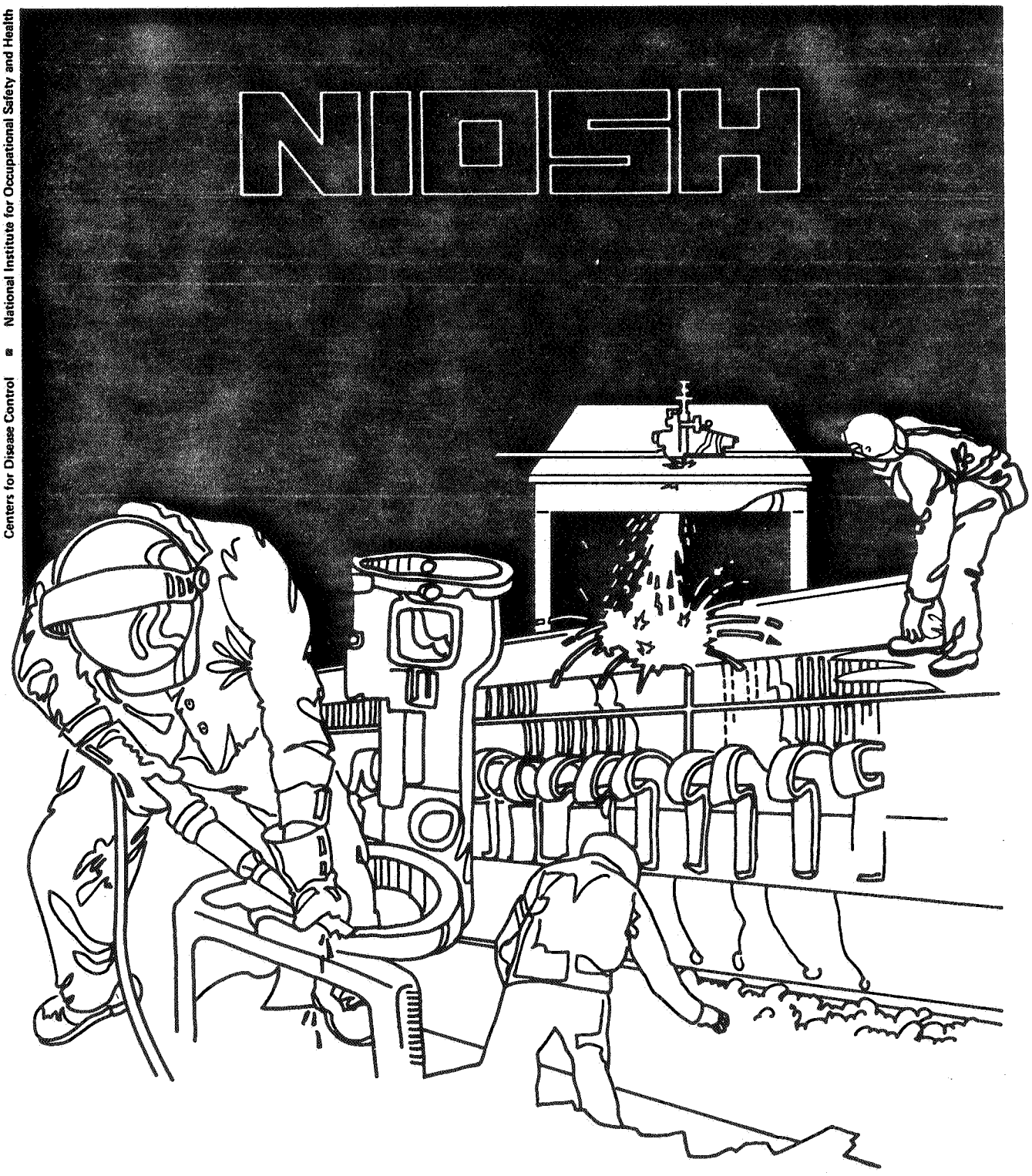
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 84-023-1462
DALE ELECTRONICS, INCORPORATED
YANKTON, SOUTH DAKOTA

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.

HETA 84-023-1462
MAY 1984
DALE ELECTRONICS, INCORPORATED
YANKTON, SOUTH DAKOTA

NIOSH INVESTIGATOR:
Steven A. Lee, M.S., C.I.H.

I. SUMMARY

In October 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request for an industrial hygiene survey of electronic resistor manufacturing processes at Dale Electronics, Inc. in Yankton, South Dakota.

On December 20-21, 1983, NIOSH investigators conducted environmental sampling at the plant. Air samples were collected for 2,4-toluene diisocyanate (TDI), organic solvent vapors, mercury, lead, diethylene triamine (DETA), triorthocresyl phosphate (TOCP), and Bisphenol A.

These air samples showed that two polyurethane mixing workers were exposed to TDI monomer concentrations of 15 ug/m^3 and less than 6 ug/m^3 while mixing small amounts of the resins for 10 to 20 minutes. The NIOSH recommended exposure limit for TDI is 140 ug/m^3 for any 20 minute sampling period.

Nineteen personal breathing-zone samples were collected for various combinations of methyl ethyl ketone, 1,1,1-trichloroethane, acetone, xylene, and toluene. Combined exposures ranged from 1% to 34% with a mean of 13% of the NIOSH recommended exposure limits.

A wire continuity-testing worker was exposed to a full-shift time-weighted average mercury vapor concentration of 20 ug/m^3 and a spray painter was exposed to a lead concentration of 5 ug/m^3. The NIOSH recommended exposure limit for both mercury and lead is 50 ug/m^3.

No DETA, TOCP, or bisphenol A were detected in either breathing zone or process air samples.

On the basis of the data collected in this evaluation, it was determined that there were no overexposure to contaminants at Dale Electronics. Recommendations for further improvements in working with potentially hazardous materials are presented in Section VII of this report.

KEYWORDS: SIC 3676 (Electronic Resistor Manufacturing) 2,4-toluene diisocyanate, methyl ethyl ketone, 1,1,1-trichloroethane, acetone, mercury, lead, diethylenetriamine, triorthocresyl phosphate, and bisphenol A.

II. INTRODUCTION

In October 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from the management of Dale Electronics Corporation for an industrial hygiene survey of their plant in Yankton, South Dakota.

On December 20-21, 1983, NIOSH investigators conducted an industrial hygiene survey and submitted preliminary recommendations, particularly for reducing worker exposure to toluene diisocyanate (TDI).

III. BACKGROUND

This 12 year old plant employs about 300 workers to manufacture electronic resistors.

Polyurethane Mixing

A two-part polyurethane material is used to hermetically seal electrical units. The product is mixed by one worker in small amounts (several ounces) and heated to pouring consistancy under heat lamps prior to use. TDI is released during mixing, which takes 10 to 20 minutes.

Impregnating Room

A clear polyester resin varnish is forced into transformer windings by vacuum. The parts are oven-cured. Methyl ethyl ketone (MEK) is used as a thinner and cleaner in this area. Three or four persons normally work here.

Potting Room

Two-part epoxies are used by five or six workers who dip and encapsulate toroidal inductors which are then oven-cured. The epoxy resin contains about 80% bisphenol A while the amine curing agent contains about 20% triorthocresyl phosphate and about 5% diethylenetriamine.

Continuity Testing

Breaks in urethane-coated wire are detected by a worker who monitors changes in the electrical contact of the wire as it passes through a small amount (1-2 cm^3) of mercury.

Degreasing

1,1,1-trichloroethane is used in two 30 ft^3 cold vapor degreasers by one to three employees per shift to clean oil, flux, mold release, etc., from various electrical parts.

Rollcoating

An epoxy coating that contains butyl glycidyl ether is applied by rolling the parts along an automated line. One worker per shift monitors this operation.

Spray Painting

Antenna masts and transformer cases are sprayed with a lead-based paint in a 4 ft x 4 ft spray painting booth by one employee.

Soldering

Wire leads are dipped into a solder pot containing 60/40 tin-lead alloy.

Winding

The wire-winding operators (3 or 4 per shift) use small amounts of acetone as a binder.

IV. METHODS

NIOSH investigators collected 50 air samples on December 20-21, 1983, to evaluate worker exposure to 2,4-toluene diisocyanate (TDI); mercury; lead; fluorides; methyl ethyl ketone (MEK); methyl isobutyl ketone (MIBK); 1,1,1-trichloroethane; buty cellosolve acetate; acetone; xylene; toluene; butyl glycidyl ether; diethylenetriamine (DETA); triorthocresyl phosphate; and bisphenol A.

Air samples for TDI were taken from both the workers' breathing-zones and from near the two-part polyurethane mixing process. The samples were drawn at a flow rate of 2 liters per minute through glass tubes containing two sections of glass wool coated with N-p-nitrobenzyl-N-propylamine. The samples were treated with dichloromethane and analyzed by high pressure liquid chromatography with an ultraviolet detector set at 254 mm (NIOSH Method P&CAM 326).

Charcoal tube samples were used to collect general organic vapors, such as, methyl isobutyl ketone; 1,1,1-trichloroethane; butyl cellosolve acetate; acetone; xylene; and toluene, which were associated with painting, degreasing, etc. The samples were drawn at a flow rate of 0.05 liters per minute with battery-powered sampling pumps. The samples were then desorbed with carbon disulfide and analysed by gas chromatography according to NIOSH Method 127.

The sampling and analytical methods used for these and other contaminants are summarized in Table I.

V. EVALUATION CRITERIA

A. Environmental Criteria

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

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

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

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

2,4-Toluene Diisocyanate (TDI)

TDI is a strong irritant of the eyes, respiratory tract, and skin. High exposure causes coughing, breathing difficulty, chest pain and pulmonary edema. TDI is a potent respiratory sensitizer, causing asthmatic reactions with wheezing and increased breathing resistance. Should this occur, further exposure should be avoided, since even extremely low concentrations of TDI can trigger asthma.[1]

The current U.S. Federal OSHA permissable exposure limit for TDI is 140 ug/m^3 as a "ceiling value" which shall not be exceeded any time during the work shift. The current NIOSH recommended exposure limit is 140 ug/m^3 for any 20 minute sampling period and 40 ug/m^3 for up to a 10-hour workday, 40-hour workweek. The NIOSH recommended standard applies only to TDI monomer. The possibility that polymeric diisocyanates may induce pulmonary hypersensitivity has not been adequately studied, but investigators have speculated that the inhalation of any species having multiple unreacted isocyanate groups may impair respiratory function or give rise to sensitization.[2,3] On February 2, 1983, the United Kingdom Health and Safety Commission set a "common control limit" for workplace exposure to all isocyanates. The new exposure limit is 20 ug of isocyanate group/m^3 for an 8-hour time-weighted average, and 70 ug of isocyanate group/m^3 during any 10-minute sampling period. This requires that the analytical method be capable of measuring both the monomers and prepolymers of isocyanates.

One bioassay study conducted by the National Toxicology Program (NTP) has shown a dose related statistically significant cancer excess in mice and rats.[4] The tumors developed after TDI was administered by gavage in very high doses.

The evaluation criteria and adverse health effects of the other substances investigated during this evaluation are presented in Table II.

VI. RESULTS

Worker exposure to TDI was 15 ug/m^3 while mixing "Conathane" and less than 6 ug/m^3 while mixing "Solithane" (Table III). TDI air levels near the mixing processes averaged about 70 ug/m^3. The NIOSH recommended exposure limit for TDI is 140 ug/m^3 during any 20 minute sampling period.

Exposures to organic solvent vapors were all below NIOSH recommended exposure limits (Table IV). Degreaser operators were exposed to 1,1,1-trichloroethane concentrations ranging from 4 to 31% with a mean of 12% of the exposure limit. Winding workers were exposed to acetone levels ranging from 8 to 20% of the recommended exposure limit. Impregnating room workers had combined exposures to MEK, 1,1,1-trichloroethane, acetone, and xylene. Considering the additive

toxic effects of these compounds, their combined concentrations ranged from 12 to 34% with a mean of 22% of the combined exposure limits. Potting room workers' exposure to these compounds averaged about 15%.

The roll coating worker was exposed to 1,1,1-trichloroethane concentrations ranging from 9 to 14% of the exposure limit. Up to 30 mg/m^3 of butyl glycidyl ether was detected near the roll coating process, but none was detected (<2.4 mg/m^3) in the worker's breathing zone.

The continuity testing worker was exposed to a mercury vapor level of 20 u/m^3 on December 20 and 19 ug/m^3 on December 21 (Table V). The NIOSH recommended exposure limit for mercury vapor is 50 ug/m^3.

No air exposure to lead (<20 ug/m^3) or fluorides (<55 ug/m^3) was detected during a 45 minute soldering operation (Table VI). The NIOSH recommended exposure limits for lead and fluorides are 50 ug/m^3 and 2500 ug/m^3, respectively. One spray painter was exposed to an airborne lead concentration of 5 ug/m^3.

VII. DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

No overexposure to any of the 15 substances sampled by NIOSH were found. However, the epoxy resin systems and polyurethane mixes should continue to be carefully handled due to the high toxicity of the materials involved. Due primarily to their fairly low volatility, bisphenol A and diethylenetriamine are not likely to pose any inhalation hazards among potting room workers, but both are capable of sensitizing the skin. Therefore, any skin contact with these materials should be strictly avoided by careful work practices and protective gloves in order to prevent allergic contact dermatitis.

Although worker exposure to TDI monomer during polyurethane mixing was found to be below the NIOSH recommended exposure limit, the question of whether these workers are adequately protected is still not thoroughly resolved, since their exposure to potentially hazardous TDI prepolymers has not been measured. Unfortunately, the only method currently available for sampling both the monomers and prepolymers of isocyanates [1-(2-methoxyphenyl) piperazine and toluene in a midget impinger][5] is not well suited for collecting personal breathing-zone samples in the field. The sample solution is not particularly stable after sampling. It also tends to evaporate very quickly during sampling, thus, causing possible samples losses and possibly exposing the worker to unexceptable levels of toluene.

It would be prudent to further reduce exposures to TDI in order to reduce the risk of sensitizing workers. A small laboratory - type hood with an exhaust volume of 150 cfm/sq. ft. of door area[6] would be ideal for mixing the polyurethane resins.

VIII. REFERENCES

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

2. Hardy HL, Devine JM. Use of organic isocyanates in industry - some industrial hygiene aspects. Annals of Occupational Hygiene. Vol 22, pp 421-427, 1979.

3. Weyel DA, Rodney BS. Sensory irritation, pulmonary irritation, and acute lethality of a polymeric isocyanate and sensory irritation of 2,6 - toluene diisocyanate. Toxicology and Applied Pharmacology. Vol 64, pp 423-430, 1982.

4. Dieter MP, NTP technical report on the carcinogenesis bioassay of toluene diisocyanate. NIH publication number 82-2507, National Toxicology Program. Research Triangle Park, North Carolina, August 1982.

5. Bagon DA, Warwick CJ. Evaluation of total isocyanate-in-air method using 1-(2-methoxyphenyl) piperazine and HPLC. American Industrial Hygiene Association Journal. Vol 45(1), pp 39-43, 1984.

6. American Conference of Governmental Industrial Hygienists. ACGIH industrial ventilation: a manual of recommended practice. ACGIH Committee on Industrial Ventilation: 16th ed., pp 5-23. Lansing, Michigan, 1982.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:	Steven A. Lee, M.S., C.I.H. Industrial Hygienist Industrial Hygiene Section
Field Assistance:	Virginia Behrens, M.S. Industrial Hygienist Industrial Hygiene Section
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies
Report Typed By:	Jacqueline Grass Clerk-Typist Industrial Hygiene Section

X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Dale Electronics Corporation
2. NIOSH, Region VIII
3. OSHA, Region VIII

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Ta. I

Sampling and Analytical Methods

Dale Electronics Corporation
Yankton, South Dakota
HETA 84-023

December 20-21, 1983

Contaminent	Sample Type and No. Collected	Sample Media	Flow Rate (lpm)	Analysis
2,4-TDI	2 - PBZ 2 - process area	glass wool treated with N-p-nitrobenzyl-N-propylamine	2.0	high pressure liquid chromatography NIOSH P&CAM 326
MIBK;1,1,1-trichlor.; butyl cellosolve acetate; acetone; xylene; toluene	17 - PBZ	charcoal tube	0.05	gas chromatography NIOSH P&CAM 127
MEK	6 - PBZ	ambersorb	0.05	gas chromatography NIOSH S-3
Mercury	2 - PBZ 2 - general area	3M No. 3600 diffusional monitor	passive	conductivity change on gold collector
Inorganic Lead	2 - PBZ	cellulose membrane filter	2.0	atomic absorption NIOSH S-341
Soluble Fluoride	1 - PBZ	alkali-impregnated cellulose pad	2.0	specific ion electrode NIOSH P&CAM 212
Butyl Glycidyl Ether	2 - PBZ 3 - process area	charcoal tube	0.02	gas chromatography NIOSH S-81
DETA and similar polyamines	3 - PBZ 2 - process area	silica gel	0.5	methanol desorption gas chromatography
Triorthocresyl phosphate	2 - PBZ 2 - process area	cellulose membrane filters	2.0	gas chromatography NIOSH S-209
Bisphenol A	3 - PBZ 2 - process area	glass fiber filters	2.0	high pressure liquid chromatography NIOSH P&CAM 333

Table II

Evaluation Criteria for Hazardous Substances

Dale Electronics Corporation
Yankton, South Dakota

HETA 84-023

Contaminant	OSHA Permissible Exposure Limit	ACGIH Threshold Limit Value	NIOSH Recommended Standard	Principle Health Effects
Toluene	750 mg/m^3	375 mg/m^3	375 mg/m^3	fatigue, weakness, confusion, euphoria, dizziness, headache, dilated pupils, lacrimation (watering of the eyes), nervousness, muscular fatigue, insomnia paresthesias (abnormal) sensations
Acetone	2400 mg/m^3	1780 mg/m^3	590 mg/m^3	irritation of the eyes, mucous membranes and skin; in high concentrations dizziness, excitement, drowsiness, incoordination, staggering gait.
Methyl Isobutyl Ketone	400 mg/m^3	200 mg/m^3	200 mg/m^3	dermatitis; irritation of the eyes, nose and throat; nausea; headache; in high concentrations drowsiness, weakness, dizziness, and staggering gait.
Methyl Ethyl Ketone	590 mg/m^3	590 mg/m^3	590 mg/m^3	dermatitis of exposed skin; irritation of the eyes, nose and throat at lower concentrations; headache, nausea, light headedness, vomiting, dizziness and incoordination at high concentrations.
1,1,1-Trichloroethane	1900 mg/m^3	1500 mg/m^3	1900 mg/m^3 15 min. ceiling	dermatitis; eye irritation; headache, dizziness and incoordination at higher concentrations.
Xylene	435 mg/m^3	435 mg/m^3	435 mg/m^3	dermatitis; irritation of eyes, nose, and throat; dizziness, drowsiness, excitement, nausea
TDI	140 ug/m^3, ceiling	40 ug/m^3 140 ug/m^3, 15 min. ceiling	40 ug/m^3 140 ug/m^3, 20 min ceiling	dermatitis; irritation of eyes, nose and throat; bronchitis; pulmonary edema; respiratory sensitization
Mercury	100 ug/m^3, ceiling	50 ug/m^3	50 ug/m^3	irritability, indecision, headache, fatigue, weakness, stomach ache, weight loss
Lead	50 ug/m^3	150 ug/m^3	50 ug/m^3	abdominal pain, constipation, anemia, insomnia, tremor
Diethylenetriamine	-	4 mg/m^3	-	skin and respiratory sensitization
Triorthocresyl Phosphate	0.1 mg/m^3	0.1 mg/m^3	-	peripheral neuropathy, leg cramps cholinestrase inhibition
Bisphenol A	-	-	-	skin sensitization

Table III

Personal Breathing-Zone Air Samples and Process Air Samples
for 2,4-Toluene Diisocyanate (TDI)

Dale Electronics Corporation
Yankton, South Dakota
HETA 84-023

December 20, 1983

Job	Sampling Period	TDI Concentration (ug/m^3)
Mixing "Conathane" (PBZ)	13:08 - 13:18	15
Mixing "Conathane" (Process)	13:08 - 13:18	80
Mixing "Solithane" (PBZ)	13:23 - 13:40	N.D.*
Mixing "Solithane" (Process)	13:23 - 13:40	68

*N.D. = none detected (<6 ug/m^3)

Evaluation Criteria 140

Table IV

Personal Breathing-Zone Air Samples for Organic Solvent Vapors

Dale Electronics Corporation
Yankton, South Dakota
HETA 84-023

December 20-21, 1983

Job	Sampling Period	Concentration in Milligrams Per Cubic Meter (mg/m^3)								
		MEK	MIBK	1,1,1-Tri-Chloroethane	Butyl Cellosolve Acetate	Acetone	Xylene	Toluene	Butyl Glycidyl Ether	Percent of Combined Exposure Limit
Impregnator	7:10 - 14:20	9.0	-	71	-	33	0.5	-	-	12
Impregnator	7:30 - 14:30	20	-	260	-	100	0.9	-	-	34
Cleaning/Impregnation	7:20 - 14:20	5.9	-	170	-	52	0.9	-	-	19
Scotchcasting	7:20 - 14:30	46	-	65	-	37	0.4	-	-	17
Scotchcasting	7:50 - 15:00	-	-	110	-	55	1.4	-	-	15
Mixing and Encapsulating	7:20 - 14:30	5.7	-	-	-	-	-	-	-	1
Mixing and Encapsulating	7:15 - 14:00	4.8	-	-	-	-	-	-	-	1
Epoxy Room Attendent	8:27 - 13:00	-	-	87	-	58	N.D.	-	-	15
Roll Coater	7:15 - 14:30	-	N.D.	170	N.D.	-	-	-	N.D.	9
Roll Coater	7:50 - 15:00	-	N.D.	270	N.D.	-	-	-	N.D.	14
Connector Degreaser	7:15 - 15:00	-	-	85	-	-	-	-	-	4
Connector Degreaser	7:15 - 15:00	-	-	100	-	-	-	-	-	5
Connector Degreaser	7:40 - 14:20	-	-	140	-	-	-	-	-	7
Chokes Degreaser	10:00 - 12:00	-	-	280	-	-	-	-	-	15
Chokes Degreaser	8:30 - 14:30	-	-	580	-	-	-	-	-	31
Winding	7:30 - 14:30	-	-	-	-	55	-	-	-	9
Winding	7:30 - 14:20	-	-	-	-	120	-	-	-	20
Winding	7:40 - 15:00	-	-	-	-	45	-	-	-	8
Painting	7:05 - 11:50	-	-	-	-	-	2.9	8.6	-	3
*N.D. = below limit of detection			(<0.4)		(<2.4)		(<0.4)		(<2.4)	
Evaluation Criteria		590	200	1900	-	590	435	375	270	100%

Table V

Mercury Vapor Concentrations

Dale Electronics Corporation
Yankton, South Dakota
HETA 84-023

December 20-21, 1983

Job	Sampling Period	Mercury Concentration (ug/m^3)
Continuity Testing (PBZ)	9:00 - 14:30 (12/20)	20
Continuity Testing (PBZ)	7:50 - 14:30 (12/21)	19
Operator's desk, general area	9:15 - 14:30 (12/20)	10
Operator's desk, general area	7:50 - 14:30 (12/21)	10
Evaluation Criteria		50

Table VI

Personal Breathing-Zone Air Samples for
Inorganic Lead and Soluble Fluorides

Dale Electronics Corporation
Yankton, South Dakota
HETA 84-023

December 20-21, 1983

Job	Sampling Period	Concen. in Micrograms per cubic meter (ug/m^3)	
		Lead	Fluorides
Spray Painting	7:05 - 11:50	5	-
Soldering	8:00 - 9:45	N.D.* (<10)	N.D. (<20)
Evaluation Criteria		50	2500

* N.D. = none detected

DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ROBERT A. TAFT LABORATORIES
4676 COLUMBIA PARKWAY, CINCINNATI, OHIO 45226

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE. $300

Third Class Mail

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF HHS
HHS 396