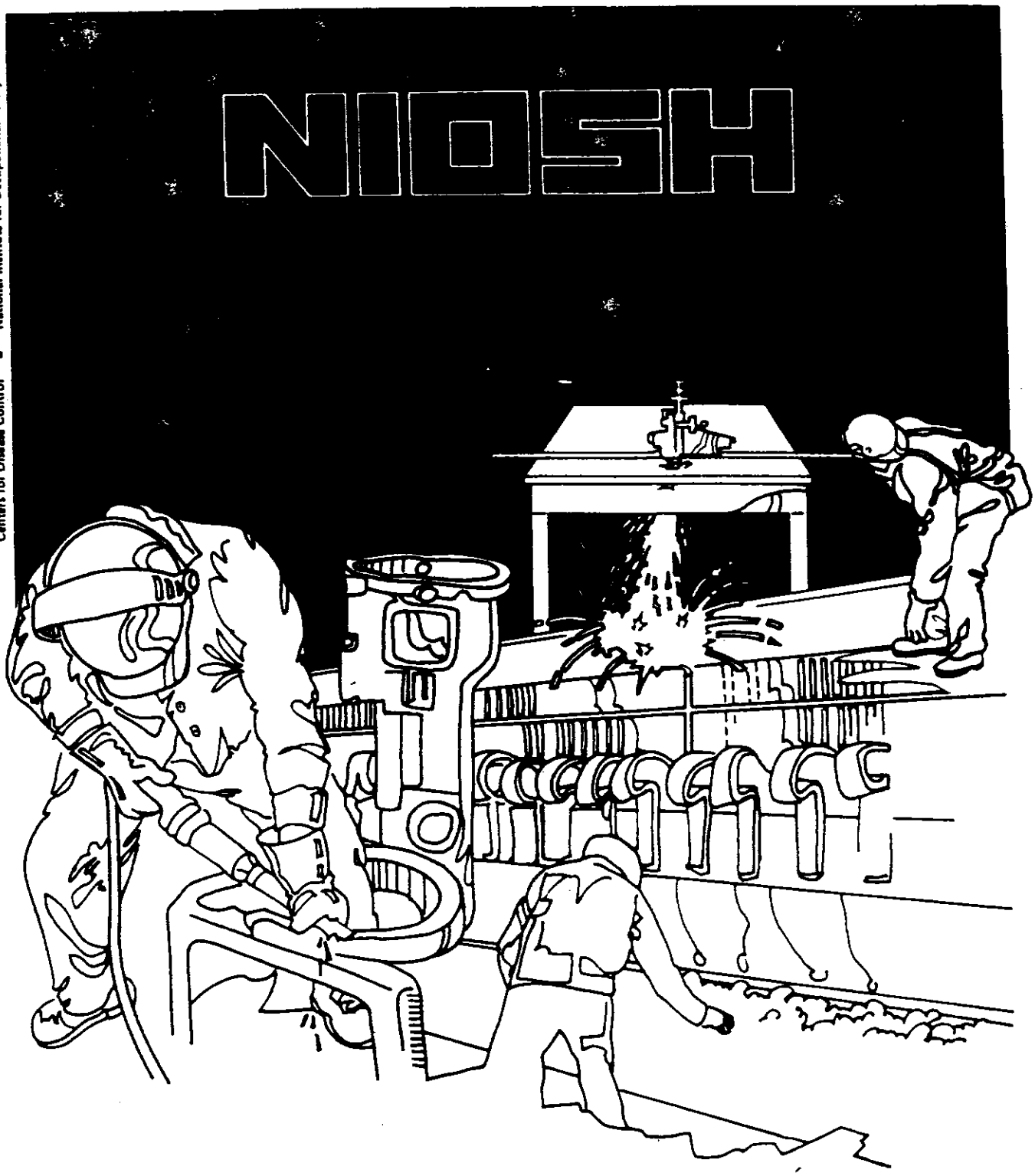
This Health Hazard Evaluation (HHE) report and any recommendations made herein are for the specific facility evaluated and may not be universally applicable. Any recommendations made are not to be considered as final statements of NIOSH policy or of any agency or individual involved.
Additional HHE reports are available at http://www.cdc.gov/niosh/hhe/reports

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



Health Hazard Evaluation Report

HETA 89-057-2003
CINCINNATI ELECTRONICS CORP.
CINCINNATI, OHIO

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 89-057-2003
DECEMBER 1989
CINCINNATI ELECTRONICS CORP.
CINCINNATI, OHIO

NIOSH INVESTIGATORS:
Bruce Hills, M.S., C.I.H.
Boris Lushniak, M.D.
Thomas Sinks, Ph.D.

I. SUMMARY

On December 8, 1988, the National Institute for Occupational Safety and Health (NIOSH) received a request from a management representative and from the local representative of the International Brotherhood of Electrical Workers (IBEW), to investigate an outbreak of illness among employees of Cincinnati Electronics Corporation in Cincinnati, Ohio which had occurred on December 5-7, 1988. Cincinnati Electronics Corporation manufactures circuit boards and electrical equipment for commercial and defense uses.

NIOSH investigators conducted a survey at the facility on December 8, 9, and 12, 1988, to interview affected employees, administer a questionnaire, and to collect environmental samples to determine exposure to toxic substances. Apparently the use of steam for humidity in the work area resulted in a "musty radiator" odor from two corrosion inhibiting chemicals, diethylaminoethanol and cyclohexylamine, which had been added to the boilers. Sixty five employees from throughout the plant had developed symptoms consistent with acute toxic effects of diethylaminoethanol and cyclohexylamine which included nausea, dizziness, vomiting, and eye, nose, and throat irritation. Employees in the areas humidified with boiler steam had a significantly higher risk of having several symptoms than employees in the non-boiler steam humidified areas.

The environmental samples which were collected 4 days after the first symptoms, for diethylaminoethanol and cyclohexylamine on work surfaces, in the air, and in the boiler water all showed non-detectable levels of these compounds. Because the boilers require fresh water daily to make up for losses, the concentration of amines in the water had been diluted by the time the NIOSH staff collected their samples. Samples collected to determine employee exposures to metals from solder fumes and methyl ethyl ketone from the manufacturing process showed that concentrations of these were well below accepted standards.

The acute out break of illness experienced by the employees on December 5-7, 1988, coincided with the introduction of steam from boiler number 2 and, therefore, was most likely the result of workers' exposure to diethylaminoethanol and cyclohexylamine. The investigators recommend that exposure to diethylaminoethanol and cyclohexylamine-containing steam be eliminated by using alternative humidification methods presented in Section VII. After the outbreak of illness, the company suspended the use of boiler steam to humidify the building. As of December 1989, there have been no further employee symptoms consistent with the acute toxic effects of diethylaminoethanol or cyclohexylamine.

KEYWORDS: SIC 3663 (Electronic equipment manufacturer) diethylaminoethanol, cyclohexylamine, steam humidification, boiler water treatment.

II. INTRODUCTION

On December 8, 1988, the National Institute for Occupational Safety and Health (NIOSH) received a request from a management representative and from the local representative of the International Brotherhood of Electrical Workers (IBEW) to investigate an outbreak of worker illness among employees of Cincinnati Electronics Corporation in Cincinnati, Ohio which had occurred on December 5-7, 1988. The corrosion inhibitors diethylaminoethanol and cyclohexylamine had been added to the boiler water, which was used to humidify to the work area. These amines were suspected as a cause of the employees' symptoms. On December 8, 9, and 12, 1988, representatives of NIOSH visited the facility, interviewed affected employees, administered a questionnaire, and collected samples to determine exposures to diethylaminoethanol, cyclohexylamine, organic solvents, and metals.

III. BACKGROUND

Cincinnati Electronics Corporation is a manufacturer of electrical circuit boards and electrical equipment for the commercial and defense industries. The facility is located in one main building, with a smaller adjacent building that houses the two coal fired boilers used to heat and humidify the main building. The Fabrication areas also receive steam humidification from an electric boiler which is independent of the two main boilers.

In September 1988, boiler number 1 and boiler number 2 were prepared for operation by adding corrosion-inhibiting chemicals. Two gallons of the amine product, which contains 25.5% diethylaminoethanol, 16.8% cyclohexylamine, and 58% water, was added to each boiler. Since each boiler holds approximately 20,000 gallons of water, the approximate concentrations of diethylaminoethanol and cyclohexylamine in the boiler water were 24 parts per million (ppm) and 16 ppm, respectively. Boiler 1 was used to generate heat and provide humidity to the Fabrication areas [room A (Prep. and R&I) and room B (Assembly)] from September until December 5, 1988. During this time there were no complaints from the employees.

On December 5, 1988, at 11:00 a.m., boiler 1 was shut down, and boiler 2 began to generate steam to heat and humidify the Fabrication areas. Employees began to complain of a musty-acrid odor; 40 employees visited the medical department complaining of a variety of symptoms associated with an unfamiliar odor that was present in the workplace on that day. Employees came to the nurse between noon and 2 p.m. The symptoms, as recorded by the nurse, included headache; nausea; and, in some individuals, rapid and irregular heartbeats. The steam from boiler 2 was turned off an hour and a half after the start up, and the room was evacuated. The incidence of symptoms subsided after the evacuation.

On December 7, 1988, the steam from boiler 2 was released into room B and other rooms. The odor built up to a strong pungent level. The affected rooms were then evacuated and the steam was shut off. Company officials determined that the steam from boiler 2 may have been the cause of the employees' illnesses. However, at the time, the company did not suspect the amine product as the causative agent. Therefore, the steam from this boiler was purged to the outdoors, once on December 6, twice on December 7, and three times on December 8. Since boilers lose water to steam and condensation that is drained off, fresh makeup water was normally added each day. Due to purging and other losses, between December 5 and December 9 the daily makeup water was between 6,900 and 18,900 gallons. Since the amine compounds were required to adjust the pH of the water, one and one-half gallons of the amine product were added during this week.

IV. EVALUATION DESIGN AND METHODS

Environmental

On December 9, 1988, environmental monitoring was performed to identify airborne organic vapors and metals, as well as to measure airborne concentrations of diethylaminoethanol and cyclohexylamine. Monitoring for the amines was performed for two hours in room B after the boiler steam had been turned off for 48 hours. The employees were in the room during the monitoring. After the employees left for the day, the boiler steam was turned on in the room, and diethylaminoethanol levels were monitored for one hour. The samples were collected on 300/150 mg silica gel tubes at a flow rate of 0.2 liters per minute (lpm) and analyzed by gas chromatography according the NIOSH Method No. 2007.[1] Bulk samples of the boiler water were collected for amine analysis by direct injection into a gas chromatograph mass spectrometry (GC/MS) without solvent dilution. Two samples were collected on 100/50 mg charcoal tubes for qualitative analysis of organics by GC/MS.

Many of the employees in room B solder electrical components to circuit boards at their work station. Breathing the fumes from the solder can result in exposure to lead, tin, and other metals. Area airborne samples were collected to measures these metals and other elements. Three samples for metals were collected on 37-mm cellulose ester membrane filters at a flow rate of 2 lpm for 3 hours. These samples were analyzed by Inductively Coupled Argon Plasma, Atomic Emission Spectroscopy (ICP-AES) according to NIOSH Method No. 7300.[1]

Unrelated to the cases of illness on December 5, 1988, an employee in room B was exposed to methyl ethyl ketone during the cleaning of the conformal coat machine. The operator was monitored for methyl ethyl ketone while performing this task on December 9, 1988. In addition,

two area samples were collected for this compound during the cleaning. Samples were collected on Ambersorb XE-347 tubes at a flow rate of 0.2 lpm and analyzed by gas chromatography flame ionization according to NIOSH Method No. 2500.[1]

On December 12, 1988, additional monitoring for diethylaminoethanol was done by collecting surface wipe samples in room B. Six samples were collected from table tops, table supports, and the floor using Whatman smear tabs. These samples were also analyzed according to NIOSH Method No. 2007.[1]

During a walk-through inspection of the boiler room, we observed that some of the insulation on the boiler was broken and friable. Two bulk samples of this material were collected for asbestos identification by polarized light microscopy according to NIOSH Method No. 7400.[1]

Medical

The medical evaluation consisted of a review of plant medical records, personal interviews with employees, questionnaire survey of employees, and a review of hospital and physician records.

On December 8, 1988, a review of the in-plant medical department records was conducted. These records included a listing of employees visiting the department from December 5 to December 8, a listing of symptoms, in some cases a documentation of vital signs, and in some cases a documentation of therapy with available over-the-counter medicines. On December 9, 1988, confidential medical interviews were conducted with sixteen randomly-selected individuals whose names appeared on the medical department's list. Information obtained during these interviews included a summary of the events preceding the visit to the medical department, present symptoms and illnesses, a review of medical care sought, therapies administered, and diagnoses given.

On December 12, 1988, a questionnaire was given to 136 employees from different areas of the plant (Test Area, Payroll, R&I, HST-4, Prep, and Area B). This self-administered questionnaire included questions on personal demographics, a brief work history, perception of an odor on December 5, the characteristics of the odor, the symptoms associated with this odor, the duration of symptoms, the recurrence of odor and symptoms, and a brief medical history. After the questionnaires were returned, a meeting was held with the employees to inform them of our preliminary findings and to answer questions.

During the week of December 12, ten medical records were obtained from hospital emergency rooms and private physicians' offices for individuals who had sought medical care. These medical records were

reviewed for documentation of the medical history, physical exam, laboratory results, diagnosis, and therapy.

V. EVALUATION CRITERIA

A. Environmental Evaluation 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 for 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. 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], (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs)[3], and (3) the U.S. Department of Labor (OSHA) occupational health standards[4]. Often, the NIOSH recommended exposure limits (RELs) and ACGIH TLVs are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLVs usually are based on more current information than are the OSHA standards, although OSHA has recently revised many of it's PELs to correspond to the TLVs. 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 RELs, 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 those levels specified by an OSHA standard.

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

B. Diethylaminoethanol (DEAE)

The OSHA standard and the ACGIH TLV for exposure to diethylaminoethanol are both 50 mg/m^3 which is equivalent to 10 parts per million of air (ppm).[3,4] Diethylaminoethanol is an eye, skin and respiratory tract irritant. It can be absorbed through the respiratory tract and through the skin.[5] No information is available regarding the air concentration of diethylaminoethanol which produces eye or respiratory tract irritation in humans. The odor threshold for diethylaminoethanol is 53.6 ug/m^3 and has been described as an "amine" odor.[6]

Animal toxicologic studies showed that rats exposed to 500 ppm, 6 hours daily, for 5 days exhibited marked eye and nasal irritation, and a number of rats had corneal opacity by end of the third day.[5] A laboratory worker conducting this study, who was accidently exposed to approximately 100 ppm DEAE for less than 30 seconds, developed nausea and vomiting within 5 minutes after exposure.

A NIOSH Health Hazard Evaluation conducted in September 1981 showed a primary chemical skin reaction (possibly phototoxic) among workers potentially exposed to several substances, including diethylaminoethanol, although NIOSH was unable to detect diethylaminoethanol with the available sampling methods (limit of detection = 0.4 mg/m^3).[7] The symptoms at that site abated after the use of diethylaminoethanol was discontinued. Two years later a similar incidence occurred at a museum in New York.[8] Employees there reported eye irritation, skin problems, and occasional headaches and sore throats. Diethylaminoethanol had been added to the boiler steam which humidified their work area but not in excessive concentrations.

C. Cyclohexylamine (CHA)

The OSHA PEL and the ACGIH TLV for cyclohexylamine exposure are both 40 mg/m^3 or 10 ppm.[3,4] CHA is a toxic liquid with a strong, fishy, amine odor. It is intensely irritating to the skin and is regarded as having moderate sensitizing potential.[2] Dermal exposure of guinea pigs to CHA for 24 hours had a 50% death

rate at a dose level between 1 and 5 milliliters per kilogram.[9] Other animals exposed to airborne concentrations of 150 ppm CHA for 70 hours resulted in a few deaths.[10] The same study described three nonfatal human exposures to CHA vapor which revealed a strong irritant property with nausea and vomiting in these individuals. The authors also reported that no symptoms of any kind occurred in workmen exposed to 4-10 ppm CHA. In 1989, nurses in a Portland, Oregon hospital had similar complaints of eye and upper respiratory tract irritation after the introduction of CHA and morpholine into the boiler water used to humidify the nursery and the newborn intensive care units.[11] The airborne concentrations of CHA and morpholine at the time of the symptoms is unknown.

D. Cadmium

Cadmium is an irritant to the respiratory tract. Inhalation of sufficiently large amounts of cadmium may cause coughing, chest pains, sweating and chills, followed by pulmonary edema. Cadmium may also cause kidney damage. Some cadmium compounds have been shown to cause excess lung cancer in human and animal studies.

NIOSH recommends that cadmium exposures be reduced to the lowest feasible level. The OSHA PEL for cadmium fume is 100 ug/m^3 and 300 $ug/^3$ as an acceptable ceiling. The ACGIH TLV for cadmium fumes is 50 ug/m^3 and 50 ug/m^3 as a 15 minute short term exposure limit.[2-4]

E. Methyl Ethyl Ketone

The OSHA PEL, NIOSH REL, and the ACGIH TLV for methyl ethyl ketone is 590 mg/m^3 or 200 ppm.[2-4] The OSHA and ACGIH short term exposure limit (STEL) for methyl ethyl ketone is 885 mg/m^3 or 300 ppm. Methyl ethyl ketone is a volatile liquid that may be absorbed by inhalation or through skin contact with the liquid or vapor. It can cause fatigue, headache, drowsiness, nausea, vomiting, dizziness, loss of coordination, and other central nervous system effects. Irritation of the eyes, skin, mucous membranes, and the respiratory tract can also occur.[12]

VI. RESULTS AND DISCUSSION

A. Environmental

The samples collected for diethylaminoethanol and cyclohexylamine from the boiler water, work place surfaces, and airborne vapors or aerosols trapped on the silica gel tubes were all non-detectable. The limit of detection was approximately 10 ppm for the boiler water and 2 ug per sample for the surface wipe and airborne

samples. A possible explanation for the lack of amines in the samples is that the steam pipes were purged six times between the first report of symptoms and the collection of samples. Also the boiler required fresh water each day which further diluted the original concentrations of the amines.

The qualitative organic analysis for area samples collected in room B revealed trace quantities of isopropanol, methyl ethyl ketone, isobutanol, 1,1,1-trichloroethane, toluene, and xylenes. The isopropanol and methyl ethyl ketone were present because the Conformal coat machine is located in this room.

The employee who cleaned the Conformal coat machine for a period of an hour and a half was exposed to 32.7 milligrams per cubic meter (mg/m^3) of methyl ethyl ketone. The area samples showed concentrations of 6.3 and 5.0 mg/m^3. The limit of detection for this analysis was 0.4 mg/m^3 and the limit of quantitation was 1.2 mg/m^3. The OSHA PEL, NIOSH REL, and the ACGIH TLV for methyl ethyl ketone is 590 mg/m^3.

The analysis for airborne metals in room B revealed 3.1 micrograms per cubic meter of air (ug/m^3) of cadmium on one sample. NIOSH recommends that cadmium exposures be reduced to the lowest feasible level. The OSHA PEL for cadmium fumes is 100 ug/m^3 and 300 ug/m^3 as an acceptable ceiling. Aluminum, sodium, and zinc were also present in trace amounts.

One of the samples collected for asbestos contained 25% amosite (asbestos), 30% chrysolite (asbestos), 5% fiber glass, and 40% unknown matrix. The second sample contained 95% fiberglass and 5% unknown matrix.

B. Medical

On Monday, December 5, 1988, 44 employees visited the plant nurse during the work day. Of these, 40 employees (91%) complained of a variety of symptoms associated with an unfamiliar odor that was present in the workplace on that day. Most employees came to the nurse between the hours of noon and 2 p.m.. The symptoms, as recorded by the nurse, included headache; nausea; dizziness; itching skin; throat, eye, dry mouth, and nose irritation/burning. The distribution, by work area, of employees who visited the nurse on that day is included in Table 1. The week's total visits to the nurse, and visits in which a complaint of odor was recorded, are included in Table 2.

The self-administered NIOSH questionnaire was distributed to 136 employees on December 12, 1988. Three questionnaires had

insufficient information and were excluded from the analysis. Eight employees were absent the day the questionnaire was distributed. The overall response rate was 133/144 or 92%. Of the respondents, 77% were female (102/133), 79% were white (105/133), 15% were black (20/133), 3% were Asian (4/133), and 3% did not designate a race. The mean age of the workers was 41 [standard deviation (s.d.) +/-12.6]. The respondents worked in the following areas: Area B - 51% (68/133); Prep - 8% (11/133); R&I - 9% (12/133); Payroll - 2% (3/133); HST-4 - 19% (25/133); Test - 11% (14/133).

Unpleasant odors at work were noted as occurring "often" by 33% of the workers, and "sometimes" by 58%. On Monday, 12/5/88, 80% (97/121) of those present smelled an unusual odor at work; this is reported by work area in Table 3. For the rest of the week, the following is a listing of those present who smelled an unusual odor: Tuesday 12/6/88 - 40% (53/133); Wednesday 12/7/88 - 61% (80/131); Thursday 12/8/88 - 37% (49/132); Friday 12/9/88 - 18% (24/131).

On Monday 12/5/88, 81% (79/97) of those reporting an odor described it as similar to ammonia and/or car-radiator overflow; 73% (71/97) noted the odor after 11:00 a.m.. Among those who reported an odor, 80% (77/97) felt that it made them sick. A list of symptoms experienced by these individuals is given in Table 4. The distribution of employees, by work area, who felt that they were sick because of an unusual odor on Monday, 12/5/88 is listed in Table 5.

The duration of symptoms varied from a few hours to a period of several days. Sixty-two percent (48/77) of those ill on 12/5/88 felt that they had a recurrence of symptoms at work on 12/6/88. This proportion rose to 74% on 12/7/88, fell to 62% on 12/8/88, and fell further to 42% on 12/9/88.

Based upon this information, along with environmental data, it appeared that both the odor and the illness may have been a result of the introduction of steam for humidification into the work areas. The steam from boiler 2 contained two corrosion inhibiting agents, diethylaminoethanol and cyclohexylamine. The boiler producing the steam had become operational after 11:00 a.m. on Monday, December 5, 1988.

To test the hypothesis that symptoms were related to steam from boiler 2, work areas B, Prep, R&I, and Payroll, which were receiving humidified air from boiler 2 or were in close proximity to the humidification system, were grouped together in the analysis

(Section 1) and compared with area HST-4 and the Test area (Section 2), where exposure to humidified steam from boiler 2 did not occur. We defined a case as a worker having two or more symptoms on 12/5 compatible with exposure to DEAE and CHA. The symptoms included: nausea, dizziness, vomiting, nose irritation, throat irritation, and eye irritation. Sixty-five employees met the case definition.

On Monday, 12/5/88, workers in Section 1 were more than 4 times as likely to become a case than workers in Section 2 [relative risk (RR) = 4.33, 95% confidence intervals (C.I.), 2.06-9.13]. This relative risk was higher in females, whites vs. other races combined, individuals with allergies, and current smokers. The relative risk did not differ significantly by education level. (Table 6) The demographic information on cases and non-cases is presented in Table 7.

The increased risk of having symptoms (not necessarily meeting the strict definition of being a case) for employees in Section 1 compared to Section 2 persisted throughout the week: Tuesday - RR=4.98 (C.I. 1.93-12.86); Wednesday - RR=2.81 (C.I. 1.56-5.08); Thursday - RR=4.31 (C.I. 1.87-9.98); and, Friday - RR=4.15 (C.I. 1.34-12.80).

Workers in Section 1 were over twice as likely to have smelled an unusual odor on 12/5/88 than those in Section 2 (RR=2.23, 95% C.I. 1.54-3.23). On each day during the week, workers in Section 1 were more likely then workers in Section 2 to have smelled an odor.

A review of the ten medical records showed that most employees were treated symptomatically for headache, nose, throat, and eye irritation. One worker was treated with a bronchodilator for wheezing. Laboratory results were all within normal limits for a general blood chemistry battery (1 person), complete blood counts (2), routine urinalysis (1), chest X-ray (4), blood gases (4), and electrocardiogram (1).

VII. CONCLUSIONS

1. The acute outbreak of illness experienced by the employees on December 5-7, 1988, coincided with the introduction of steam from boiler number 2 and, therefore, was most likely the result of workers' exposure to DEAE and CHA. This conclusion is supported by the following observations:

   a. The acute outbreak occurred after the introduction into the Fabrication rooms of steam containing DEAE and CHA.

b. Employees in these and nearby areas had a higher relative risk of being ill than employees in non-humidified areas.

c. Both affected and non-affected individuals in areas supplied by steam from boiler 2 described an odor characteristic of DEAE and CHA.

d. The irritant symptoms experienced by the workers were those to be expected following exposure to DEAE and CHA. Diethylaminoethanol has resulted in similar symptoms in other facilities where diethylaminoethanol has been used to humidify the work area.[1,2]

e. In 1985, one manufacturer-supplier of diethylaminoethanol issued a strong warning to its customers not to use steam containing this substance for humidification of public or private buildings. Although the airborne levels of these amines may be below the OSHA PELs and ACGIH TLVs for these compounds, they still appeared to be resulting in eye and upper respiratory tract irritation in exposed employees, even when they are applied to the boiler water at recommended levels.

2. The insulation on the boiler does contain some friable asbestos material that presents a potential health hazard to employees in the boiler room.

3. The employee who cleaned the conformal coat machine had an exposure to methyl ethyl ketone well below the NIOSH REL.

4. Employees in room B are exposed to metals from solder fumes, but the concentrations are below NIOSH RELs and ACGIH TLVs.

5. After the outbreak of illness, the company suspended the use of boiler steam to humidify the building. Humidity is now provided by electric humidifiers that use only municipal water free of amine compounds. As of December 1989, there have been on further employee symptoms consistent with acute toxic effects of diethylaminoethanol or cyclohexylamine.

VIII. RECOMMENDATIONS

1. As we stated during our site visit on December 8, 1988, and in our letter of December 23, 1988, the use of steam containing diethylaminoethanol and cyclohexylamine for humidity should be terminated. If additional humidity is needed in the work area, alternative sources of moisture should be considered.

2. Dermal exposure to diethylaminoethanol may occur through contact with condensed diethylaminoethanol on workroom surfaces. Although our monitoring of surfaces for diethylaminoethanol did not detect diethylaminoethanol, it would be prudent to clean the surfaces with a detergent solution in the rooms supplied by the amine containing steam to eliminate a potential exposure.

3. The friable asbestos on boiler 1 should be encapsulated or removed by workers trained in the correct procedures for asbestos removal.

IX. REFERENCES

1. NIOSH Manual of Analytical Methods, third edition, DHHS, CDC, NIOSH, Cincinnati, Ohio 1984.

2. NIOSH/OSHA Occupational health guidelines for chemical hazards. DHHS (NIOSH) publication no. 81-123, January 1981.

3. American Conference of Governmental Industrial Hygienists. Threshold limit values and biological exposure indices for 1989-1990. Cincinnati, Ohio; ACGIH, 1989.

4. Occupational Safety and Health Administration. Air Contaminants - Permissible Exposure Limits (29 CFR, 1910.1000) OSHA, USDOL, 1989.

5. Cornish, H: Oral and inhalation toxicity of 2-diethylaminoethanol. Am Ind Hyg Assoc J 26:479, 1965.

6. Ruth JH: Odor threshold and irritation levels of several chemical substances: A review. Am Ind Hyg Assoc J 47; A-142-151, March 1986.

7. McManus K, Baker D: Health hazard evaluation report no. 81-247-958: Boehringer Ingleheim, Ltd., Cincinnati, Ohio; NIOSH 1981.

8. Fannick N, Lipscomb J, McManus K: Health hazard evaluation report no. 83-020-1351: Johnson Museum, Cornell University, Cincinnati, Ohio; NIOSH, 1983.

9. Sutton WL: Aliphatic and alicyclic amines. In Fassett DW, Irish DD (eds): Industrial Hygiene and Toxicology, 2nd ed, Vol 2, Toxicology, p 2045. New York, Interscience, 1963.

10. Watrour RM and HN Schulz: Cyclohexylamine, p-chloronitrobenzene, 2-aminopyridine: Toxic effects in industrial use. Ind Med Surg 19:317, 1950.

11. Daniels W: Health hazard evaluation report no. 89-039, Bess Kaiser Medical Center, Portland, Oregon; Personal communication. 2 February 1989.

12. Proctor NH, Hughes JP, Fischman ML: Chemical Hazards of the Workplace, pp 199-200, 172-173, Lippincott, 1988

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:	Bruce Hills, M.S., C.I.H. Industrial Hygienist Industrial Hygiene Section
	Boris Lushniak, M.D. Medical Officer Medical Section
Field Assistance:	Thomas Sinks, Ph.D. Medical Officer Medical Section
Originating Office:	Hazard Evaluation and Technical Assistance Branch Division of Surveillance, Hazard Evaluation, and Field Studies
Report Typed by:	Sharon Jerkins Clerk-typist Industrial Hygiene Section

XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluation and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publication Office at the Cincinnati address. Copies of this report have been sent to:

1. Cincinnati Electronics Corporation
2. International Brotherhood of Electrical Workers, Local 1842
3. International Brotherhood of Electrical Workers, International
4. Occupational Safety and Health Administration, Cincinnati, Ohio

TABLE 1

EMPLOYEES VISITING THE MEDICAL DEPARTMENT
FOR WHOM AN ODOR RELATED COMPLAINT WAS RECORDED
ON DECEMBER, 5, 1988
Cincinnati Electronics Corporation
Cincinnati, Ohio
HHE 89-057

WORK AREA	EMPLOYEES VISITING THE NURSE	TOTAL EMPLOYEES IN THE AREA	PERCENT VISITING THE NURSE
B	30	59	51
PREP	3	11	27
R&I	5	12	42
PAYROLL	2	3	67
HST-4	0	24	0
TEST	0	13	0
	40	122	33

TABLE 2

EMPLOYEE VISITS TO THE NURSE FOR THE WEEK OF DECEMBER 5
Cincinnati Electronics Corporation
Cincinnati, Ohio
HHE 89-057

DATE	ODOR COMPLAINTS	TOTAL VISITS	PERCENT INVOLVING ODOR COMPLAINT
Monday 12/5/88	40	44	91
Tuesday 12/6/88	4	17	24
Wednesday 12/7/88	2	4	50
Thursday 12/8/88	13	15	87

TABLE 3

RESPONDENTS SMELLING AN UNUSUAL ODOR, BY WORK AREA,
ON MONDAY DECEMBER 5, 1988
Cincinnati Electronics Corporation
Cincinnati, Ohio
HHE 89-057

AREA	EMPLOYEES SMELLING ODOR	PERCENT
AREA B	55/58	95
PREP	11/11	100
R&I	12/12	100
PAYROLL	3/3	100
HST-4	12/24	50
TEST	4/13	31
	97/121	80

TABLE 4

SYMPTOMS EXPERIENCED BY 77 EMPLOYEES
SMELLING AN ODOR
ON MONDAY, DECEMBER 5, 1988
Cincinnati Electronics Corporation
Cincinnati, Ohio
HHE 89-057

SYMPTOM	NUMBER WITH SYMPTOM	PERCENT
headache	67	87
throat irritation	48	62
eye irritation	45	58
nausea	42	55
dizziness	36	47
nose irritation	28	36
chest tightness	21	27
shortness of breath	20	26
furry feeling on tongue	19	25
burning/itching skin	13	17
racing heart beat	8	10
vomiting	8	10
skin rash	6	8
wheezing	6	8
tingling fingers	5	7
tinging in ears	3	4

TABLE 5

EMPLOYEES FOR EACH WORK AREA
WHO COMPLAINED OF SYMPTOMS BECAUSE OF AN ODOR
ON MONDAY DECEMBER 5, 1988
Cincinnati Electronics Corporation
Cincinnati, Ohio
HHE 89-057

AREA	SYMPTOMATIC EMPLOYEES	PERCENT
AREA B	50/58	86
PREP	10/11	91
R&I	7/12	58
PAYROLL	3/3	100
HST-4	6/24	25
TEST	1/13	8
	77/121	64

TABLE 6

THE OVERALL RELATIVE RISK OF BEING A CASE* FOR WORKERS IN SECTION 1 COMPARED TO WORKERS IN SECTION 2, AND STRATIFIED BY SEX, SMOKING STATUS, RACE, ALLERGY HISTORY AND EDUCATION
Cincinnati Electronics Corporation
Cincinnati, Ohio
HHE 89-057

		Relative Risk (95% Confidence intervals)
Overall		4.33 (2.06-9.13)
Sex	Males	1.42 (0.23-8.7)
	Females	3.96 (1.63-9.59)
Smoking	Current smokers	8.32 (1.27-54.43)
	Ex- and non-smokers	3.43 (1.52-7.74)
Race	White	5.75 (2.27-14.57)
	Black /Asian	1.41 (0.44-4.47)
Allergies	History of allergies	6.50 (1.02-41.28)
	No allergy history	3.90 (1.72-8.81)
Education	High school education or less	4.93 (1.37-17.79)
	Beyond high school education	4.15 (1.36-12.70)

* A case is defined as a worker having two or more of the following symptoms on 12/5: nausea, dizziness, vomiting, nose irritation, throat irritation, eye irritation

TABLE 7

DEMOGRAPHICS OF CASES AND NON-CASES
Cincinnati Electronics Corporation
Cincinnati, Ohio
HHE 89-057

Category		Cases	Non-cases
Mean age (years)		41	41
Sex			
	Males	4 (6%)	25 (45%)
	Females	61 (94%)	31 (55%)
Race			
	Whites	50 (77%)	46 (82%)
	Blacks	10 (15%)	7 (13%)
	Asians	1 (2%)	3 (5%)
	Not designated	4 (6%)	0
Education			
	High school or less	46 (70%)	25 (45%)
	Beyond high school	16 (25%)	31 (55%)
	Not designated	3 (5%)	0