

HEALTH HAZARD EVALUATION REPORT 72-48-35
HAZARD EVALUATION SERVICES BRANCH
DIVISION OF TECHNICAL SERVICES

FILE COPY

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Sheffield, Illinois

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

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HEALTH HAZARD EVALUATION REPORT 72-48
BARCOL OVERDOOR CO., INC.
SHEFFIELD, ILLINOIS

I. SUMMARY DETERMINATION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from the employer, Barcol Overdoor Co., Inc., to evaluate the potential hazards associated with the use of a contact cement (containing primarily polychloroprene, mineral spirits, and toluene) used for gluing operations in the manufacturing of wooden overhead doors for industry and residential homes at the company's facility in Sheffield, Illinois.

The Occupational Health Standards promulgated by the U.S. Department of Labor (Title 29, Code of Federal Regulations, Chapter XVII, Part 1910.93 entitled "Air Contaminants") applicable to substances of this evaluation are as follows:

<u>Substance</u>	<u>Eight-Hour Time-Weighted Concentration</u>	
	p.p.m. ^a	mg/M ³ ^b
Toluene	200	750
Stoddard solvent (Mineral Spirits)	500	2,950
Chloroprene (2-chloro-1, 3-butadiene) -skin	25	90

Occupational health standards are established at levels designed to protect workers occupationally exposed to a substance on a 8-hour per day, 40-hour per week basis over a normal working lifetime.

^a p.p.m. - parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm Hg pressure.

^b mg/M³ - approximate milligrams of compound per cubic meter of air.

Additionally, The American Conference of Governmental Industrial Hygienists (ACGIH) has recommended changes in the Threshold Limit Values (TLV) or health standards based on recent evaluations to the following levels:

Toluene	100 ppm	-	375 mg/M ³
Stoddard solvent	200 ppm	-	1150 mg/M ³

NIOSH investigators conducted environmental and medical investigations of these operations on August 17 and November 28-29, 1972. Forty-two (42) personal and general area air samples were collected during the environmental survey on November 28-29. Sample concentration levels which exceeded the Federal Standards (individual and combined) were obtained for the substance toluene. The average concentration levels of the personal air samples for the two (2) gluer operators were 524 mg/M³ and 403 mg/M³. A maximum level of 801 mg/M³ was detected during cleanup operations. The average levels for the two (2) dryer operators were 108 mg/M³ and 69 mg/M³ with a maximum level detected of 328 mg/M³. Air sample concentrations of personal and general area samples for mineral spirits were less than five (5) percent of the Federal Standard. Laboratory analysis of two (2) bulk samples of the glue did not show any unreacted polychloroprene or chloroprene.

None of the exposed employees ever experienced any adverse clinical effects; interviews conducted on August 17, 1972, with the four (4) workers indicated there were no complaints of dizziness, lightheadedness, fatigue, and loss of appetite nor of skin and eye irritation. One worker stated that when the air was heavy and hot, the odor of the cement glue and toluene mixture was more noticeable and he experienced slight difficulty in breathing but no dyspnea or cough. Previous unrelated studies show that the amount of hippuric acid excretion in the urine is relatively proportional to the level of exposure to toluene vapors. Hence, urine samples were obtained from 4 employees on November 28, 1972, and subsequently analyzed for hippuric acid levels. All four (4) workers exposed to toluene vapors had hippuric acid levels above 3.00 grams/liter ranging from 3.00 to 4.59. This most likely means that these workers are being exposed to atmospheric concentrations of toluene in excess of the Federal Standard of 750 mg/M³.

It is our determination that the substance toluene is potentially toxic at the concentrations found in the workers' environment for the gluing area and vicinity. This conclusion is based on the following pertinent information: (1) the hippuric acid levels of the four (4) exposed workers exceeded the expected levels for an eight (8) hour exposure at 750 mg/M³ to toluene; (2) the new ACGIH criteria for toluene suggests a level of 375 mg/M³ be utilized as the TLV or standard as they have evidence that deleterious clinical symptomatology can occur above this level, although such symptomatology was not observed with the workers involved in this study; and (3) environmental survey results show that the two (2) glue operators were exposed to toluene concentrations significantly in excess of 375 mg/M³. It is also judged that the substances mineral spirits and unreacted polychloroprene or chloroprene are not toxic at the concentrations found in the workers' environment for the gluing and drying areas. This conclusion is based on the following pertinent information: (1) the concentrations of mineral spirits in the work environment were less than five (5) percent of the Federal Standard of 2,950 mg/M³ or 10% of the ACGIH recommended TLV of 1,150 mg/M³ and (2) laboratory analysis of two (2) bulk samples of the glue did not detect any unreacted polychloroprene or chloroprene.

Time-weighted exposures to noise levels were not made during the survey although sound levels measured in several of the machining areas exceeded the standard for noise exposure (Federal Register, Part II, paragraph 1910.95, Table G-16). Exposure to excessive noise levels can produce both temporary and permanent hearing loss in man.

Recommendations have been submitted to management to obviate the potentially toxic conditions existing from exposure to toluene involving the four (4) exposed employees. Recommendations have also been suggested to management to control the potential hazard from noise exposure to approximately 20 workers in the machining operation.

Copies of this Summary Determination, as well as the Full Report of the evaluation are available to employees upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, Fifth & Walnut Streets, Cincinnati, Ohio 45202. Copies of both have been sent to:

- a) Barcol Overdoor Co., Inc.
- b) U.S. Department of Labor - Region V

For purposes of informing the approximately 24 affected employees, the employer will promptly "post" the Summary Determination in a prominent place(s) near where employees work for a period of 30 calendar days.

II. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from the employer, the Barcol Overdoor Co., Inc., Sheffield, Illinois. The primary hazard evaluated concerned the exposure of employees to various vapors during the use of contact cement in gluing operations involved in the manufacturing of wooden overhead doors. These gluing operations involve the application of a contact cement glue to wooden portions of the door frame drying in ambient air, and reactivation of the glue using heat plus a roller press to glue the door frame together. These operations involve a total of four (4) employees and are discussed in more detail in section IV.A. of this report. The plant produces overhead doors for residential homes and industry starting with the basic wood, cardboard and other types of filler, and the basic hardware which is purchased from suppliers.

There is a total of approximately 100 employees at the plant of which 75 are involved in the production areas. Most of the production is carried out on day shift although a partial swing shift may be added depending upon production needs.

III. BACKGROUND HAZARD INFORMATION

A. Standards

The Occupational Health Standards as promulgated by the U.S. Department of Labor (Title 29 Code of Federal Regulations, Chapter XVII, Part 1910, Subpart 1910.93, entitled, "Air Contaminants") applicable to substances of this evaluation are as follows:

<u>Substance</u>	<u>Eight-Hour Time-Weighted Concentration</u>	
	p.p.m. ^a	mg/M ³ ^b
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Stoddard solvent (Mineral Spirits)	500	2,950
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^a p.p.m. - parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 mm Hg pressure.

^b mg/M³ - approximate milligrams of compound per cubic meter of air.

Occupational health standards are established at levels designed to protect workers occupationally exposed to a substance on a 8-hour per day, 40-hour per week basis over a normal working lifetime. Additionally, The American Conference of Governmental Industrial Hygienists (ACGIH) has recommended changes in the Threshold Limit Values (TLV) or health standards based on recent evaluations to the following levels⁹:

Toluene	100 ppm	-	375 mg/M ³
Stoddard solvent	200 ppm	-	1150 mg/M ³

B. Toxic Effects

Toluene: Also known as Toluol or methylbenzene, is not a highly toxic chemical; however, under certain circumstances, it can be hazardous and measures to minimize exposures are necessary. Toluene has several portals of entry into the human body. This chemical is readily absorbed from the gastrointestinal tract, the lungs, and in a minimal amount through the skin. Most of the absorbed toluene is excreted in the urine in the form of hippuric acid, with the rest being excreted in the expired air. Industrial hazards arise from inhalation of excessive concentrations of the vapor, liquid contamination of the eyes, and prolonged skin contact with the liquid. Toluene, in high vapor concentrations, has the potential to exert a powerful narcotic action. With sustained high level of exposure, death may ensue from paralysis of the respiratory centers.

Vapors in subnarcotic concentrations, but in excess of 375 mg/M³, produce varying but usually transitory manifestations of central nervous system disturbances. The clinical picture of chronic toluene intoxication may show varying degrees of fatigue, general nervousness, insomnia, giddiness, and loss of appetite and weight. Generally, upon complete cessation of exposure, such individuals, usually soon regain their normal levels of health. One cannot rely upon common subjective responses, such as recognition of odor and irritation of the eyes and nose as reliable warning signs of excessive exposure.

Contact of the skin with liquid toluene will often result in a temporary burning sensation. Occasional accidental contamination of the skin with the liquid presents no serious hazard if affected areas are washed with soap and water until free of the chemical. Frequent or sustained skin contact with liquid toluene may result in the development of dermatitis because of the defatting properties of toluene as well as its local irritative action.

Contact of the eyes with liquid toluene results in burns of varying degrees of severity. This may produce opacities, eye irritations and corneal burns unless the liquid is removed immediately by copious eye irrigation of an acceptable solution.

Toluene, as mentioned previously, is a known skin irritant, but it is poorly absorbed through the intact skin, so that systemic intoxication by percutaneous absorption is highly improbable. Of the absorbed toluene, approximately 20% is eliminated unchanged from the lungs and less than 0.1% is excreted intact in the urine. The remainder, 80% is oxidized to benzoic acid and then conjugated with glycine and excreted as hippuric acid in the urine.^{1,2} The amount of hippuric acid excretion is relatively proportional to the level of exposure to toluene vapors.

Hippuric acid is a normal urinary constituent from foods containing benzoic acid either as a natural constituent or added as a preservative.

Pagnotte and Lieberman³ reported variations in hippuric acid excretion in non-exposed subjects ranging from 0.4 to 1.4 grams per liter (gm/l) with an average of 0.8 gm/l as determined by an ultraviolet absorption method at 230 nm. Ogata, Tamakuni and Takatsuka⁴ in 1969, reported hippuric acid concentrations in non-exposed persons of 0.3 gm/l utilizing a procedure of paper and thin-layer chromatography.

Von Oettingen, Neal and Donahue⁵ reported that in subjects exposed to toluene vapors at various levels from 188 to 3,000 mg/M³ the excretion of hippuric acid roughly paralleled the intensity of exposure to toluene in air. At 750 mg/M³ the average value of hippuric acid excretion in the urine collected during an eight-hour exposure period was 1.6 gm and for 24 hours, the average value was 2.3 gm. This work led Elkins⁶ to postulate that an exposure of 750 mg/M³ of toluene should result in a hippuric acid excretion of 3 to 5 gm/l in 200 to 300 ml. of urine excreted during the last four to five hours of exposure.

Ikeda and Ohtsuji⁷ in 1969 reported that the urinary excretion of hippuric acid of 118 workers in the printing factories was within wide variation, proportional to the environmental concentrations of toluene. The urinary concentration of hippuric acid corresponding to environmental exposures to 200 ppm of toluene was 3.5 gm/l (sp. grav. 1.016).

Stoddard solvent: (Mineral spirits, Ligroin, Varsol, etc.) consists of mixtures of straight and branched chain paraffins naphthenes (cycloparaffins), and alkyl derivatives of benzene, boiling in the range of 305° to 410°F. Pharmacologically and toxicologically, these mixtures are qualitatively comparable with heptanes and octanes.

Heptane in concentrations of 40,000 to 60,000 mg/M³ (1 to 1.5 percent) produces narcosis in mice within 30 to 60 minutes. Slight vertigo developed in men exposed for 6 minutes to 4,000 mg/M³ and for 4 minutes to 8,000 mg/M³. A four-minute exposure to 20,000 mg/M³ heptane caused marked vertigo, inability to walk a straight line, hilarity and incoordination. It is significant that these signs and symptoms of systemic effects were produced in the absence of evidence or complaints of mucous membrane irritation. The standard is recommended to prevent narcotic and irritant response.

Chloroprene: Polychloroprene is the main constituent of the glue used. The finished produce is relatively non-toxic according to the 8th Edition of the Merck Index. This is a high molecular weight polymer, and its monomer or any unreacted chloroprene may cause irritation of skin and respiratory tract. Responses at high concentrations are depression of the central nervous system and injury to lungs, liver, and kidneys. The standard of 90 mg/M³ is sufficiently low to prevent any systemic effects.

IV. HEALTH HAZARD EVALUATION

A. Initial Visit - Observational Survey

An initial hazard and medical evaluation survey of the Barcol Overdoor Co., Inc., Sheffield, Illinois, was conducted on August 17, 1972 by Raymond L. Hervin and Phillip L. Polakoff, M.D. The functions of the National Institute for Occupational Safety and Health and its relation to Section 20(a)(6) of the Occupational Safety and Health Act of 1970 were explained to _____, Comptroller; _____, Works Manager; and _____, Production Manager. The National Surveillance Part I Questionnaire Form was completed with their assistance.

Plant Processes - Conditions of Use:

The facility started in 1953 as a mill and woodworking facility. In 1963, they began the purchase of some hardware and the manufacturing of the entire overhead door. The facility is about 65% devoted to woodworking (e.g., sawing, milling, drilling, etc.) and 35% devoted to hardware installation and some fabrication of hardware.

The area covered by the request is about 1,000 square feet and is referred to as the gluing operation. The pre-formed parts (3' x 8') of the overhead doors are received from another department and placed on the table for minor cleaning. These parts are inserted into a Black Brothers Roller Glue Spreader which applies the glue uniformly to the surface of the wood. The part is then placed on drying racks to allow the glue to dry. The Glue Spreader has a tank capacity of 15 gallons of the glue. There was little effective ventilation in the glue application area or the drying area noted at the time of the walk-through. After a period of approximately an hour, the piece is placed on a table in front of the drying oven and cardboard or other corrugated material placed inside and enclosed with top and/or bottom of section before being placed in the Drying oven which operates at 160°F. The drying oven uses approximately 100 infrared industrial reflectors (115-125 volts) as a source of heat and is 20 feet long by 5 feet wide with a metal covered exhaust hood over the top. The door section is in the oven for several minutes and is automatically transferred to the conveyor line on the opposite side of the oven. The glue is again activated due to the heat and the section is then pressed between 2 rollers in a Black Brothers Rolling Machine to assure good surface contact for gluing. The door section then is transferred to other operations (not covered by the request) for further processing. Only four (4) employees (2 gluing operators and 2 dryer operators) are involved in the gluing operations covered by the request.

The employer's concern of the exposure of employees to the vapors during gluing operations prompted the request for the health hazard evaluation. The employer also had an outside consultant conduct a survey prior to our initial observational review. The NIOSH investigators had access to the report and did not disagree with the findings of the consultant's report. However, we did suggest that appropriate respiratory protection be worn by the employees until necessary ventilation modifications were accomplished. A review of the findings of the initial visit was made with personnel of the Barcol Overdoor Co., Inc.

Bulk samples were obtained of the glue and solvent (toluene). About 1 gallon of toluene is added to 12 gallons of glue which is received in 53-gallon barrels.

As the result of this initial survey, it was determined that environmental measurements were necessary in order to evaluate the exposure levels to the alleged hazards. In addition, it was determined that urine samples be obtained from the four (4) employees involved in the gluing operation to determine if urine hippuric acid levels were elevated.

B. Environmental Evaluation

1. Procedure

The bulk samples of solutions were analyzed for major ingredients and the company which manufactures the glue was contacted concerning their formulation. Appropriate sampling and analytical procedures were obtained for those contaminants which may become airborne in concentrations which may present a potential hazard. On November 28-29, 1972, an environmental sampling survey was conducted by Messrs. Raymond L. Hervin and Richard S. Kramkowski to determine environmental exposure of employees.

A total of 30 personal air samples and 12 general area samples were collected and analyzed for the contaminants of concern during all hours of two day shifts. Samples for the organic solvents were collected in MSA charcoal sampling tubes by a MSA Model G vacuum pump at 1 liter per minute for 10 minutes. Personal air samples were obtained by attaching the tygon tubing containing the charcoal tube to an employee's collar or lapel which was connected to the pump attached to a belt at the waist. The general area zone samples were collected in specific fixed locations in the working environment.

2. Methods

All of the 42 air samples were analyzed by the Division of Laboratories and Criteria Development, NIOSH, Cincinnati, Ohio. One hundred and three (103) analytical determinations were made to evaluate the working environment. Air samples were analyzed by gas chromatographic procedures for toluene and mineral spirits with a minimum detection level for these compounds of 1/20th of the Federal Standard.

Contact with the manufacturer of the glue indicated that the glue is composed of 40% toluene, 40% aliphatic (some aromatic) petroleum distillate such as Stoddard solvent, and 20% polychloroprene. The manufacturer's representative said that they have not found any unreacted polychloroprene or chloroprene in any concentrations which could conceivably be considered hazardous during gluing operations and the main or only hazard during such operations would be from the organic hydrocarbon solvents. As reported in Merck Index, polychloroprene (neoprene) is non-toxic but any unreacted chloroprene may cause irritation of the skin and respiratory tract.

With the above paragraph in mind, the laboratory simulated the use of the glue (Bulk Sample obtained in walk-through) by spreading a portion between two boards and heating with a heat lamp. Temperature was in the range of 210-240°F. A Gastech Halide Meter was used to monitor for chloroprene. There was no response from the instrument when the edges were sniffed with the instrument. The boards were then taken apart and the glue was subjected to the direct heat from the lamps. Again there was no response from the instrument. A bulk sample of the glue was also obtained during the environmental survey and the laboratory experiment was repeated with the same results.

In light of the manufacturer's statements and our laboratory experiments described above, it is reasonable to assume that unreacted polychloroprene or chloroprene is not evolved during the gluing operation and that there is no need to obtain environmental samples for this compound. Therefore, unreacted polychloroprene or chloroprene is not considered as a hazard and is not discussed further in this report.

3. Survey Results

a. General

Respirators were available although not much utilized by the four employees. Improvements to the ventilation system, particularly to the glue spreading machine, have been started although were not completed at the time of the survey. An exit interview was held with Mr. _____ Plant Manager and others to discuss the initial findings (e.g., ventilation and noise results) and recommendations. It was further noted that tight-fitting containers with safety vents were not in use for the transport or storage of toluene in the gluing operation.

In obtaining the air samples, the NIOSH investigators sampled the employees only during typical operations involving the 2 gluer operators and the 2 dryer operators. In this regard, the 2 dryer operators were, on several occasions, assisting the gluer operators during the environmental survey. Interviews with the dryer operators indicated that they very seldom or almost never assist the gluer operators. Hence, samples were obtained from the dryer operators during typical drying operations only and not while they were assisting the gluer operators.

b. Toluene

Table I presents the results of 14 personal air samples and 7 general area samples (vicinity of gluing and drying operations) which were obtained during gluing operations. The general area sample concentrations were all less than the Federal Standard with the average being 27% of the ACGIH recommended TLV. The personal air sample levels for the two (2) glue operators varied from 214 mg/M³ to 801 mg/M³ with an average of 524 mg/M³ and 403 mg/M³ respectively for the two (2) operators. The average for each operator may be considered as an eight-hour time-weighted average.

Table II presents the results of 16 personal air samples and 5 general area samples (vicinity of dryer oven) which were obtained during drying operations. The results from all the samples obtained varied from 10 mg/M³ to 328 mg/M³. The average of the personal air sample concentrations for each dryer operator were about 20% and 30% of the TLV. Hence, it is concluded that the two (2) dryer operators are not being exposed to toluene in concentrations which are in excess of the Federal Standard or the TLV during their normal operations, although this may not be true if the dryer operators assist in the gluing operations.

c. Stoddard Solvent (Mineral Spirits)

All of the charcoal tube samples were also analyzed for the presence of Stoddard Solvent (Mineral Spirits), or Ligroin and in each case all the results were less than 100 mg/M³. The figure of 100 mg/M³ is a maximum concentration and represents less than 5% of the Federal Standard. Hence, it is concluded that exposure of all four (4) employees to Stoddard solvent is minimal and the evaluation of exposure to toluene is the major consideration involved in gluing and drying operations.

d. Ventilation

Ventilation measurements (Alnor Junior Velometer) and smoke tube tests (Bendix) were made in 3 main areas of concern: (1) Black Brothers Gluing Machines, (2) Ceiling Hood and two (2) floor-level exhaust ducts used in the Drying Area, and (3) the hood to the dryer oven used to reactivate the glue prior to the conveyor/roller press area. It is noted that the company did make some improvements (e.g., gluing machine, etc.) after our initial survey, and has plans to further improve the ventilation in all three areas. The following summarizes the results in these areas:

(1) Air flow at the hood to the gluing machine averaged 50 feet per minute. Smoke tube tests indicate it does provide for capture of fumes to a distance of about 1 foot from the machine.

(2) The two (2) floor-level exhaust ducts, 1 each side, in the drying area produced velometer readings of approximately 400 feet per minute. However, due to the poor location of the vents, smoke tube tests in this area showed that these vents were of little or no use due to the many cross currents involved in the wide open area. The ceiling or top hood in the drying area was of little or no use and did not indicate an effective flow (velometer and smoke tube tests) other than directly at the exhaust vent itself.

(3) The drier oven hood did not provide any measurable indication (less than 10 feet per minute at front only) of exhaust. The use of the smoke tubes showed some intake to the hood from the front and indicated control while the glue is being reactivated by the heat lamps inside the hood. However, the smoke tubes at the back of the hood showed the smoke was blown away from the hood rather than drawn into the hood. The hood is well designed and a few modifications were discussed with management to improve this minor problem.

e. Noise

The standards for occupational noise exposures as published in the Federal Register, Part II, §1910.95, Table G-16, are shown in Table III. Sound levels were measured with a General Radio Company Permissible Sound Level Meter Type 1565-B in dBA with a slow response. It has been determined that "substances" as presently defined in Section 20(a)(6) of the Act do not include physical agents. However, for completeness of our overall responsibilities for acknowledging any occupational hazards encountered during the course of a health hazard evaluation, these findings were reported.

Noise levels measured in the gluing/drying area did not indicate any levels exceeding 90 dBA. However, some operations (e.g. saw, planer, etc.) outside of the gluing/drying operations did exceed the 90 dBA level and the noise level results of a few typical operations are summarized below:

(1) The 03 Planer Machine was 92 dBA (employee's exposure during operation) at 8 feet, and up to 99 dBA in the front of the machine at about 1 foot.

(2) The 04 Rip Saw Machine was 92 dBA at 5 feet and up to 95 dBA in the front of the machine at 1 foot.

(3) The 05 Spacer Saw was 110 dBA at side where the operator works while the machine is on and rotating without any material being cut. When Molding is being cut by the machine, the noise level is reduced to 100 dBA as the molding muffles the sound of the saw.

(4) The 09 Moulder Machine varied from 93 to 100 dBA on all heads with the highest obtained during sawing at the machine, and the lowest obtained at the outfeed end of the machine.

The above results are somewhat typical of what one may expect from the use of such sawing machines in the lumber industry. No attempt was made to ascertain whether employees were over-exposed as levels fluctuated considerably due to the nature of the operations, the time, and stay of an employee at any specific location and the machines are not always operated during the day. However, it is felt that a more detailed evaluation would show certain employees exceeding the federal standard for noise as shown in Table III. It should also be noted that a few employees were also wearing hearing protection devices, but this practice was not strictly enforced.

C. Medical Evaluation

1. Method

A walk-through inspection was made on August 17, 1972. Workers were questioned throughout the production process as to whether they suffered from any occupational ill-effects including occupational dermatoses, upper respiratory symptomatology, mental status, and hearing deficit. No medical examinations, except personal observations, were performed at this time.

2. Findings

The average age of the production worker is 59. In the field of occupational preventive medicine, the following information was obtained. The company requires no pre-employment physical examinations nor does it require periodic check-ups for its employees. On-the-job application form very basic medical data is solicited prior to employment. The county health department performs x-rays on the workers biannually.

The company employs no occupational health nurse. Five people within the plant have been trained in advanced first aid by the American Red Cross. In cases involving greater medical severity, the company refers the worker either to a local practitioner in Sheffied or to the emergency room at Princeton, Illinois (15 miles away).

The company has set policy requiring the mandatory use of hearing protection devices in certain areas and respirators in the painting area. Safety shoes are not required; the wearing of safety glasses is encouraged.

Four individuals who worked in the glue-application and glue-drying areas were interviewed. Two workers worked in each area. None of the four employees ever experienced any adverse clinical effects; there were no complaints of dizziness, lightheadedness, fatigue and loss of appetite or weight, nor of skin and eye irritation. One worker stated that when the air was heavy and hot, the odor of the cement and toluene mixture was more noticeable and he experienced slight difficulty in breathing but no dyspnea or cough.

3. Clinical Chemistry Findings

Four urine samples from the four employees involved in the gluing operation and two urine samples (blanks) from non-exposed employees were obtained at the time of the environmental survey on November 28-29, 1972. The urinary hippuric acid levels (See Table IV) that were determined in NIOSH's clinical chemistry laboratory by the direct method of Tomakuni and Ogata⁸. This method was chosen because of its simplicity and the absence of xylene exposure to the workers. This method involves reacting 0.5 ml urine with 0.5 ml pyridine and 0.2 ml benzenesulfonyl chloride. After mixing and incubation, the hippuric acid was determined at 410 nm against appropriate blanks and standards. All results are expressed in g/liter of hippuric acid corrected to a specific gravity of 1.024. In order to establish "normal values", four urine specimens from Toxicology Branch Personnel, NIOSH, were analyzed.

The data for all six controls shows a mean of 1.25 g/l \pm 0.50 and a range of 0.82 - 2.19 g/l. If one chooses the 95% limit from the mean, the normal range would be 0.26 - 2.26.

All four workers exposed to toluene vapors had hippuric acid levels above 3.00 g/liter ranging from 3.00 to 4.59. This most likely means that these workers are being exposed to atmospheric concentrations of toluene in excess of 750 mg/M³.

V. CONCLUSIONS

It has been determined that the substance toluene is potentially toxic at the concentrations found in the workers' environment in the gluing area and vicinity. This conclusion is based on the following pertinent information: (1) the hippuric acid levels of four exposed workers exceeded the expected levels for an eight (8)-hour exposure at 750 mg/M³ to toluene; (2) the new ACGIH criteria suggests that a level of 375 mg/M³ be utilized as the standard as they have evidence

that deleterious clinical symptomatology can occur above this level, although such symptomatology was not observed with the workers involved in this study; and (3) environmental survey results show that the two (2) glue operators were exposed to concentrations significantly in excess of the level of 375 mg/M³. It has also been determined that Stoddard solvent (mineral spirits) and unreacted polychloroprene or chloroprene are not toxic at the concentrations used or found in the workers' environment. This conclusion is based on: (1) personal and general area concentrations of Stoddard solvent were less than five percent of the Federal Standard or ten percent of the ACGIH TLV and (2) laboratory analysis of the glue did not detect any unreacted polychloroprene or chloroprene. In addition, a potential hazard exists to some employees from exposure to noise.

VI. RECOMMENDATIONS

The following recommendations are submitted to management to obviate the potentially toxic conditions reported above and to provide for a more desirable working environment for all personnel.

1. The company should immediately complete the proposed improvements to the ventilation systems to reduce the concentrations of toluene in the gluing area. Particular emphasis should be given to the ventilation systems for the Black Brothers Roller/Gluing Machine and the exhaust hood in the drying rack area.

2. All employees should be required to wear Bureau of Mines approved organic vapor respirators and cartridges when working around the gluing machine. The use of the respirators should continue until appropriate modifications to the ventilation systems (recommendation 1 above) are made and air concentrations are less than appropriate health standards for toluene. Further, the gluing operators should wear such respirators after ventilation modifications for those operations which require his head or breathing zone to be in close proximity to the rollers or handling uncapped containers or saturated rags containing toluene.

3. Safety containers with appropriate vents should be used for the in-plant transportation and storage of solvents such as toluene to avoid unnecessary exposures of employees. Rags saturated with toluene should be placed in appropriate, tight-fitting containers when not in use.

4. Employees who may be exposed to solvents such as toluene and Stoddard solvent should be instructed concerning the toxic effects of such solvents. Table V plus other sections of this report and the few enclosed brochures may be used for this purpose and should include appropriate handling procedures to preclude unnecessary exposure to solvents.

5. The current hearing conservation programs should be expanded to include any of the items below which may not now be part of the current program:

a. Pre-employment, periodic, and termination audiometric examinations for employees potentially exposed to high noise levels.

b. Identification of areas and periodic evaluation of noise levels where noise may be a problem.

c. Elimination of noise at its source by engineering methods, where feasible.

d. Provide and encourage workers to wear properly-fitted hearing protection devices until the high noise level is eliminated, or where it is not feasible to control the high noise levels by engineering methods.

6. As a matter of good industrial practice, it is suggested that a separate area within the plant be designated as a first aid area.

VII. REFERENCES

1. Srbova, J. and R. Teisinger. "Absorption and Elimination of Toluene in Man." *Pracovni Lekarstvi*, Vol. 4, pp. 41-47, 1952.

2. El Masry, A.M., J. N. Smith and R. T. William. "Studies in Detoxication in Metabolism of Alkylbenzenes" *Biochem. J.*, Vol. 64, pp. 50-56, 1956.

3. Pagnotte, L. D. and L. Lieberman. "Urinary Hippuric Acid Excretion as an Index of Toluene Exposure." *Am. Ind. Hyg. Assoc. J.*, Vol. 28, pp. 129-134, 1967.

4. Ogata, M., K. Tamakuni and Y. Takatuska. "Quantitative Determination in Urine of Hippuric Acid and m- or p-Methylhippuric Acid Metabolites of Toluene and m- or p-xylene." Brit. J. Ind. Med., Vol. 26, pp. 330-334, 1969.
5. Von Oettingen, W.F., P.A. Neal, and D.D. Donahue. "The Toxicity and Potential Dangers of Toluene." J. Am. Med. Assoc., Vol. 118, pp. 579-584, 1956.
6. Elkins, H.B. The Chemistry of Industrial Toxicology, p. 404, 2nd Ed., John Wiley & Sons, N.Y. 1959.
7. Ikeda, M. and H. Ohtsuji. "Significance of Urinary Hippuric Acid Determination as an Index of Toluene Exposure." Brit. J. Ind. Med., Vol. 26, pp. 244-246, 1969.
8. Tomakuni, K. and Ogata, M., Clinical Chemistry, Vol. 18, pp. 349-351, 1972.
9. TLV's - Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1972; American Conference of Governmental Industrial Hygienists.

TABLE I

PERSONAL AIR SAMPLE RESULTS - GLUING OPERATION

mg/M³ - milligrams of compound per cubic meter of air

<u>Operator No. 1</u> <u>Sample No.</u>	<u>mg/M³</u> <u>Toluene</u>	<u>Operator No. 2</u> <u>Sample No.</u>	<u>mg/M³</u> <u>Toluene</u>
2	622	4	458
8	244	11	338
17	486	19	515
32	572	33	266
37	801	36	214
41	517	40	618
46	428	45	411
Average	524	Average	403

GENERAL AREA AIR SAMPLE RESULTS - GLUING OPERATION

<u>Sample No.</u>	<u>mg/M³</u> <u>Toluene</u>
1	134
12	83
18	196
23	18
34	124
14	124
29	35
Average	102

TABLE II

PERSONAL AIR SAMPLE RESULTS - DRYING OPERATION

<u>Operator No. 1</u> <u>Sample No.</u>	<u>mg/M³</u> <u>Toluene</u>	<u>Operator No. 2</u> <u>Sample No.</u>	<u>mg/M³</u> <u>Toluene</u>
5	71	3	53
16	158	15	125
20	16	26	10
22	17	28	15
30	46	31	42
42	328	43	124
44	199	47	153
49	33	48	30
Average	108	Average	69

GENERAL AREA AIR SAMPLE RESULTS - DRYING OPERATION

<u>Sample No.</u>	<u>mg/M³</u> <u>Toluene</u>
6	44
13	55
21	8
27	14
35	30
Average	30

TABLE III
PERMISSIBLE NOISE EXPOSURES*

<u>Duration Per Day, Hours</u>	<u>Sound Level dBA Slow Response</u>
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or Less	115 Ceiling Value

*When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 + C_n/T_n$ exceeds unity, then the mixed exposure should be considered to exceed the limit value. C_n indicates the total time of exposure at a specified noise level, and T_n indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level.

TABLE IV

URINARY LEVELS FOR HIPPURIC ACID IN PEOPLE EXPOSED
TO TOLUENE AND TO A CONTROL GROUP

<u>SAMPLE</u>	<u>URINE SP. GRAV.</u>	<u>HIPPURIC ACID*</u>
1. Blank #1 (Non-exposed employee)	1.010	0.98
2. Blank #2 (Non-exposed employee)	1.018	0.98
3. #1 (Gluer Operator)	1.017	4.59
4. #2 (Gluer Operator)	1.033	3.89
5. #3 (Dryer Operator)	1.026	4.57
6. #4 (Dryer Operator)	1.025	3.00
Toxicology Branch Control Samples of Employees (non-exposed)		
#1	1.023	1.43
#2	1.016	1.17
#3	1.023	0.82
#4	1.023	2.19

*Hippuric acid expressed as g/liter of urine corrected to a specific gravity of 1.024.

TABLE V

Probable Response of Humans to Various Atmospheric Concentrations of Toluene

<u>Toluene Vapor Concentration</u>	<u>Time of Exposure</u>	<u>Probable Response</u>	<u>Probable After Effects</u>
50-100 ppm	8 hours	No serious effects. Slight drowsiness and possibly slight headache in the unconditioned worker.	None
200 ppm(MAC)	8 hours	Unconditioned workers may complain of fatigue, some muscular weakness and burning, itching or "crawling" skin. There may be complaints of headache and some nausea.	Unconditioned workers may complain of fatigue of short duration and a few may suffer restless sleep.
300-400 ppm	8 hours	Varying degrees of fatigue and headache. Varying degrees of muscular weakness, mental confusion and slight incoordination.	Fatigue lasting several hours and insomnia.
600 ppm	3 hours	Marked fatigue and mental confusion, exhilaration, headache and dizziness.	Fatigue and weakness lasts several hours. There may be complaints of nausea and nervousness. Many suffer headache.
	8 hours	Definite mental confusion, considerable incoordination and staggering gait.	
800 ppm	3 hours	Nausea and pronounced confusion. Considerable incoordination and staggering gait.	Nervousness and fatigue may last several days. There may be marked insomnia.

* Chemical Safety Data Sheet SD-63, Manufacturing Chemists Association.