U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 76-84-377

Kenner Products Company
2950 Robertson Road
Cincinnati, Ohio 45209

March 1977

I. TOXICITY DETERMINATION

A Health Hazard Evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) in Building B-1 at the Kenner Products Company on August 18-19, 1976, and October 6, 1976. The intent of the evaluation was to determine whether exposures to toluene-2,4,-diisocyanate (TDI) and methylene bisphenyl isocyanate (MDI) were posing a health hazard to the employees. On the basis of air sample results, employee interviews, available toxicity information, and discussions with the plant medical department, it is concluded that exposures to TDI and MDI did not present a health hazard to the employees at the time of the survey. Air sample results for the proprietary amine catalysts (used in the urethane foam systems) likewise did not indicate significant airborne quantities. Small amounts of methylene chloride, used to clean the injector nozzles, produced significant air concentrations but exposure times were limited so that employee health should not be adversely affected.

The Kenner Company has gone to considerable efforts and expense to develop industrial hygiene and medical programs directed towards the isocyanate exposures in Building B-1. It is important that the company continue these programs, paying close attention to all facets thereof. Several other lesser recommendations are given in the text of this report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are available from the National Institute for Occupational Safety and Health, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability can be obtained from the NIOSH Publications Office at the Cincinnati address. Copies have been sent to:

1. Kenner Products Company, Cincinnati, Ohio
2. Authorized Representatives of Employees
3. U.S. Department of Labor, Region V
4. NIOSH, Region V
5. President, Local #38, International Union, Allied Industrial Workers of America

To inform the approximately 70 affected employees, copies of the report shall be posted in a place prominent to these employees for a period of 30 days.

III. INTRODUCTION

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

NIOSH received such a request from authorized employee representatives to evaluate the potential hazards associated with the use of polyurethane foams in Building B-1 at the Kenner Complex. The request was at least in part prompted by several employees allegedly having breathing problems, coughing, and skin irritations.

IV. HEALTH HAZARD EVALUATION

A. Facility and Process Description

The facility (Bldg. B-1) houses an area of approximately 9000 square feet and provides for two separate production lines located at opposite ends of the building. The products are a polyurethane filled doll and a firmer polyurethane horse. The doll line operates on a one shift per day basis while the horse line operates on a two shift per day basis. All told, 20-25 individuals are employed on each line per shift.

Since the two processes are quite similar only one need be described. The isocyanate-polyol systems arrive in 55 gallon drums. The drums are tapped and the contents are metered to the single injection foam filling station located on each line. After the molds are filled, they pass through the curing ovens (13 minutes for dolls, 8 minutes for horses) into the packing and inspection areas where the dolls or horses are removed from the molds, inspected, and placed in cardboard boxes for delivery to another building. Normally, one or two individuals work in and out of the pump rooms, two to three individuals work in the near vicinity of the foam

filling operations, and the remainder are employed in the mold unloading, inspection, and packing areas. The urethane system for the doll line consists of TDI, MDI, polyols, and proprietary tertiary amine catalysts. The urethane system for the horse line was similar except that it supposedly did not contain TDI.

Methylene chloride is used to clean the metering nozzles. Normally this takes one man about one half hour per shift and is done at a workbench using open pans of methylene chloride (each containing perhaps one half quart of methylene chloride).

B. Evaluation Sequence

8/16/76	Company was visited by NIOSH staff. The health hazard evaluation program and intended protocol was explained to company and union officials. A walk-through was made at Building B-1.
8/18-19/76	Evaluation survey was conducted. Survey included air and bulk sampling, process reviews, appraisal of control systems, non-directed medical questioning of workers, and discussion related to the company industrial hygiene and medical programs.
10/6/76	Because of undetermined sample interference leading to a lack of adequate analytical sensitivity, it was necessary to resample for TDI and MDI. The earlier sample results were of no value.

C. Evaluation Methods and Results

1. Environmental

Fixed location air samples for TDI and MDI were collected by drawing air at a rate of 1 liter per minute through midget impingers containing the absorbing solution. The reagents and analytical procedures follow the "modified" Marcali method as reported by Grim and Lynch.[1] The absorbing solutions were sent to the Salt Lake City NIOSH contract analytical laboratory[2] where the amounts of TDI and MDI were measured colorimetrically.

Air samples for tertiary amines were collected by drawing air through silica gel tubes at a rate of approximately 100 cc/min. The silica gel tubes were analyzed in the NIOSH contract analytical laboratory by a gas

chromatography method.[3] Several charcoal samples for amines were collected for comparative purposes. It should be noted that the current analytical methods for amines are in need of further development.

Air samples for methylene chloride were taken by charcoal tube and colorimetric indicator tubes. The charcoal tube sample was analyzed in the NIOSH contract analytical laboratory by a gas chromatography method.[4]

2. Medical

On August 28, 1976, 28 workers were questioned via non-directed questionnaires. Of these 28 workers, 12 mentioned the following symptomatology which they felt may or may not be work related: Occasional dry throat - 3 persons (1 smoker), occasional headache - 2 persons, coughing - 2 persons (both smokers), daily headache - 1 person, sleepiness - 1 person, burning of eyes - 1 person, a single dermatitis event - 1 person, and unspecified rash - 1 person.

D. Evaluation Criteria

1. Environmental

The primary sources of environmental evaluation criteria considered for this study were 1) NIOSH criteria documents,[5] 2) the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's)[6] and 3) the U.S. Department of Labor Federal Occupational Health Standards.[7] Only the criteria or standards considered most applicable are listed as follows:

Substance	Ceiling Value	8-hour Time Weighted Average	15 Minute Peak
Methylene bisphenyl isocyanate[a]	.02 ppm	-	-
Toluene diisocyanate[b]	.02 ppm	.005 ppm	-
Methylene chloride[b]	-	75 ppm	500 ppm

[a]ACGIH Threshold Limit Value
[b]NIOSH Criteria Documents

It should be noted that there are no published recommended environmental evaluation criteria for the proprietary tertiary amines used in the urethane systems. This is a moot point since none of these amines were detectable in the work room air.

2. Physiological Effects

The isocyanates are most irritating to the mucous membranes accounting for: 1) bronchitis, 2) bronchospasm, 3) rhinitis, 4) pharyngitis, and 5) conjunctivitis. This irritating property is not related to an allergic reaction. Sensitization and allergic reaction to isocyanates appears to require genetic predisposition, presumably explaining the restricted prevalence. With allergic sensitization, low concentrations of TDI and MDI may elicit dyspnea and cough (including nocturnal) with the ultimate clinical picture being that of asthmatic bronchitis. This asthmatic reaction may be severe and has been fatal in a few cases. A third respiratory system response to TDI and MDI is apparently that of acute and chronic impairment of lung function or ventilatory capacity. This syndrome is currently under study with further investigation being needed.[8]

Methylene chloride is one of the least hazardous of the chlorinated hydrocarbons, the principal hazardous effect being a depressant action on the central nervous system. There is experimental animal evidence that methylene chloride can produce liver and kidney changes. Recent studies have shown that methylene chloride can be metabolized in the body to carbon monoxide, resulting in significant levels of carboxyhemoglobin.[8]

Amines produce effects in man largely related to local actions. Exposures to vapors may produce eye, skin, and mucous membrane irritation. Direct contact with liquids produces severe eye damage and skin burns. Cutaneous sensitization has been reported and systemic symptoms from inhalation of vapors may include headache, nausea, faintness, and anxiety.[9]

E. Discussion of Survey Findings - Recommendations

A review of the air sample results for TDI, MDI, and aromatic amines (Tables 1 & 2) indicates that at the time of the survey the air concentrations of these chemicals were within acceptable limits. Of 26 samples analyzed, most showed non-detectable quantities of TDI and MDI. The highest sample result for TDI was 0.010 ppm and for MDI was 0.002 ppm. None of the air samples for the proprietary amines indicated detectable quantities but it should be remembered that the sampling and analytical methods for amines are in need of further development. That these air concentrations are acceptable is due in part to the ventilation systems in use at the time of the survey. Even though smoke tube tests indicated these systems to be working quite well, several recommendations are suggested:

1. The pedestal floor fans used for comfort ventilation should not be directed into the exhaust hoods. This causes considerable turbulence which upsets the operating characteristics of these hoods.

2. The unused duct on the ventilation system for the doll line foam filling operation might be capped.

3. The panels on the curing oven for the horse line should be kept in place.

4. There were "chinese hat" weather caps on a couple of the exhaust system stack heads. By current ventilation design practice, the use of chinese weather caps is not recommended and other designs are available.[10]

5. Several of the exhaust system stack heads were in fairly close proximity with doors, windows, etc. These should be closely watched for evidence of "short circuiting".

6. It was recommended during the survey that side baffles be installed on the small canopy hood located in the horse line pump room. These were installed by the company.

The company has a "Manufacturing Engineering Procedure No. 5" which is directed towards the safe handling of TDI and MDI. They were assisted in the development of this protocol by the University of Cincinnati Kettering Laboratory. The program is quite complete but there is always the problem that many safety and health procedures have a tendency to deteriorate with time. It is recommended that the company follow closely their own program for the safe handling of TDI and MDI. The importance of this recommendation cannot be overstressed.

A review of the NIOSH questionnaires by a NIOSH physician indicated two employees felt to need further follow-up via telephone discussion.

1) One person apparently had an aggravation of a skin condition from handling the warm plastic on the doll line. This condition can probably be prevented by wearing white cotton gloves - such as the company provides.

2) The other person - with daily headache - NIOSH attempted to contact via telephone and letter. No response was received to either the telephone or letter request for additional information.

The company medical program for the employees actually or potentially exposed to TDI/MDI in Building B-1 was also developed by the University of Cincinnati Kettering Laboratory. This program was reviewed by the HETAB Medical Section and after discussion with the plant physician was judged to be adequate. Basically the medical program provides for:

1. A pre-employment medical examination

2. Periodic medical examinations

3. Re-examination on return to work following sickness absence

4. Full respiratory evaluation in the event of sensitization to isocyanates

5. Re-evaluation of respiratory status in the event of accidental exposure to isocyanates

As with the company program for the safe handling of TDI and MDI, it is necessary that the company not relax their current medical program.

The air sample results for methylene chloride (Table 3) indicate that air concentrations measured approximately 50 percent of the 15 minute peak concentration allowed (500 ppm); since exposure is limited to about one half hour per shift, exposure would not exceed the 8-hour time-weighted average limit of 75 ppm. In spite of acceptable air levels it is recommended that:

1) Open pans of methylene chloride be covered when not in use.

2) The worker wear impermeable protective gloves when working with the methylene chloride.

3) If possible, the ejector nozzles should be cleaned in an exhaust hood or in front of an air exhaust source.

The company is referred to the NIOSH criteria document on methylene chloride for a more complete reference on work practices.

On the basis of this study, it is obvious that the company (management and union) has made efforts and achievements in the field of worker health. They are to be commended.

V. REFERENCES

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9. Frank A. Patty, Editor. Industrial Hygiene and Toxicology, Volume II. (New York: John Wiley & Sons, Inc.) 1963.

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TABLE 1

Results of Fixed Location Air Sampling for Toluene Diisocyanate (TDI) and Methylene Bisphenyl Isocyanate (MDI)

Kenner Products Co.
Cincinnati, Ohio
October 6, 1976

Time	Doll Line	MDI (ppm)*	TDI (ppm)*
0715 - 1039	Upper pump room	.002	N.D.*
1039 - 1144, 1213 - 1318	Upper pump room	.002	N.D.
0714 - 1038	Lower pump room	.001	N.D.
1038 - 1144, 1213 - 1432	Lower pump room	.001	N.D.
0825 - 1030	Conveyor transfer by foam filling	Sample lost	
0721 - 1050	Foam filling	.001	N.D.
1050 - 1145, 1215 - 1330	Foam filling	.001	N.D.
0716 - 1040	Neck cup closing	.001	N.D.
1040 - 1145, 1214 - 1432	Neck cup closing	.001	N.D.
0723 - 1055	Oven discharge	.001	N.D.
1057 - 1145, 1215 - 1440	Oven discharge	.001	N.D.
0821 - 1145	Inspection	N.D.	N.D.
1215 - 1317	Inspection	N.D.	N.D.
	Horse Line		
0740 - 1115	Pump room	N.D.	N.D.
0836 - 1141	Pump room	N.D.	N.D.
1116 - 1141, 1215 - 1422	Pump room	N.D.	N.D.
1215 - 1422	Pump room	N.D.	N.D.
0746 - 1120	Foam filling	N.D.	.010
1120 - 1142, 1216 - 1425	Foam filling	N.D.	.006
0802 - 1134	Work bench, by curing oven	N.D.	N.D.
1134 - 1142, 1216 - 1435	Work bench, by curing oven	N.D.	N.D.
0755 - 1125	Opening molds	N.D.	N.D.
1126 - 1143, 1217 - 1430	Opening molds	N.D.	N.D.
0803 - 1138	Loading mold frames	N.D.	N.D.
1216 - 1433	Loading mold frames	N.D.	N.D.
0800 - 1131	Inspection	N.D.	N.D.
1131 - 1144, 1218 - 1415	Inspection	N.D.	N.D.

*Notes:

1. Parts of TDI or MDI per million parts of air by volume

2. N.D. = None detected

3. The 1976 ACGIH Threshold Limit Value for MDI is 0.02 ppm (ceiling value).

   The NIOSH recommended standard for TDI is 0.005 ppm for an 8-hour time-weighted average daily exposure.

TABLE 2

Results of Air Sampling for Amine Catalysts

Kenner Products Co.
Cincinnati, Ohio

Date	Time	Sampling Media	Amine*	Location	Concentration (ppm)*
8-18-76	0945 - 1305	Silica Gel	A	Doll line - pump room	N.D.*
8-18-76	0945 - 1305	Silica Gel	B	Doll line - pump room	N.D.
8-18-76	0950 - 1130	Silica Gel	A	Doll line - foam filler	N.D.
8-18-76	0955 - 1130	Silica Gel	A	Doll line - neck cup closer	N.D.
8-18-76	1018 - 1505	Silica Gel	A	Horse line - pump room	N.D.
8-18-76	1220 - 1510	Silica Gel	A	Horse line - foam filler	N.D.
8-18-76	1220 - 1511	Silica Gel	A	Horse line - Asst. foam filler	N.D.
8-18-76	1233 - 1515	Silica Gel	A	Horse line - Mold opener	N.D.
8-19-76	0726 - 1140	Silica Gel	A	Doll line - pump room	N.D.
8-19-76	0726 - 1140	Charcoal	A	Doll line - pump room	N.D.
8-19-76	0804 - 1141	Silica Gel	A	Doll line - lower pump room	N.D.
8-19-76	0804 - 1131	Charcoal	A	Doll line - lower pump room	N.D.
8-19-76	0740 - 1130	Silica Gel	A	Horse line - pump room	N.D.
8-19-76	0740 - 1130	Charcoal	A	Horse line - pump room	N.D.
8-19-76	0813 - 1131	Silica Gel	A	Horse line - foam filling	N.D.
8-19-76	0813 - 1141	Charcoal	A	Horse line - foam filling	N.D.
10-6-76	0856 - 1432	Silica Gel	C	Doll line - lower pump room	N.D.
10-6-76	0857 - 1431	Silica Gel	D	Doll line - upper pump room	N.D.

*Notes:

1. Sampling was conducted for 4 proprietary amines

2. PPM = Parts of amine per million parts of air volume

3. N.D. = None detected: Amine "A" limit of detection was 0.1 ppm
   " "B" " " " " 0.001 ppm
   " "C" " " " " 0.001 ppm
   " "D" " " " " 0.001 ppm

TABLE 3

Results of Air Sampling for Methylene Chloride

Kenner Products Co.
Cincinnati, Ohio
August 19, 1976

Type	Time	Job Description	Concentration (ppm)*
Charcoal Tube	1245 - 1325	Mechanic cleaning injector nozzles	250
Indicator Tube	1305	Mechanic cleaning injector nozzles	200
Indicator Tube	1320	Mechanic cleaning injector nozzles	200

*Parts of methylene chloride per million parts of air by volume

The NIOSH recommended standard for methylene chloride is 75 ppm for an 8-hour time-weighted average daily exposure or 500 ppm for a 15 minute peak.