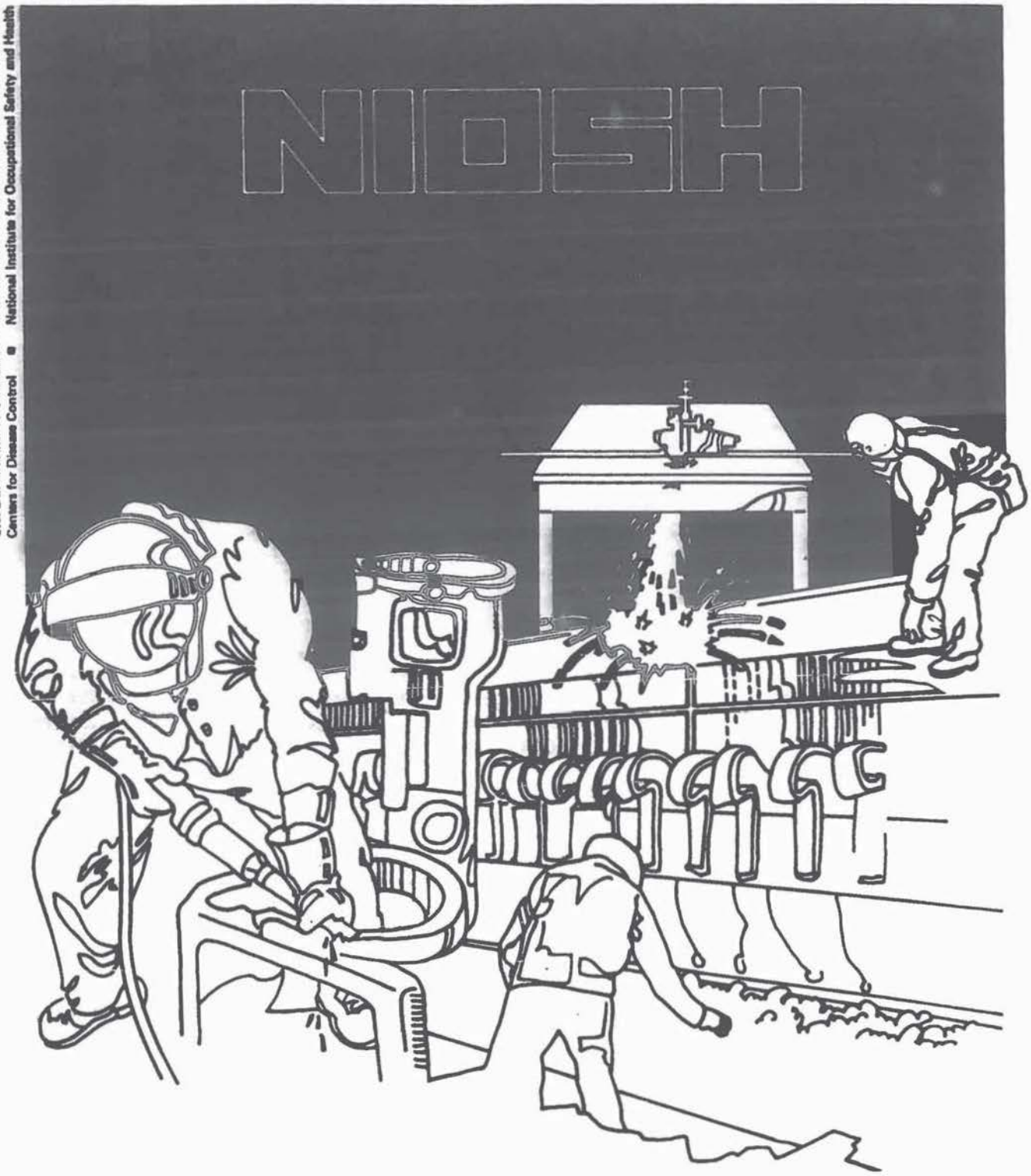
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 82-025-1413
AMERICAN TRANSPORTATION CORPORATION
CONWAY, ARKANSAS

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 82-025-1413
JANUARY 1984
AMERICAN TRANSPORTATION CORPORATION
CONWAY, ARKANSAS

NIOSH INVESTIGATORS:
John N. Zey, I.H.
Tar-Ching Aw, M.D.

I. SUMMARY

In October 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation at American Transportation Corporation, Conway, Arkansas. The request resulted from an outbreak of dermatitis, which occurred during the summer of 1981, and health concerns expressed by employees regarding exposure to solvents and other chemicals in and around the paint area on the main assembly line of the main plant.

In February 1982, NIOSH conducted an environmental and medical field evaluation at the Conway facility.Environmental samples were collected to evaluate employee exposure to airborne lead, hexavalent chromium, total particulate, and various organic solvents. A medical questionnaire was adminstered to workers in the paint area (Dept. 46) and Finish I department (Dept. 47), and a comparison group of 26 employees. Blood and urine specimens were collected from all participants for determination of systemtic absorption and effects of lead and organic solvents.

Five airborne hexavalent chromium samples had concentrations ranging from 0.03 to 0.45 mg/m^3. All were above the NIOSH recommended standard of 0.001 mg/m^3 for carcinogenic hexavalent chromium compounds. Four of the samples were also above the OSHA ceiling value of 0.1 mg/m^3. Airborne lead concentrations ranged from below the laboratory limit of detection to 2.01 mg/m^3. Four of the eight samples collected were above the lowest current criterion (OSHA, NIOSH) of 0.05 mg/m^3. Total particulate concentrations ranged from 4.3 to 19.2 mg/m^3. Four of the eight personal samples collected exceeded the ACGIH TLV of 10 mg/m^3 for total nuisance particulate and two exceeded the OSHA PEL of 15 mg/m^3. Airborne concentrations for solvent mixtures (additive effects were calculated using the ACGIH TLV formula for mixtures) ranged from 0.03 to 0.87. The values were all below current criteria for individual components and for cumulative exposures. Overexposure for additive effects would be indicated by exceeding 1.0 using the ACGIH TLV formula.

All excessive values for lead and hexavalent chromium were obtained on spray painters who wore airline respirators while painting. The exact concentration inside the hood was not determined. However, a number of problems were noted concerning the maintenance of the supplied air respirators and the ventilation system for the exhaust booth.

The medical evaluation confirmed an outbreak of short-duration dermatitis during the summer in 1981 affecting mainly workers in the Finish I department. This department is located next to the high-temperature (250-300°F) drying oven. Unusual working conditions at the time included (1) adverse weather conditions of high environmental temperature with high relative humidity (2) Increasing use of glues and solvents due to increased production, and (3) a new solvent introduced just before the outbreak occurred, but which was shortly withdrawn following worker complaints regarding its odor. Several or all of these factors acting together could have been responsible for the outbreak of dermatitis.

Based on these results, NIOSH has determined that a potential health hazard did exist from exposure to hexavalent chromium and lead for employees working in and around the paint booth. In addition, a number of potential health and/or safety hazards were observed in and near the paint booth. These include a dermatitis risk next to the drying oven, ignition sources being used near flammable materials, improper storage of potentially toxic chemicals, and using solvents for cleaning the hands at the end of the shift. Recommendations are made in this report (Section VIII) for improving work practices and personal protective equipment, and reducing the risk of dermatitis.

KEYWORDS: SIC 3711 (Motor Vehicle and Passenger Car Bodies), hexavalent chromium, lead, toluene, xylene, chemical storage, dermatitis.

II. INTRODUCTION

On October 26, 1981, NIOSH received a request from an authorized representative of the United Auto Workers, Local 1762, for a health hazard evaluation at American Transportation Corporation, Conway, Arkansas. The request concerned an outbreak of dermatitis in the summer of 1981, and irritation of the eyes, nose, throat and respiratory tract among employees working in and around the paint area on the main assembly line of the main plant. Health concerns were also expressed by employees exposed to solvents and other chemicals.

NIOSH conducted an evaluation during February 8-12, 1982. The survey consisted of an opening conference and a subsequent walk-through survey on February 8, an environmental/medical evaluation on February 9-11, and a closing conference on February 12.

An interim report presenting preliminary environmental findings was distributed in November 1982. Results of medical tests were forwarded to all individuals who participated in the medical evaluation.

III. BACKGROUND

American Transportation Corporation manufactures school and general purpose buses. The Conway facility began production in 1933. The area with which the request was concerned began production in 1954. The facility was formerly known as the Ward Bus Company. American Transportation purchased the facility in 1980.

This facility receives bus chassis (with motor) and builds and finishes the bus body. The paint area is located near the end of a production line which builds the bus body. Initially, the body floor, made of commercial quality galvanized steel, is assembled. Subsequently, the remaining body sections (front and rear sections, side panels, roof, and an inside lining) are added. Employees located approximately 20 to 40 feet from the entrance of the paint booth wash down the inside of the body using petroleum-based naphtha and/or lacquer solvents. Adjacent to the paint booth entrance is a pit where one employee undercoats each bus. Inside the paint booth, four employees wash down the outside of the body using naphtha and/or lacquer solvents. Next, two employees touch up the primer to ensure that all bare metal has been coated. Subsequently, three employees (one for the inside) paint the front, back, and inside of the body. While spray painting, the employees wear supplied-air hoods consisting of a hard cap with a polylaminated Tyvek® shroud, a flexible breathing tube, a regulating valve assembly, and a high pressure hose. In conjunction with the manual spray painting, automatic spray guns paint the sides and top of

the body. Following spray painting, bus bodies go through an oven where they are heated to approximately 250-300°F. They exit from the oven to enter an area called Finish I. In Finish I, windows, doors, floor mats, lights, seats, and all other finishing materials are added to the body. In the installation of the floor mats, one employee sprays a hexane-based adhesive onto the bottom of the floor mats, which are subsequently allowed to air dry for approximately 30 minutes. Then, a second employee sprays adhesive onto the bottom of the bus floor, after which the floor mats are installed. Near the end of Finish I, lettering is applied to each bus using either stencils and paint, or decals. As each bus body reaches the end of the main assembly line, it is attached to a chassis/motor unit forming a complete bus.

IV. METHODS AND MATERIALS

A. Environmental

Environmental monitoring was conducted to evaluate employee exposures to airborne concentrations of lead, hexavalent chromium, total particulate, and organic solvent vapors.

Lead samples were collected on polyvinyl chloride (PVC) filters attached via flexible tubing to a battery-operated pump calibrated at 1.5 liters per minute (LPM). Hexavalent chromium samples were collected on PVC filters attached via flexible tubing to a battery-operated pump calibrated at 1.5 LPM. Personal samples for solvent vapors were collected to evaluate specific organics (methyl ethyl ketone, hexane, toluene, xylene, and benzene) and petroleum naphtha. Sampling trains consisting of two charcoal tubes attached via flexible tubing to a battery-operated pump were used. Each charcoal tube (of the two-tube setup) had a separate limiting orifice that enabled concurrent samples to be collected at flow rates of approximately 20 cubic centimeters per minute (cc/m). Area airborne bulk samples for solvent vapors were collected on charcoal tubes attached via flexible tubing to a battery-operated pump calibrated at 50 cc/m. These samples were collected to assist the laboratory in the analysis of personal samples.

Grab samples were collected for n-hexane and toluene using certified direct-reading indicator tubes.

Lead samples were wet ashed with nitric and perchloric acids to ensure their complete oxidation and then analyzed by atomic absorption spectrophotometry using NIOSH Method No. P&CAM 173.[1]

Hexavalent chromium samples were analyzed using colorimetry according to NIOSH Method No. P&CAM 319.[2]

Samples used to collect organics were analyzed using gas chromatography according to NIOSH Method No. P&CAM 127[3] with modifications specific for the analytes of concern.

For the naphtha analysis, bulk liquid material samples were analyzed directly or mixed with carbon disulfide first to extract any organic solvents present. These liquid bulk or bulk extracts were then screened by gas chromatography utilizing a flame ionization detector. The bulk air samples were desorbed with carbon disulfide and also screened by gas chromatography. Subsequently, some of the airborne bulks were further analyzed by gas chromatography/mass spectroscopy to identify major peaks. Based on the qualitative results obtained from the bulk air samples, personal airborne samples were quantitated for various compounds identified on the bulk samples but not requested on the duplicate set of charcoal tubes (duplicate tubes had been analyzed separately for specific organics).

For this report a personal sample refers to a sample collected on an employee. The specific collection media was thus attached to an employee's lapel and as close as possible to the employee's nose and mouth.

B. Medical

The medical aspect of the survey consisted of a medical assessment of all 37 employees in Department 46 (paint line) and all 20 workers from Department 47 (Finish I), which were the two main areas where symptoms reportedly occurred. A total of 57 workers from both of these areas participated. In addition, a comparison group of 26 employees selected from Department 50 (Glass department, - 19 workers) and Department 57 (Upholstery department, - 7 workers) were similarly assessed. This group was randomly selected from a list of all current employees in Departments 50 and 57. These two departments were chosen because they were distant from the Finish I and paint line areas, and there was minimal chemical usage in these departments. The size of this comparison group was intended to be comparable to the number of workers in Department 46 (37 workers) and Department 47 (20 workers).

A questionnaire on dermatological problems and occupational exposure to organic solvents and other chemicals was administered to all participants. Blood specimens were taken by venipuncture for assessment of lead absorption (blood lead levels, hemoglobin, and free erythrocyte protoporphyrin) and effects of organic solvents (liver and kidney function tests). The liver function tests included

determination of serum levels of the liver enzymes alanine aminotransaminase (ALT), aspartate aminotransaminase (AST), and gamma glutamyl transpeptidase (GGT). The renal function tests were blood urea and serum creatinine levels.

Urine specimens were collected for hippuric acid and methyl hippuric acid analysis. Hippuric acid is a metabolite of toluene, and methyl hippuric acid is a specific metabolite for xylene. The urine samples were collected in 250 ml plastic bottles, preserved with thymol, and maintained at reduced temperatures while in transit and in storage before laboratory analysis. Hippuric acid analysis was done by high-performance liquid chromatography using the method described by Matsui et al.[4] Methyl hippuric acid analysis was by a similiar method.

IV. 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 standards, 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 industry is legally required to meet only 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. Environmental criteria are included in Table I.

The following is a discussion of the main chemicals evaluated at this facility:

A. Toluene

Toluene (methyl benzene) is a clear aromatic organic solvent. It can cause irritation of the eyes, respiratory tract, and skin. In high concentrations, it causes dizziness, drowsiness, headaches, nausea, and vomiting.[5,6] Blood effects linked to toluene exposure are thought to be due to benzene present as a contaminant in commercial toluene. Toluene may be absorbed systemically through the skin and respiratory tract. It is metabolized in the liver by conversion to benzoic acid, which is then conjugated with glycine to form hippuric acid. Hippuric acid is excreted in the urine. Dietary sources contribute to endogenous hippuric acid. Urinary levels in individuals not exposed to toluene range from 0.4 to 1.4 mg/ml.[7] In workers exposed to 100 parts per million (ppm) of toluene, the end-of-shift hippuric acid level is about 4 mg/ml. NIOSH recommends that an end-of-shift level of more than 5 mg/ml be considered unacceptable since it is indicative of toluene exposure averaging 200 ppm. The NIOSH recommended standard for toluene is 100 ppm or 375 milligrams per cubic meter of air (mg/M^3) as a TWA exposure for an 8-hour workday with a ceiling of 200 ppm for a 10-minute sampling period.[8] The ACGIH TLV is 100 ppm as an 8-hour TWA with a short term limit of 150 ppm.[9] The OSHA Permissible Exposure Limit (PEL) for toluene is 200 ppm (750 mg/m^3) as an 8-hour TWA with an acceptable ceiling concentration of 300 ppm.[10]

B. Xylene

Xylene is a colorless, flammable liquid with an aromatic odor. It

exists in three isomeric forms - ortho-, meta-, and para-xylene. Commercial xylene (xylol) is a blend of these isomers, with meta-xylene as the predominant component. Xylene vapor can irritate the eyes, nose, and throat. Acute exposures can cause central nervous system depression and reversible effects upon the liver and kidneys.[11]. Repeated or prolonged exposure to xylene can cause dermatitis. Systemic absorption can occur through the intact skin and respiratory tract. Reversible hematopoeitic depression has been shown in animal studies. Rabbits repeatedly exposed to isomers of xylene show a reversible decrease in red and white cell count and an increase in thrombocytes.[5] Variation may exist in the degree of individual sensitivity to xylene; continual exposure may increase such sensitivity.[6] Xylene is metabolized to methyl hippuric acid which is then excreted in the urine. Methyl hippuric acid is not a normal urinary constituent and its presence therefore indicates xylene absorption. The current criteria for xylene is 100 ppm (435 mg/m) as a TWA exposure for NIOSH (up to 10-hour) OSHA (8-hour) and ACGIH (8-hour).[9,10,12]

C. Lead

Inhalation of lead dust and fumes is the major route of lead exposure in industry. A secondary source of exposure may be from ingestion of lead dust contaminated on food, cigarettes, or other objects. Once absorbed, lead is excreted from the body very slowly. The absorbed lead can damage the kidneys and nervous system, and affect bone marrow function. These effects may manifest as weakness, tiredness, abdominal colic, constipation, and encephalopathy.

Blood lead levels from daily environmental exposure are ordinarily below 40 ug/100 ml whole blood, usually below 30 ug/100 ml. Fetal damage in pregnant women may occur at blood lead levels as low as 30 ug/100 ml. Lead levels between 40-60 ug/100 ml in lead-exposed workers indicate excessive absorption of lead and may result in some adverse health effects. Levels of 60-100 ug/100 ml represent unacceptable elevations which may cause serious adverse health effects. Levels over 100 ug/100 ml are considered dangerous and often require hospitalization and medical treatment.

Free erythrocyte protoporphyrin (FEP) reflects the average lead effect over a period of about 120 days.[13] The Centers for Disease Control consider an FEP level equal to or more than 50 ug/dl of whole blood as an indication of undue lead absorption.[14] Reduction of hemoglobin and hematocrit can indicate an effect on the red blood cells by lead. Normal values for these parameters are shown in Section VI.

Portions of the OSHA lead standard have been stayed by the courts. However, the current OSHA standard for airborne exposure to lead has an implementation schedule requiring the various lead associated industries to eventually achieve an airborne exposure level of 50 ug/m^3. Some industries (i.e. primary lead production) are given longer to achieve this exposure level without the use of respirators. For this particular industrial operation (spray-painting), the current permissible exposure limit is 50 ug/m^3. The NIOSH recommended standard is also 50 ug/m^3 and the ACGIH TLV is 150 ug/m^3.[9] If an employee is exposed to lead levels greater than OSHA's present action level of 30 ug/m^3, the standard dictates that the employer must develop and implement: 1) a semi-annual blood lead monitoring program; 2) annual physical examinations; and 3) training of employees regarding the signs and symptoms of overexposure to lead. A stayed portion of the lead standard states that workers with blood lead levels greater than 50 micrograms of lead per 100 grams of blood (50 ug/100 g) must be immediately removed from further lead exposure and in some circumstances workers with lead levels less than 50 ug/100 g must also be removed. Removed workers have protection for wage, benefits, and seniority for up to 18 months until their blood lead levels decline to less than 40 ug/100 g and they can return to lead exposure areas.[15]

D. Hexavalent Chromium

Chromium compounds may exist in the bivalent (+2), trivalent (+3) or hexavalent (+6) states. Exposure to chromium compounds has been associated with dermatitis and the development of pulmonary sensitization. In general, bivalent and trivalent compounds are considered to be of a low order of toxicity.[11,16]

Hexavalent chromium compounds have been implicated in a number of health problems including skin ulceration, ulcerated nasal mucosal, perforated nasal septum, rhinitis, nosebleed, perforated eardrums, kidney damage, pulmonary congestion and edema, epigastric pain, erosion and discoloration of the teeth, and dermatitis. In addition, some hexavalent chromium compounds have been associated with an increased rate of lung cancer.[17]

Hexavalent chromium compounds have been divided into noncarcinogenic chromium (+6) compounds including the monochromates and bichromates of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium, and chromium (+6) oxide (chromium acid anbydride). Carcinogenic chromium (+6) compounds represent all chromium (+6) materials not included in the noncarcinogenic group above.[17]

The OSHA PEL for chromium compounds is 0.5 mg/m^3 for soluble chromic and chromous salts as Cr and 1.0 mg/m^3 for chromium metal and insoluble salts with a ceiling value of 0.1 mg/m^3 for chromic acid and chromates. The ACGIH TLV is 0.50 mg/m^3 with certain water insoluble compounds being considered as human carcinogens.[9] The NIOSH recommended standard is 0.025 ug/m^3 for non-carcinogenic and 0.001 ug/m^3 for carcinogenic chromium (+6) compounds.[17]

E. n-Hexane

Overexposure to hexane may cause lightheadedness, giddiness, nausea, and headache. It may also cause irritation of the eyes and nose. Higher exposures may cause unconsciousness and death.

Polyneuropathy has been reported in workers exposed to the vapors. Other chronic effects have rarely been reported. The liquid is a defatting agent and prolonged exposure may cause irritation of the skin. Aspiration may cause a chemical pneumonia.[5]

The OSHA PEL for hexane is 1800 mg/m^3 (500 ppm) based on an 8-hour time TWA.[10] NIOSH recommends that occupational exposure to airborne hexane be no greater than 350 mg/m^3 (100 ppm) for up to a 10-hour workshift with a ceiling concentration of 1800 mg/m^3 (510 ppm) as determined over a 15-minute sampling period.[18] The ACGIH TLV is 180 mg/m^3 (50 ppm) as an 8-hour TWA.[9]

VI. RESULTS

A. Environmental

Table II presents the results of sampling for airborne chromium VI. Concentrations ranged from 0.03 to 0.45 mg/m^3. Seven samples were collected, but only five have reported values. The other two could not be analyzed accurately due to chemical interferences. All five samples are above the NIOSH recommended standard of 0.001 mg/m^3 for carcinogenic chromium (VI) compounds. The sampling and analytical technique for determination of chromium VI does not distinguish between carcinogenic and noncarcinogenic chromium IV. Information from material safety data sheets and the combined chromium VI and lead results indicate that lead chromate is the principal chromium component of the paint being used. This is one of the chromium VI compounds considered to be carcinogenic by NIOSH and ACGIH.

Table III presents the results of sampling for airborne inorganic

lead. Concentration ranged from below the limit of detection to 2.01 mg/m^3. Four of eight personal samples are above the OSHA PEL and NIOSH criteria of 0.05 mg/m^3.

Table III also presents the results of sampling for total particulates. Airborne concentrations ranged from 4.3 to 19.2 mg/m^3. Four of the eight personal samples exceeded the ACGIH TLV of 10 mg/m^3 and two of the eight are above the OSHA PEL of 15 mg/m^3.

Table IV presents the results of sampling for solvent vapors. Results are presented for cumulative exposure for materials quantified on the petroleum naphtha tube (acetone, n-hexane, heptane, methyl isobutyl ketone, methylcyclohexane, isobutyl acetate), individual components quantified on the organic solvent tube (toluene, xylene, benzene), and for the total cumulative exposure from both tubes. Exposures to the individual components of the solvent mixtures were below all current criteria. In addition, the cumulative exposures were all below 1 (range 0.03 to 0.87). If the cumulative values had exceeded 1, this would signify overexposure using the ACGIH TLV for mixtures.[9] The maximum exposure concentrations were obtained on employees using solvents to wash buses.

Table V presents the results of sampling for solvent vapors in the undercoat pit and in Finish I. The highest concentrations obtained for individual components were for n-hexane. Two of six samples had concentrations of over 170 mg/m^3. These are approximately one-half of the ACGIH TLV, and the NIOSH recommended criteria of 350 mg/m^3. The cumulative exposures were all below 1.0 (range <0.01 to 0.50). The highest cumulative exposure was one-half of the ACGIH TLV for mixtures.

Table VI presents the results of sampling for airborne vapors of toluene and n-hexane using certified direct-reading indicator tubes. Certified direct-reading indicator tubes are accurate to approximately ±35 percent at one-half the test concentration and ±25 percent at 1 to 5 times the test concentration. The test concentration usually corresponds to the OSHA PEL.[10,19] Concentrations for toluene ranged from nondetected to 25 parts per million (ppm). The highest concentrations (25 ppm) are approximately 17 percent of the ACGIH criteria for short-term exposure TLV-STEL (15-minute period).[9] Airborne concentrations for n-hexane ranged from 15 ppm to 800 ppm. The highest concentrations (500 and 800 ppm) are equal to and 1.6 times the NIOSH recommended criteria for short-term exposure of 510 ppm

(15-minute). Due to a difference in time units, grab sample results cannot be compared directly to the short-term criteria. However, the n-hexane results indicate that at the time of collection the airborne concentrations were at and above the short-term criteria. The highest values were obtained in the breathing zone of employees using glue inside the bus. The actual time required for spraying the adhesive was approximately five minutes inside and five minutes outside, for each bus.

B. General Observations

Production during the survey was estimated to be approximately 35% of what it had been during the time of the dermatitis outbreak. During high production periods, the speed of the main assembly line is increased and additional employees are added to the line.

Both the respiratory protection and hearing protection programs were found to be deficient. Copies of both written programs were requested. No respiratory protection program was received and the hearing protection program was in essence a draft of what would be needed to have a program meeting the OSHA requirements of 1910.95.[20]

Maintenance of the ventilation system for the paint booth and the supplied air hoods needs to be improved. There were cracks and some missing panels in the ventilation ducts for the paint booth. Employees stated that supplies of materials including filters for the airline supplied hood were not always available.

A number of potential safety hazards were noted during the field survey. Employees were observed smoking in areas where flammable solvents are used and/or stored. In addition, some employees cleaned painting equipment with solvents without wearing gloves or any other type of skin protection. Many employees used solvents to clean their hands and arms at the end of the work shift. Employees used two different solvents for washing buses. There were no apparent standard mixtures nor operating procedures for washing the buses. After solvent soaked cloths had been used, they were stored in an open bucket.

Open buckets of solvent materials were routinely setting in the bus wash area. In addition gas fired heaters are located along the conveyor at about 8 feet off the floor. Some of the solvents used in the bus wash and paint booth areas are flammable with flash points below 100°F.

The chemical storage area located outside of the main plant was

primarily uncovered. This was probably responsible for water getting into the larger (55 gallon) paint containers. On several occasions the paint mixer had to remove water from a barrel of paint prior to mixing it with the appropriate solvent. There was one shed used to store 5-gallon cans of paint, but the remaining chemicals were stored in the open. Water covered a lot of the ground and floor of the shed. Many chemical barrels were sitting in water. Labels on some barrels, which had apparently been stored the longest, were not legible. In addition, storage areas for different chemicals were not well defined. These factors contributed occasionally to the wrong barrel of material being taken to the bus wash area.

Welding operations ongoing in other areas of the plant were not always properly screened. At times, it was possible to directly observe welding operations, thus creating a potential eye hazard from ultraviolet radiation.

A riveting operation normally performed prior to bus wash would occassionally be delayed and subsequently both operations performed simultaneously. When this occurred the employees conducting the riveting operation wore hearing protection but some of the employees washing the inside of the bus did not wear any protection. Some employees stated that hearing protection was required in the bus wash area when riveting was conducted nearby.

The availability of personal protective equipment needs to be improved. Employees reported that in addition to filters for the air line hoods, protective gloves were periodically unavailable.

C. Medical

Eighty-three workers participated in the medical evaluation. Five of the 37 painters from Department 46 were excluded from the epidemiologic analyses because while they belong to this department, they work in a different building (the new building) from the rest of the 32 line painters who are in the old building. Hence, statistical analyses were confined to medical evaluation data on 78 workers. Seventy-seven of the 78 workers provided blood samples. Seventy-six of the 78 workers provided urine samples.

The characteristics of the 78 workers included in the data analysis are as shown in Table VII

1. Dermatological Problems

To confirm whether there was an outbreak of dermatitis in the

paint area during the summer of 1981, information on skin problems experienced was gathered on the questionnaire. The case definition used for dermatitis was a skin rash lasting three or more days and/or a physician-diagnosed dermatitis. Forty of the 78 workers (51%) had a "case" history of dermatitis. Fifteen of these cases occurred before the worker began work at this company. Of the remaining 25 workers, 11 had dermatitis in the summer of 1981. Specific non-occupational dermatoses such as scabies, fungal infections, and poison oak and poison ivy rash were excluded from the Table VIII which shows cases of dermatitis occurring during the summer months of 1981.

The difference in rates between all three departments was statistically significant ($p<0.05$; Chi-square test). The dermatitis was commonly described as red, itchy, pin-point spots occurring on the forearms and chest. Most of the cases lasted less than a week and went away without specific treatment.

2. Exposure to Toluene

Seventy-six of the 78 workers provided end-of-shift urine specimens for hippuric acid determination (Table IX).

None of the workers in the 3 departments had urinary hippuric acid levels above 5 mg/ml, which NIOSH considers as unacceptable and indicative of an exposure to 200 ppm of toluene.[8] A urinary level of 4 mg/ml indicates an exposure of around the TLV for toluene i.e. 100 ppm. One worker from the Finish I department had a urinary hippuric acid reading above this level. Environmental hygiene measures however do not indicate air toluene levels near the NIOSH criteria level. In individuals not exposed to toluene the urinary hippuric acid level ranged from 0.4 to 1.4 mg/ml. Six (19%) of 32 workers from the paint department, 5 (25%) out of 20 workers from the Finish I department, and 2 (8%) out of 24 from the glass and upholstery department had urinary hippuric acid levels above 1.4 mg/ml. This suggests a small amount of toluene absorption. There was no significant difference ($p>0.05$; Chi-square test) in hippuric acid levels between the three groups. The paint and Finish I departments nevertheless had a higher proportion of workers with urinary hippuric acid levels above 1.4 mg/ml, consistent with occupational exposure to toluene.

Urinary hippuric acid expressed in mg/ml does not take into account the concentration of the urine sample. Dilute urine samples may show low urinary levels of hippuric acid when such units are used, even if the actual amount of the metabolite is considerable. The use of mg/g creatinine as the unit of expression for urinary hippuric acid is preferable, as the amount of creatinine excreted by a person per day is relatively constant and independent of degree of hydration, diet, and protein metabolism.[21] The use of this unit requires an extra laboratory determination - the amount of creatinine in the urine sample. This was done for all the 74 end-of-shift urine samples collected, and the results for urinary hippuric acid expressed in mg/g creatinine are as shown in the previous table. There is also no statistical difference ($p>0.05$) between the 3 groups for hippuric acid levels expressed in these units.

3. Exposure to Xylene

Nine out of 32 line painters had methyl hippuric acid in the urine (Table X). The mean level was 0.16 mg/ml (0.09 mg/g creatinine) and the range 0.08 to 0.33 mg/ml (0.04 to 0.1 mg/g creatinine). None of the Finish I workers had any detectable urinary methyl hippuric acid. Four of the presumably unexposed comparison group had detectable urinary methyl hippuric acid; all were from the glass department. The mean level was 0.16 mg/ml (0.1 mg/g creatinine)and the range was 0.08 to 0.22 mg/ml (0.06 to 0.13 mg/g creatinine).

These results indicate xylene exposure in the paint and glass departments. NIOSH has no recommended biological monitoring standards for xylene exposure.

4. Central Nervous System Symptoms

All 78 workers interviewed (including the 1 worker who did not provide a blood sample) were asked about specific symptoms experienced more frequently since starting their present job at the company. Symptoms asked were those that can occur with organic solvent exposure and systemic absorption.
All of the symptoms except two (unusually tired and poor memory) were more frequent in the paint department than in the Finish I and glass and upholstery department. (Table XI) "Unusually tired" was reported more in the Finish I than the paint department and less in the glass and upholstery department. "Poor memory" was reported more in the glass and

upholstery department than the paint or Finish I departments. The workers in these 3 departments are comparable in age and length of time in their present jobs. The paint department workers have significantly more dizziness than either the Finish I workers or the glass and upholstery department workers ($p<0.01$, Chi-square test). Drowsiness and headache were reported more frequently in the paint department, though the differences were not statistically significant ($p>0.05$, Chi-square test).

Within the group of 32 painters, urinary methyl hippuric acid levels, and thus xylene exposure, was not epidemiologically associated with symptoms (Table XII).

However, the mean urinary hippuric acid level is statistically significantly higher for the painters with symptoms compared to those without ($p<0.05$; student "t" test) (Table XIII). This applies to the urinary hippuric acid expressed both in mg/ml and mg/g creatinine. Hence, the presence of symptoms appears to be related to the level of toluene absorption.

5. Symptoms of Mucosal Irritation

There was a higher proportion of line painters and Finish I workers with eye, nose, and throat irritation when compared with the glass and upholstery department workers (Table XIV). This difference was statistically significant for nasal irritation ($p<0.05$; Chi-square test).

6. Peripheral Neurological Symptoms

There is no significant difference between departments in the proportion of workers with any one of the following symptoms - pain, weakness, numbness, and tingling (or pins and needles sensation) in the hands or feet, lasting for a total duration of more than a week over the past 3 months (Table XV). Weakness and numbness were the two commonest symptoms. These cases do not include individuals with an underlying medical or surgical condition that could account for the symptoms.

7. Lead Absorption

Blood samples were obtained from 77 of the 78 workers. All except one of the 77 workers had blood lead levels less than 40 ug/100 ml. The exception was one worker in the paint

department with a blood lead level of 44 ug/100 ml. His free erythrocyte protoporphyrin (FEP) level (102 ug/dl) was also elevated. This painter reported tiredness and headaches, but no abdominal colic or constipation.

In addition to the above worker, there were 3 others with an FEP level above 50 ug/dl. One was a painter with an FEP level of 76 ug/dl and no other laboratory or clinical evidence of excessive lead absorption. The second person was a painter with an FEP of 63 ug/dl, a blood lead of 31 ug/100 ml, and slight microcytic, hypochromic anemia. This worker was symptom-free with no past history of chronic blood loss, porphyrias, nor other serious illnesses. The laboratory results suggest an effect of previous excessive lead absorption. The third person was an upholstery department worker with no previous or current occupational lead exposure, who had an FEP level of 104 ug/dl and a blood lead level of 9 ug/100 ml, and there was a microcytic, hypochromic anemia. This latter worker's elevated FEP, and possibly the second painter, may have been due to iron deficiency rather than lead toxicity.

8. Hematology

Exposure to lead or to benzene - contaminated xylene and toluene can cause alterations in blood cell counts. Hemoglobin levels below the normal range of 14 - 18 g/dl for males and 12 - 16 g/dl for females were noted in 6 workers (Table XVI). Total white cell counts were reduced below 4,300/mm^3 in 1 painter, 1 Finish I worker, 3 glass department workers, and 1 upholstery worker. There were no cases showing thrombocytosis, though one painter had thrombocytopenia (less than 140,000 platelets/mm^3). In most of these cases, there was only one hematological abnormality. In 3 cases there were more than one hematological abnormalities. These were:

a. A Finish I Department worker with a reduced total white cell count and a reduced hemoglobin.

b. A glass department worker with hypochromic, microcytic anemia and a reduced white cell count.

c. A painter with a reduced hemoglobin, hematocrit, elevated FEP, and a reduced total white count. This worker, as discussed earlier, may have had previous excessive lead absorption.

The hematological abnormalities did not occur in any pattern suggesting an occupational cause.

9. Renal Function Tests

There is no significant difference between departments for blood urea nitrogen (BUN) or serum creatinine levels.

10. Liver Function Tests

Sixteen of the 77 workers who provided blood samples for analysis had the level of at least one of the 3 liver enzymes (aspartate aminotransaminase, alanine aminotransaminase, and gamma glutamyltranspeptidase) elevated. Eight were from the paint department (25%), 3 from the Finish I department (15%), and 5 (19%) from the combined glass and upholstery department. There was no statistical difference between these groups ($p>0.05$; Chi-square test).

VII. DISCUSSION

Environmental sampling indicates that employees were not exposed to excessive levels of solvent vapors during spray painting or bus wash operations. However, direct-reading indicator tubes detected short-term concentrations of n-hexane at and above the NIOSH recommended short-term criterion in the Finish I area. These values were obtained while employees were spraying glue.

Some personal samples had airborne concentrations of lead and hexavalent chromium in excess of current criteria. The excessive values were all obtained on employees who painted inside the paint booth. These employees wore airline respirators while painting. Due to the collection of samples on the employee's lapel, the actual concentrations inside the respirator was not determined. However, due to the high levels obtained for chromium VI and lead and the problems observed with the respiratory protection equipment it has been determined that a potential health hazard existed for employees exposed to these chemicals.

Due to the health hazards associated with chromium VI and lead, it is imperative that all equipment (respiratory protection, paint booth ventilation equipment) be maintained in proper working order.

The supplied air hoods worn by the painters are accepted by NIOSH for atmospheres containing lead.[14,19] However, these supplied air hoods are not acceptable for protection against carcinogenic chromium VI.[17,19]

The only NIOSH-accepted respiratory protection are self-contained breathing apparatus with positive pressure in full facepiece or combination supplied air respirator, pressure-demand type, with an auxiliary self-contained air supply.

In general, the rules concerning use of personal protective equipment need to be emphasized and enforced. There was confusion among employees concerning where specific types of personal protective equipment are required.

Periodic industrial hygiene sampling should be conducted at the Conway facility. This is needed due to the number of potentially hazardous chemicals used and the fact that the areas evaluated in this study represent a relatively small portion of the entire operation. If the industrial hygiene surveys were conducted by a qualified person at the Conway facility, this individual could assume a number of responsibilities including environmental sampling, periodic evaluation of the paint booth ventilation system, routine maintenance (changing filters) of the paint booth ventilation system, and training and education of the employees concerning potential health hazards of the chemicals they work with.

Because production was down at the time of the NIOSH survey, airborne concentrations of all contaminants would probably be increased during high-production periods. Jobs with no local exhaust ventilation (bus wash, floor mat gluing) would be affected most.

The questionnaire data showed that there was a definite outbreak of dermatitis, occurring primarily in the Finish I department, in the summer of 1981. Several factors could have contributed to this outbreak:

A. The adverse environmental conditions during that time. Information was obtained from the National Weather Service, North Little Rock, Arkansas on the following indices:

   1. Maximum monthly temperature
   2. Monthly average highest temperature
   3. Monthly average lowest temperature
   4. Relative humidity (%) at 3 p.m.

   The information for the geographical area in which the factory is situated, for 1978 through 1981 inclusive, is summarized in Figure 1.

   Figure 1 shows that July and August of 1981 were the only 2 months in the 4 years preceeding the NIOSH investigation where a maximum temperature of more than 100°F occurred together with a 3 p.m.

relative humidity of more than 55% (See Figure 1 in Appendix). Hot, humid weather conditions can contribute to the development of heat rashes.[11,22] Rashes can also be produced in susceptible subjects by repeated epidermal injury. There is a striking variation in individual susceptibility to such factors. The environmental conditions alone however cannot explain the occurrence of dermatitis mainly in the Finish I department and not in the glass or upholstery department.

B. The location of the Finish I department next to the drying oven. This oven functions at a temperature of approximately 250-300°F; and the work in this department involves putting the finish to assembled buses after they emerge from the drying oven. This work includes glueing floor mats and seats, putting up light fittings and mirrors, and assembling windows. Such manual work in proximity to the oven during a period of high environmental temperature and humidity can contribute to the development of heat rashes.

C. The use of solvent-based glues in this department. Environmental monitoring in the Finish I area showed the presence of hexane and trace amounts of benzene. While biological monitoring for toluene and xylene showed no excessive systemic absorption of these organic solvents in this department, it is possible that local skin contact with such solvents can occur.

D. The increased use of glues, solvents, and other chemicals as a result of increased production during the summer of 1981. Such increased use increases the likelihood of frequent skin contact with these chemicals. The total production was estimated to be about three times more in the summer of 1981 compared with the summer of 1982 when no outbreak of rashes was reported.

E. The introduction of a new solvent just before the outbreak of dermatitis occurred. This was said to be the only new chemical introduced into the Finish I department and the surrounding work area. It was subsequently withdrawn from use within a few weeks, because of worker complaints about its disagreeable odor. The introduction and withdrawal of this solvent fits in with the timing of the appearance and subsequent clearing up of the rashes. Attempts by NIOSH to determine the identify of this solvent were unsuccessful.

Measurement of exposure to toluene and xylene showed levels below the TLV for both these solvents in the paint department. Toluene and xylene were not evaluated in the Finish I area, where n-hexane was the major solvent vapor componant. However, symptoms

consistent with solvent exposure were reported more frequently in the paint department than in the Finish I or glass and upholstery departments. Amongst the painters, there did not appear to be a relation between the reporting of symptoms and the mean level of urinary methyl hippuric acid (the metabolite of xylene). But there was a statistically significant difference in urinary hippuric acid (the metabolite of toluene) levels amongst the painters with symptoms compared to those without. These findings suggest that toluene may contribute more to the reported symptoms than xylene. These symptoms have been reported even at environmental levels below the current TLV. This may be due to the combined effect of several organic solvents which are used in the paint department, of which one of the main contributors appears to be toluene.

VIII. RECOMMENDATIONS

1. Due to the variety of potential employee exposures, periodic industrial hygiene surveys should be conducted at the Conway facility.

2. Employees spraying glue should be issued chemical cartridge respirators certified for protection against n-hexane. In addition, management should further evaluate employee exposure to n-hexane during glue-spraying periods.

3. General maintenance of the spray paint booth should be improved with emphasis on repairing openings in the ductwork. In addition, management should ensure that the air compressor supplying air to the supplied air hoods meets the OSHA requirements of 1910.134(d)(2)(ii).[23] For example, oil-lubricated compressors must be equipped with a high temperature or carbon monoxide alarm or both.

4. Supplies of personal protective equipment and paint booth airline filters should be kept in greater quantities to guard against not having these items when they are needed. In addition, the charcoal filters located in the airline of the supplied-air respirators should be changed on a routine basis. Information on the recommended frequency of filter changes can be obtained from the supplier.

5. The respiratory protection program should be strengthened to meet OSHA requirements (29 CFR 1910.134) with particular emphasis on developement of a written respiratory protection program. In addition if paints containing carcinogenic chromium VI materials are to continue being used, the respiratory protection for spray paint employees should be upgraded per the NIOSH recommendations.[17,19]

6. The hearing protection program should be improved by adopting the draft hearing protection program. Additionally there should be better enforcement of hearing protection requirements, and better designation as to when and where hearing protection is required.

7. There should be an adequate supply of impervious gloves for employees to use at all times when handling chemicals, especially organic solvents and epoxy resins. Management should insure that gloves are appropriate for the chemicals being used. Information has been forwarded to both management and the union concerning suitability of various gloves for use with specific chemicals.

8. Washing of hands with organic solvents should be discouraged. Commercially available cleansing creams should be used instead. Information on specific cleansing creams should be available from the paint supplier.

9. Barrier creams may be used to protect bare areas of skin, especially on the arms where they are not covered by gloves.

10. The provision and use of a moisturizing or conditioning cream, after washing the hands at the end of a workday, will aid in preventing drying and cracking of the skin.

11. Simple personal hygiene is important in the prevention of rashes due to chemical contact and high environmental temperatures. In this regard, the use of adequate wash-up and changing facilities will remove chemical contaminants from the skin and also prevent them from being brought back to the home environment.

12. As a general rule, food and drinks should not be consumed in areas where lead compounds, organic solvents and other chemicals are being used. A geographically separate area away from chemicals should be provided for the storage and consumption of food and drink.

13. Employees should not smoke in areas where flammable materials are used or stored. All areas where flammable materials are used or stored should be posted as no smoking areas. Concurrently the no-smoking rule should be enforced.

14. Flammable chemicals used at the bus wash and paint booth areas should be stored in approved containers per the OSHA requirements of 1910.106. The quantity of these chemical present in the area should be the minumium amount required for production.[24]

15. Standard operating procedures, should be developed for the bus wash operation.

16. Welding operations should be conducted in shielded areas to protect adjacent workers against sparks and possible eye burns.

17. The chemical storage area should be covered, and an effective drainage system should be installed. In addition, specific storage locations for different chemicals should be established and posted.

18. The bucket used to store solvent soaked cloths should be replaced with a safety container.

19. In future situations where adverse weather conditions of high temperature and high humidity prevail, the work system may need to be altered to reduce the length of time workers in the Finish I and paint departments spend in the vicinity of the oven.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 5, 2nd ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1979. (DHEW (NIOSH) publication no. 79-141).

2. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 6, 2nd ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1980. (DHHS (NIOSH) publication no. 80-125).

3. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. Vol 1, 2nd ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) publication no. 77-157-A).

4. Matsui H, Kasao M, Imamura S. High-performance liquid chromatographic determination of hippuric acid in human urine. J. Chromatography 1978; 145:231-236.

5. National Institute for Occupational Safety and Health. NIOSH/OSHA occupational health guidelines for chemical hazards. Cincinnati, OH: National Institute for Occupational Safety and Health, 1981. (DHHS [NIOSH] publication no. 81-123).

6. International Labour Office. Encyclopaedia of occupational health and safety. Vol II/1-z. Geneva: International Labour Office, 1971.

7. Baselt RC. Biological monitoring methods for industrial chemicals. Davis, California: Biomedical Publications, 1980.

8. National Institute for Occupational Safety and Health. Criteria for a recommended standard--occupational exposure to toluene. Cincinnati, OH: National Institute for Occupational Safety and Health, 1973. (DHEW [NIOSH] publication no. 73-11022).

9. American Conference of Governmental Industrial Hygienists. Threshold limit values for chemical substances and physical agents in the workroom environment with intended changes for 1983-84. Cincinnati, Ohio: ACGIH, 1983.

10. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CRF 1910.1000. Occupational Safety and Health Administration, revised 1980.

11. National Institute for Occupational Safety and Health. Occupational diseases: a guide to their recognition. Revised ed. Cincinnati, OH: National Institute for Occupational Health and Safety, 1977. (DHEW [NIOSH] publication no. 77-181)

12. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to xylene. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1975. (DHEW publication no. (NIOSH) 75-168).

13. Eisinger J, Blumberg WE, Fischbein, Lilis R, Selikoff IJ. Zinc protoporphyrin in blood as a biologic indicator of chronic lead intoxication. J. Env. Path. and Tox. 1978, 1:897-910.

14. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to inorganic lead (revised). Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1978. (DHEW publication no. (NIOSH) 78-158).

15. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.1025. Occupational Safety and Health Administration, revised 1980.

16. American Conference of Governmental Industrial Hygienists. Documentation of the threshold limit values. 4th ed. Cincinnati, Ohio: ACGIH, 1980.

17. National Institute for Occupational Safety and Health. Criteria

for a recommended standard: occupational exposure to chromium VI. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1976. (DHEW publication no. (NIOSH) 76-129).

18. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to alkanes. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW publication no. (NIOSH) 77-151).

19. National Institute for Occupational Safety and Health. Supplement to the NIOSH certified equipment list. Morgantown, WV: National Institute for Occupational Safety and Health, 1981.

20. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.95. Occupational Safety and Health Administration, Revised 1980.

21. Henry JB. Todd, Sandford, Davidsohn 'Clinical Diagnosis and Management by Laboratory Methods' 16th Ed. Philadelphia, London, Toronto: W.B. Saunders. 1979.

22. Rook A, Wilkinson DS, Ebling FJG. Textbook of Dermatology. Vol 2. 2nd Ed. Blackwell Scientific Publications. Oxford, London, Edinburgh, Melbourne 1972.

23. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.134. Occupational Safety and Health Administration. Revised 1980.

24. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.106. Occupational Safety and Health Administration. Revised 1980.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:

John N. Zey, M.S.
Industrial Hygienist
Industrial Hygiene Section

Tar-Ching Aw, M.D.
Medical Officer
Medical Section

Field Assistance:

Richard L. Stephenson
Industrial Hygienist
Industrial Hygiene Section

Jai P. Narain, M.D.
Epidemic Intelligence Service (EIS) Officer
Field Services Division
Centers for Disease Control

Robert G. Schutte
Section Chief
Medical Support Section

Laboratory Analysis: Staff, MRSB, DPSE
NIOSH
Cincinnati, Ohio

Staff, UTBL
Salt Lake City, Utah

Frederick C. Phipps
Chemist
Clinical and Biochemical Support Section
Technical Support Branch

Originating Office: Hazard Evaluations and Technical Assistance Branch
Division of Surveillance, Hazard Evaluations, and Field Studies

Report Typed By: Betty Williams
Clerk-Typist
Industrial Hygiene Section

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. American Transportation Corporation
2. United Auto Workers, Union Local 1762
3. NIOSH, Region VI
4. OSHA, Region VI

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

Sampling and Analytical Methods and Environmental Criteria

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Contaminant	Flow Rate (LPM)	Collection Media	Analytical Method	Environmental Criteria (mg/m^3 unless otherwise noted) OSHA PEL	NIOSH Recommendation	ACGIH TLV
Chromium VI	1.5	Polyvinyl Chloride Filter	Colorimetry according to P&CAM No. 319	0.10[A]	0.001[B]	0.05[C]
Lead	1.5	Polyvinyl Chloride Filter	Atomic absorption according to P&CAM No. 173	0.05[C]	0.05[B]	0.15[C]
Total Particulate	1.5	Polyvinyl Chloride Filters (Lead and total particulate obtained on same filter)	Gravimetric	15[C]	None	10[C]
Solvent Vapor Mixture	Approx. 0.02	Charcoal Tube (Double Tube Set-up)	Gas Chromatography in association with analysis of liquid and airborne bulk samples.	$\frac{Conc_1}{TLV_1} + \frac{Conc_2}{TLV_2} + \ldots \frac{Conc_n}{TLV_n} = 1$		
n-Hexane	Approx. 0.02	Charcoal Tube (Double Tube Set-up)	Gas Chromatography According to P&CAM No. 127.	1800[C]	360[B]	180[C]

(Continued)

TABLE I
(Continued)

Contaminant	Flow Rate (LPM)	Collection Media	Analytical Method	Environmental Criteria (mg/m^3 unless otherwise noted) OSHA PEL	NIOSH Recommendation	ACGIH TLV
Toluene	Approx. 0.02	Charcoal Tube (Double Tube Set-up)	Gas Chromatography According To P&CAM No. 127	750[C]	375[B]	375[C]
Xylene	Approx. 0.02	Charcoal Tube (Double Tube Set-up)	Gas Chromatography According To P&CAM No. 127.	435[C]	435[B]	435[C]
Benzene	Approx. 0.02	Charcoal Tube (Double Tube Set-up)	Gas Chromatography According To P&CAM No. 127	3[C]	3.2[D]	30[C]
MEK	Approx. 0.02	Charcoal Tube (Double Tube Set-up)	Gas Chromatography According To P&CAM No. 127	590[C]	590[B]	590[C]
n-Hexane (Short Term Sample)	-	Certified Direct Reading Indicator Tubes	Visual	-	510ppm[F]	-
Toluene (Short Term Sample)	-	Certified Direct Reading Indicator Tubes	Visual	500ppm[G]	200ppm[G]	150ppm[E]

A - Ceiling value not to be exceeded
B - Up to a 10.0 hr. Time-Weighted-Average (TWA)
C - 8.0 hr. TWA
D - Ceiling value, not to be exceeded during any 60.0 minute period.
E - TLV-STEL (Threshold limit value - short term exposure limit) The maximum concentration to which workers can be exposed for a period up to 15 minutes. No more than 4 excursions per day, each being at least 60 minutes apart. This is not a separate independent exposure limit, but is a supplement to the TWA limit.
F - Ceiling value (15 minute period).
G - Ceiling value (10 minute period).

TABLE II

Airborne Concentrations of Chromium VI
Personal Samples

American Transportation Corporation
Conway, Arkansas
HETA 82-025

February 9-10, 1982

Date	Job/Location	Sample Time	Volume (Liters)	Concentration (mg/m^3)
2-9	Spray Painter - Outside Bus	0656-1529	770	0.18
2-9	Spray Painter - Outside Bus	0710-1524	741	0.45
2-10	Spray Painter - Outside Bus	0656-1501	728	0.15
2-10	Spray Painter - Outside Bus	90705-1522	755	0.36
2-9	Spray Painter - Inside Bus	0708-1504	714	*
2-10	Spray Painter - Inside Bus	0703-1509	729	*
2-10	Spray Painter - Primer	0735-1510	683	0.03

Note: Spray painters wore airline supplied air respirators while painting.

* Laboratory results indicate the values were less than 0.01 mg/m^3 but due to chemical interference the results are not reported.

Environmental Criteria (mg/m^3): 0.001 (NIOSH for carcinogenic chromium as a TWA)
0.1 (OSHA as a ceiling value not to be exceeded)
0.05 (ACGIH as a TWA)

TABLE III

Airborne Concentrations of Lead and Total Particulate
Personal Samples

American Transportation Corporation
Conway, Arkansas
HETA 82-025

February 9-10, 1982

Date	Job/Location	Sample Time	Volume (Liters)	Concentration (mg/m^3) Total Particulate	Lead
2-9	Spray Painter - Outside Bus	0656-1529	770	7.3	0.97
2-9	Spray Painter - Outside Bus	0710-1524	741	15.8	1.89
2-10	Spray Painter - Outside Bus	0705-1522	746	13.3	2.01
2-10	Spray Painter - Outside Bus	0656-1501	728	7.2	1.22
2-10	Spray Painter - Inside Bus	0703-1509	730	6.7	0.03
2-10	Spray Painter - Primer Touch Up And Sander	0735-1510	683	4.3	0.14
2-10	Undercoater And Sander	0701-1514	740	10.9	LLD
2-11	Undercoater And Sander	0710-1514	727	19.2	<.01

Note: Spray painters wore airline supplied air respirators while painting

LLD = Below the laboratory limit of detection (3 ug/filter)

Environmental Criteria (mg/m^3): Total Particulates = 10 (ACGIH as a TWA)
15 (OSHA as a TWA)
Lead = 0.05 (OSHA and NIOSH as a TWA)
0.15 (ACGIH as a TWA)

TABLE IV

Airborne Concentrations of Solvent Vapors on Personal Samples
Cumulative Exposure of Naptha and Organic Components
Collected With Two-Tube Set-up

American Transportation Corporation
Conway, Arkansas
HETA 82-025

February 9-11, 1982

Date	Job Location	Sample Time	Volume (Liters)	Tube A	Tube B			Total Cumulative[2] Exposure From All Solvent Vapors
				Cumulative[1] Exposure From Petroleum Naptha Tube	Toluene (mg/m^3)	Xylene (mg/m^3)	Benzene (mg/m^3)	
2-9-82	Bus Wash - Inside Booth And Sander	0652-1518	8.0	0.02	70.4	1.2	LLD	0.21
2-9-82	Bus Wash - Inside And Outside Booth	0654-1507	10.0	0.13	256	1.2	LLD	0.81
2-9-82	Bus Wash - Inside And Outside Booth	0650-1509	9.0	0.07	179	2.1	LLD	0.56
2-9-82	Bus Wash - Inside Booth	0658-1528	9.0	0.04	91.2	2.2	LLD	0.29
2-10-82	Bus Wash - Inside Booth	0653-1514	10.0	0.09	222	6.0	0.1	0.69
2-10-82	Bus Wash - Inside Booth	0652-1520	9.0	0.04	101	3.4	LLD	0.32
2-10-82	Bus Wash - Inside And Outside Booth	0645-1520	8.0	0.13	231	4.4	0.1	0.76

(Continued)

TABLE IV
(Continued)

Date	Job Location	Sample Time	Volume (Liters)	Tube A	Tube B			Total Cumulative[2] Exposure From All Solvent Vapors
				Cumulative[1] Exposure From Petroleum Naptha Tube	Toluene (mg/m^3)	Xylene (mg/m^3)	Benzene (mg/m^3)	
2-10-82	Bus Wash - Outside Booth	0650-1504	9.0	0.17	242	16.4	0.2	0.87
2-10-82	Bus Wash - Inside Booth And Sander	0719-1512	11.0	0.08	222	3.4	0.2	0.69
2-10-82	Bus Wash - Outside Booth	0737-1505	7.0	0.03	75.4	3.1	LLD	0.24
2-9-82	Spray Paint Primer	0734-1503	9.0	0.04	33.0	11.7	LLD	0.15
2-9-82	Spray Paint Primer And Sander	0725-1510	8.0	<0.01	32.5	11.6	LLD	0.10
2-10-82	Spray Paint Primer	0709-1508	10.0	0.01	51.3	16.6	0.4	0.20
2-9-82	Spray Paint Inside Bus	0708-1504	8.0	0.04	59.3	46.5	0.4	0.32
2-11-82	Spray Paint Inside Bus	0711-1525	10.0	0.01	95.9	79.5	0.8	0.25
2-11-82	Paint Mixer	0718-1504	7.0	<0.01	8.7	2.9	LLD	0.03

(Continued)

TABLE IV
(Continued)

1. = These values are calculated from individual solvent concentrations following ACGIH formula for mixtures. Includes concentrations of quantified components of mixture (acetone, n-hexane, heptane, MIBK, methylcyclohexane, and isobutyl acetate).

2. = These values represent the cumulative exposure for all components of mixture (Naptha Tube and organics tube). Calculated per the ACGIH TLV formula for mixtures.

3. = Sample worn by two employees. First employee went home, replaced at same job by second employee.

Note: Cumulative exposure calculated using ACGIH TLV for mixtures. If sum of fractions exceeds 1, consider the TLV as being exceeded.

Environmental Criteria (mg/m^3): Toluene = 750 (OSHA as a TWA)
375 (NIOSH as a TWA)
375 (ACGIH as a TWA)

Xylene = 435 (NIOSH, OSHA, and ACGIH as a TWA)

Benzene = 3 (OSHA as a TWA)
3.2 (NIOSH as a ceiling value, 60 min.)
30 (ACGIH as a TWA)

Cumulative Exposure of Mixtures = $\frac{Conc_1}{TLV_1} + \frac{Conc_2}{TLV_2} + \ldots\frac{Conc_n}{TLV_n}$

TABLE V

Airborne Concentrations of Solvent Vapors
Collected in the Undercoat Pit and Finish I Areas
Personal Samples

American Transportation Corporation
Conway, Arkansas
HETA 82-025

February 9-11, 1982

Date	Job/Location	Sample Time	Volume (Liters)	Concentration (mg/m^3) n-Hexane	Benzene	MEK	Toluene	Cumulative Exposure
2-9-82	Finish I - Glue, Outside Bus	0740-1514	11	171	0.3	-	-	.48
2-9-82	Finish - I Glue, Inside Bus	0742-1501	6	175	0.4	-	-	.50
2-9-82	Finish I - Glue, Inside Bus	0718-1527	15	29.1	0.2	-	-	.09
2-9-82	Undercoat Pit - Employee Also Part-time Sander	0705-1500	10	4.0	-	2.0	14.0	.05
2-10-82	Undercoat Pit - Employee Also Part-time Sander	0705-1514	10	LLD	-	8.0	40.0	.12
2-11-82	Undercoat Pit - Employee Also Part-time Sander	0710-1514	7	LLD	-	LLD	1.0	<.01

(Continued)

TABLE V
(Continued)

NOTE: Cumulative exposure calculated using ACGIH TLV for mixtures. If sum of fractions exceed 1, consider TLV as being exceeded. Two tube set-up used to collect samples, but only one tube used for analysis.

- = Not evaluated on this sample.

MEK = Methyl ethyl ketone

Environmental Criteria (mg/m^3): n-Hexane = 360 (NIOSH as a TWA)
1800 (OSHA as a TWA)
180 (ACGIH as a TWA)

Toluene = 750 (OSHA as a TWA)
375 (NIOSH and ACGIH as a TWA)

MEK = 590 (OSHA, NIOSH, and ACGIH as a TWA)

Benzene = 3 (OSHA as a TWA)
3.2 (NIOSH as a TWA)
30 (ACGIH as a TWA)

$$\text{Cumulative Exposure for Mixture} = \frac{Conc_1}{TLV_1} + \frac{Conc_2}{TLV_2} + \ldots\frac{Conc_n}{TLV_n} = 1$$

TABLE VI

Airborne Concentrations of Solvent Vapors
Samples Collected with Certified Direct Reading Indicator Tubes

American Transportation Corporation
Conway, Arkansas
HETA 82-025

February 11, 1982

Job/Location	Type of Sample	Time	Type	Conc (ppm)
Paint Mixing Area* - Employee Mixing Paint	GA	0655	Toluene	25
Bus Wash Area - Three Employees Washing Inside Of bus	BZ	0731	Toluene	25
Paint Booth - Employee Washing Outside Of Bus. Side Opposite From Windows	BZ	0740	Toluene	Trace
Paint Booth - Above Undercoat Pit Opposite From Windows. Side Of Paint Line	BZ	0750	Toluene	N.D.
Paint Booth - One Employee Washing Exterior Of Bus. Side Of Booth Opposite From Windows	BZ	0753	Toluene	10
Paint Booth - Interior Of Bus Being Painted. Sample Taken On Side Of Booth Opposite From Windows	BZ	0800	Toluene	20
Paint Booth - At Door On Side Of Booth Near Windows	GA	0844	Toluene	25
Undercoat Pit	GA	1025	Toluene	Trace

(Continued)

TABLE VI
(Continued)

Job/Location	Type of Sample	Time	Type	Conc (ppm)
Finish I - Spraying Glue On Floor Of Bus	BZ	0910	n-Hexane	800
Finish I - Inside Bus, Floor Mats In Place	BZ	0925	n-Hexane	25
Finish I - Employee Spraying Glue On Floor Mats, Outside Of Bus	BZ	0950	n-Hexane	125
Finish I - Employee Spraying Glue On Floor Mats, Outside Of Bus	BZ	1040	n-Hexane	100
Finish I - Glue Spraying Inside Bus	BZ	1110	n-Hexane	260
Finish I - Glue Spraying Inside Bus	BZ	1512	n-Hexane	500
Finish I - Inside Bus, Mats Being Positioned On Floor	BZ	1517	n-Hexane	100
Finish I - Inside bus, Mats In Place	BZ	1525	n-Hexane	15

* = Reddish-brown discoloration of tubes indicates presence of petroleum hydrocarbons.

ND = Not detected

GA = General area sample

BZ = Area breathing zone sample

Environmental Criteria (ppm): Toluene = 200 (NIOSH - ceiling value 10 min.)
150 (ACGIH - short term exposure limit, 15 min.)
500 (OSHA - maximum peak, 10 min.)

n-Hexane = 500 (NIOSH - ceiling value 15 min.)

Table VII

Characteristics of Participants

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Dept.	No. of workers	Age	Sex	Race
PAINT	32	Range: 21 to 57 yrs Mean = 33 yrs	17 males 15 females	16 whites 16 blacks
FINISH I	20	Range: 26 to 63 yrs Mean = 46 yrs	13 males 7 females	19 whites 1 black
GLASS AND UPHOLSTERY	26	Range: 21 to 60 yrs Mean = 39 yrs	16 males 10 females	22 whites 4 blacks
TOTAL	78		46 males 32 females	57 whites 21 blacks

Dept.	No. of workers	Smoking status		Alcohol consumption	
		Non-smokers and ex-smokers	Current smokers	NO	YES
PAINT	32	18	14 (44%)	25	7 (22%)
FINISH I	20	7	13 (65%)	18	2 (10%)
GLASS AND UPHOLSTERY	26	17	9 (35%)	19	7 (27%)
TOTAL	78	42	36	61	16

Table VIII

Cases of Dermatitis during Summer 1981

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Dept.	Cases of dermatitis during summer in 1981	Total no. of workers seen	Attack rate
PAINT	2	32	6.3 %
FINISH I	9	20	45.0 %
GLASS AND UPHOLSTERY	0	26	0 %

Table IX

Urinary Hippuric Acid Levels

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Dept.	No. of workers	URINARY HIPPURIC ACID in mg/ml	in mg/g creatinine
PAINT	32	Range: 0.13 to 2.60 Mean: 0.84	Range: 0.09 to 2.62 Mean: 0.54
FINISH I	20	Range: 0.04 to 4.40 Mean: 0.90	Range: 0.03 to 1.14 Mean: 0.48
GLASS AND UPHOLSTERY	24	Range: 0.07 to 2.39 Mean: 0.73	Range: 0.06 to 1.59 Mean: 0.43

Table X

Urinary Methyl Hippuric Acid Levels

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Dept.	No. of samples showing presence of methyl hippuric acid	No. of samples showing absence of methyl hippuric acid	Total no. of samples
PAINT	9 (28%)	23	32
FINISH I	0 (0%)	20	20
GLASS AND UPHOLSTERY	4 (17%)	20	24

Table XI

Central Nervous System Symptoms

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

SYMPTOMS	DEPARTMENT		
	PAINT	FINISH I	GLASS AND UPHOLSTERY
Dizziness	11 / 32 (34%)	1 / 20 (5%)	1 / 26 (4%)
Drowsiness	9 / 32 (28%)	3 / 20 (15%)	2 / 26 (8%)
Nausea	5 / 32 (15%)	2 / 20 (10%)	1 / 26 (4%)
Vomiting	2 / 32 (6%)	0 / 20 (0%)	0 / 26 (0%)
Headache	9 / 32 (28%)	3 / 20 (15%)	2 / 26 (8%)
Unusually tired	11 / 32 (11%)	8 / 20 (40%)	5 / 26 (19%)
Poor memory	5 / 32 (16%)	3 / 20 (15%)	7 / 26 (27%)

Table XII

Mean Urinary methyl hippuric acid levels in worker with and without symptoms

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

methyl levels	WORKERS WITH SYMPTOMS No. of workers	Mean urinary methyl hippuric acid levels	WORKERS WITHOUT SYMPTOMS No. of workers	Mean urinary hippuric acid
Methyl hippuric acid detected in urine	4 / 10 (40%)	0.15 mg/ml (0.10 mg/g creatinine)	6 / 10 (60%)	0.24 mg/ml (0.11 mg/g creatinine)
No methyl hippuric acid detected	14 / 22 (64%)	-	8 / 22 (36%)	-

Table XIII

Mean urinary hippuric acid levels in workers with and without symptoms

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

WORKERS WITH SYMPTOMS		WORKERS WITHOUT SYMPTOMS	
No. of workers	Mean urinary hippuric acid levels	No. of workers	Mean urinary hippuric acid levels
18 / 32 (56%)	1.04 mg/ml 0.69 mg/g creatinine	14 / 32 (44%)	0.59 mg/ml 0.50 mg/g creatinine

Table XIV

Symptoms of Mucosal Irritation

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Dept.	Proportion of workers with Sore throat	Nasal irritation	Eye irritation
PAINT	6 / 32 (19%)	14 / 32 (44%)	12 / 32 (38%)
FINISH I	3 / 20 (15%)	7 / 20 (35%)	8 / 20 (40%)
GLASS AND UPHOLSTERY	4 / 26 (8%)	8 / 26 (15%)	5 / 26 (19%)

Table XV

Peripheral neurological symptoms

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Dept	Proportion of workers with at least one symptom*
PAINT	4 / 32 (12.5%)
FINISH I	2 / 20 (10%)
GLASS AND UPHOLSTERY	2 / 26 (7.7%)

Table XVI

Hematology results

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Dept.	PROPORTION OF WORKERS WITH: Reduced hemoglobin	Reduced total white cell count	Decreased platelets
PAINT	2 / 32 (6%)	1 / 32 (3%)	1 / 32 (3%)
FINISH I	1 / 20 (5%)	1 / 20 (5%)	0 / 20 (0%)
GLASS AND UPHOLSTERY	3 / 25 (12%)	4 / 25 (16%)	0 / 25 (0%)

Table XVII(a)

Renal Function Tests

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Group	(Blood Urea Nitrogen) BUN (in mg/dl) Mean	Range	Ser. creatinine (in mg/dl) Mean	Range
PAINT	15	7 to 28	1.0	0.2 to 1.7
FINISH I	16	9 to 26	1.1	0.6 to 1.9
GLASS AND UPHOLSTERY	15	8 to 28	1.0	0.7 to 1.5
ALL WORKERS	14.9	7 to 31	1.0	0.2 to 1.9

Table XVII (b)

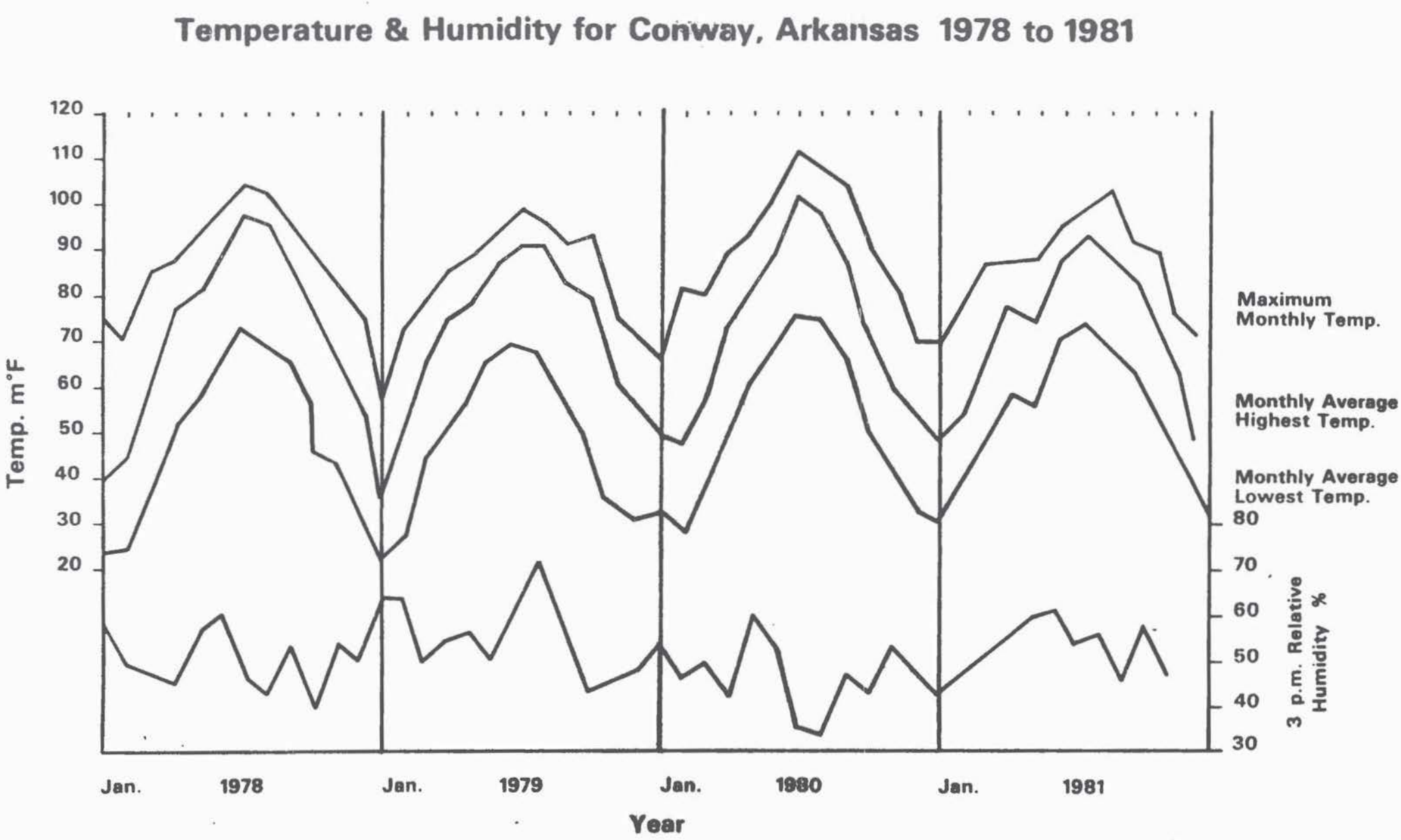
Renal Function Tests

American Transportation Company
Conway, Arkansas
HETA 82-025

February 9-12, 1982

Group	Proportion of workers with Raised BUN levels (Blood Urea Nitrogen)	Raised serum creatinine levels
PAINT	2 / 32 (6%)	2 / 32 (6%)
FINISH I	1 / 20 (5%)	2 / 20 (10%)
GLASS AND UPHOLSTERY	2 / 25 (8%)	1 / 25 (4%)

FIGURE 1


Temperature & Humidity for Conway, Arkansas 1978 to 1981
Temp. m°F
120
110
100
90
80
70
60
50
40
30
20
Maximum Monthly Temp.
Monthly Average Highest Temp.
Monthly Average Lowest Temp.
80
70
60
50
40
30
3 p.m. Relative Humidity %
Jan. 1978
Jan. 1979
Jan. 1980
Jan. 1981
Year