers exposed to concentrations above 200 ppm complain of loss of appetite, nausea, vomiting, and abdominal pain. Brief exposure of humans to 200 ppm has caused irritation of the eyes, nose, and throat.[6]

The current OSHA PEL for xylene is 100 ppm averaged over an 8-hour work shift. The NIOSH REL is 100 ppm, averaged over a work shift of up to 10 hours per day, 40 hours per week, with an acceptable ceiling level of 200 ppm averaged over a 10-minute exposure.[7] The ACGIH TLV, first adopted in 1967, is retained, with a short-term exposure limit (STEL) of 150 ppm for a 15-minute exposure and a 100 ppm time-weighted average TLV for an 8-hour exposure.[5]

3. Mineral Spirits

Mineral spirits are clear colorless liquids with a pleasant sweetish odor. They are commonly used as a general-purpose industrial solvent and as a thinner in paints and varnishes. Prolonged or repeated contact with the skin can cause moderate skin irritation or dermatitis. Ingestion of mineral spirits can cause gastrointestinal irritation, nausea, vomiting, and diarrhea. If swallowed, aspiration into the lungs causes chemical pneumonitis, which can be fatal. Airborne concentrations of mineral spirits above 2,500 mg/M^3 have been shown to cause nausea and vertigo in humans.[8] Inhalation of mineral spirits vapors can irritate the upper respiratory tract and will depress the central nervous system, resulting in dizziness, weakness, fatigue, nausea, headache, and under conditions of severe exposure, unconsciousness and possible asphyxiation. The 10-hour TWA exposure limit recommended by NIOSH is 350 mg/M^3, with a ceiling limit of 500 mg/M^3. These limits were established to prevent symptoms of central nervous system depression, upper respiratory irritation, and chronic responses based on the projected toxicities of the major aliphatic (70-90%) and aromatic (10-30%) components of mineral spirits.[8]

C. Adverse Health Effects from Solvent Exposure

In the past, the effects of solvents most often described were the acute irritating effects on mucous membranes, acute intoxication, and the effects on the blood. More recently, extensive studies in Scandinavia have shifted the focus to chronic, neurological and neuropsychological effects, as well as to the cancer-causing potential of the aromatic and halogenated hydrocarbons.[1-13-14] These studies have resulted in progressively declining recommended exposure limits for organic solvents, enclosure of processes, and substitution of toxic solvents with less hazardous solvents.

1. Solvent Effects on Mucous Membrane

Nasal and sinus symptoms are common among solvent-exposed workers and, along with eye irritation, form the basis for many of the existing TLVs.[10] A study of solvent-exposed painters

revealed a high prevalence of asymptomatic histologic abnormalities on nasal mucosal biopsy, compared with non-exposed controls.[11] Paraosmia and hyposmia (smell disorders) are also commonly induced by respiratory exposure to solvents.

2. Neurologic Effects of Solvents

Solvents easily cross the blood-brain barrier, with high concentrations found in the white matter. The assessment of neuropsychological effects of exposure to solvents has been a controversial subject, beginning with individual case reports in the mid 1940s associated with carbon disulfide exposure, and including the studies of 50 workers chronically exposed to trichloroethylene while degreasing metal. Using neurobehavioral tests and psychiatric evaluations, investigators defined a syndrome they called the "psychoorganic syndrome."[12] The syndrome comprises memory disturbances, difficulties in understanding, and mood changes. Acute intoxicating symptoms, such as dizziness, usually follow exposures.

The symptoms are worse during the week and resolve over the weekend. Later, anxiety and depression are common, with chronic symptoms of headache and dizziness. Memory impairment, fatigue, difficulty in concentration, emotional lability, and dysfunction of the automatic nervous system follow bursts of perspiration, palpitations, diarrhea, and impotence.[13]

Compared with non-exposed workers, workers exposed to mixtures of organic solvents have increased symptoms of fatigue, difficulty concentrating, and headache.[1] In some cases, pre-exposure military neuropsychological test results were available for comparison, allowing the demonstration of deterioration of intellectual performance and memory, differences in psychomotor performance and dexterity, and reduction in emotional responsiveness.[14]

VI. RESULTS AND DISCUSSION

A. Environmental

The exposures to xylene, toluene, VM&P naptha, mineral spirits and n-butyl acetate are given in Table 1. Individually none of these exposures were in excess of the NIOSH REL. Because each of the vapors detected can adversely effect the central nervous system, their combined effects may be considered additive. A combined exposure value was calculated according to the formula recommended by the American Conference of Governmental Industrial Hygienists (ACGIH).[5] If the combined exposure value exceeds unity (1.0), exposure to the solvent mixture is considered to exceed the ACGIH recommended limit. When considering combined exposures to all the solvent vapors quantitated, only the paint maker/filler (sample CT-3) was exposed above existing criteria (Table 1).

Excess exposures to xylene vapors were detected for two workers stripping paint from parts left soaking in a tank of xylene solvent. Exposures of these workers during parts cleaning operation averaged 156 ppm for 1 hour, and 173 ppm for 30 minutes respectively. The ACGIH recommended short term exposure limit (STEL) for xylene is 150 ppm for an exposure duration of no more than 15 minutes.

A bulk air sample, collected in Plant No.2 during spray painting of the mine caps with green lacquer, was submitted to the NIOSH laboratory for qualitative analysis by gas chromatography/mass spectrometry (GCMS). The organic vapors identified in the sample were methyl ethyl ketone (MEK), isopropanol, toluene, xylenes, n-butyl acetate, isopropyl acetate, ethyl acetate, and a trace of n-butanol. MEK and isopropanol were the major contaminants of the air sample collected. All of these compounds had been listed as components of the paint on the supplier's Material Safety Data Sheet.

B. Medical

Of the 18 employees initially interviewed, one complained of difficulty concentrating, three complained of headaches, and two complained of strong odors. There were no other specific health complaints reported. The questionnaires, however, did not reveal any specific neurological complaints nor was any job category or department associated with an increase prevalence of symptoms. The personnel records indicated a high turnover of the workforce. This may have been due to layoffs as a result of changes in workload. (Workers who had left work were not contacted and their health status remains unknown).

Methyl-hippuric acid results are summarized in Table 2. The lowest and highest values of methyl-hippuric acid for the pre-shift urine samples were 15.5 and 349.6 mg/gram of creatinine, respectively (average = 89.9). The lowest and highest post-shift values were 29.0 and 3421.0 mg/g creatinine, respectively (average = 458.2). The average cross-shift rise in urinary methyl-hippuric acid was 461.4, with a standard deviation (S.D.) of 827.4 ($p< 0.05$). The levels of urinary MHA as a "tentative maximum permissible value" is 1500 mg/g creatinine, which corresponds to an approximate xylene exposure of 100 ppm, the OSHA PEL.[9] Two of the participants, both paint makers, had a post-shift urine MHA concentration greater than 1500 mg/gram of creatinine. Two other workers, a paint maker and a filler, had levels between 500 and 1000 mg/gram creatinine. The area and personal air sampling showed that the paint makers and filler and labelers had the highest full-shift exposures (Table 1). The two paint strippers had an average cross-shift change in MHA of 387.3 mg/g creatinine.

VII. RECOMMENDATIONS

1. A ventilation consultant should determine the appropriate local exhaust methods to control exposures in the paint formulation areas in Plant No. 1 and for paint stripping operations in Plant No. 2. General ventilation improvements are also needed, particularly in the basement area of Plant No. 1.

2. Until such time as the ventilation is improved, the paint makers should wear NIOSH-approved organic vapor respirators when working in the basement of Plant No. 1. A respiratory program consistent with the requirements of the General Industry Occupational Safety and Health Standards (29 CFR 1910.134) should be implemented.

3. Special tasks such as parts cleaning, or other activities where solvents are used extensively, should also require the wearing of proper respiratory protection.

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:

Suresh Gupta, M.D.
Visiting Scientist
Medical Section
Hazard Evaluations and
Technical Assistance Branch
Cincinnati, Ohio

Richard Kramkowski
Industrial Hygiene Engineer
NIOSH, Atlanta Regional Office
Atlanta, Georgia

Stan Salisbury, C.I.H.
Industrial Hygienist
NIOSH, Atlanta Regional Office
Atlanta, Georgia

Report Typed By:	Patricia C. McGraw Clerk (Typing) Medical Section
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies NIOSH Cincinnati, Ohio
Laboratory Analyses:	Staff Measurements Research Support Branch, NIOSH Cincinnati, Ohio

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 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 the NIOSH Publications Office at the Cincinnati, Ohio address. Copies of this report have been sent to:

1. Riley Brothers Inc., Burlington Iowa
2. DHHS, PHS, DPHS, Region V, Chicago, Illinois
3. OSHA, Region V, Chicago, Illinois

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 1
AIR SAMPLE RESULTS

HETA 87-121
RILEY BROTHERS INC.
BURLINGTON, IOWA

May 13, 1987

Job Classification	Sample No.	Start	Stop	minutes	Xylene ppm	Toluene ppm	VM&P mg/m^3	M Sp mg/m^3	NBA ppm	Combined Exposure Value
Plant 1		(24 hr. clock)								
Spray Painter (epoxy)	CT-1	0655	1352	417	ND	ND	trace	ND	ND	0.1
Painter Helper (epoxy)	CT-5	0701	1350	409	trace	ND	47.5	ND	ND	0.2
Paint Maker	CT-2	0501	1250	469	trace	trace	126.1	55.2	trace	0.8
Paint Filler & Labeler	CT-4	0510	1320	490	36.6	ND	124.4	ND	ND	0.7
Paint Maker & Filler	CT-3	0512	1300	468	90.6	ND	254.0	ND	trace	[1.7]
Paint Making Area	CT-9	0737	1316	339	30.1	ND	196.0	trace	ND	0.9
Paint Making Area	ST-2	1206	1316	70	trace	ND	234.2	ND	trace	1.2
Paint Filling Area	ST-3	1207	1320	73	54.7	ND	118.5	ND	ND	0.9
Plant 2										
Sprayer, mine caps primer	CT-6	0717	0850	93	ND	ND	ND	ND	ND	0
Sprayer, mine caps green	CT-11	0850	1023	93	ND	ND	ND	ND	ND	0
Sprayer, mine caps both	CT-13	1025	1428	243	ND	ND	trace	ND	ND	0.1
Drying Oven Area	CT-7	0720	1426	426	ND	ND	ND	ND	ND	0
Spray Line Parts Handler	CT-8	0726	1427	421	ND	ND	ND	55.1	ND	0.2
Xylene Parts Cleaning	ST-1	0914	1015	61	[156.3]	ND	trace	ND	ND	N/A
Xylene Parts Cleaning	ST-4	1340	1414	34	[172.9]	ND	trace	ND	ND	N/A
Evaluation Criteria - ACGIH 8-hour TWA or (NIOSH REL)					100	100	(350)	(350)	150	1.0
- Short Term Exposure Limit (STEL)					150	150	1800	1800	200	N/A
- [Indicates Excess Exposure]										

M Sp = mineral spirits ND = None Detected
NBA = n-butyl acetate N/A = Not Applicable

Trace - Value indicates substance was detected but its concentration was below the limit of quantitation. Limits of quantitation varied depending on the air sample volume, but were typically less than (<) 25 ppm for xylene, <6 ppm for toluene, <86 mg/m^3 for VM & P naptha, <55 mg/m$_3$ for mineral spirits, and <17 ppm for n-butyl acetate.

TABLE 2

MEAN CHANGES IN METHYLHIPPURIC ACID
AND
COMBINED SOLVENT EXPOSURE BY JOB CATEGORY

RILEY BROTHERS, INC.
BURLINGTON, IOWA

HETA 87-121

Job Category	No.of Samples	Mean Increase in HA*	S.D.
Paint Maker	6	1117.5	1229.6
Paint Sprayer	5	47.9	61.8
Filler & Labeler	3	286.6	183.1
Lab Tech.	2	154.5	81.9
Supervisors	2	77.3	90.2
Truck Driver	2	4.8	15.0

* The difference in hippuric acid level between pre and post-shift.

MAJOR DEPARTMENTS

Plant No. 1

Spray paints (epoxy)
Painter helper (epoxy)
Paint maker
Paint filler and labeler
Paint maker and filler

Plant No. 2

Sprayer
Spray line parts handler
Parts cleaner