U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 79-111-701

GTE SYLVANIA PLANT
STANDISH, MAINE

June 1980

I. SUMMARY

On June 13, 1979 National Institute for Occupational Safety and Health (NIOSH) received a confidential request from employees of the GTE Sylvania Company in Standish, Maine for a health hazard evaluation. The plant manufactures small electrical components (SIC #3670). The request was prompted by findings of elevated 24-hour urinary excretion of copper in several workers. Two workers had been under medical investigation for some time for numerous unexplained symptoms. Each had operated a Sealex machine that seals electrical circuit protection devices into glass tubes. On July 31 - August 1, 1979 NIOSH conducted an evaluation of the plant concentrating on the areas around the Sealex machines.

Copper, isopropanol and organic vapors were measured in area air samples and found to be at levels well below acceptable health standards. Copper was detected in only 1 of 10 area samples. However, elevated levels of airborne lead were detected throughout the plant, 80% of which were in excess of the acceptable standard.

The employees with previously documented high copper excretion levels were interviewed and had blood and 24-hour urine samples taken for lead and copper analysis. Their symptoms were not compatible with the reported effects of lead or copper intoxication, and increased urinary copper excretion could not be confirmed using NIOSH methods. It was concluded that there was no excessive exposure to copper in the work-place and that the illnesses in these workers were not due to copper toxicity.

A follow-up study to evaluate lead exposure in workers at the plant was carried out on November 14-15. Blood samples were obtained from 88 workers for lead analysis. Levels ranged from 12 to 68 micrograms per deciliter (ug/dl). Sixteen percent exceeded 40 ug/dl. Six of 11 (55%) of Sealex machine operators had levels greater than 40 ug/dl. Thirteen area air samples, and 31 personal breathing zone samples documented airborne lead concentrations that ranged from not-detectable (ND) to 306, and ND to 113 micrograms per cubic meter (ug/M^3), respectively. Fifty-two percent (14 of 27) breathing zone samples were above the Occupational Safety and Health Administration (OSHA) lead standard of 50 ug/M^3. The highest inspired air lead levels were recorded in those working around the Sealex machines.

It was concluded that no significant exposure to copper exists at the GTE Sylvania plant in Standish, Maine. However, unacceptably high levels of airborne lead were detected and these were reflected in elevated blood lead levels in workers. Lead levels were highest among those working close to Sealex machines that heat leaded glass. Recommended measures to reduce lead exposure in employees included engineering controls, improved ventilation, substitution of the leaded glass used, and initiation of a program to monitor blood lead levels in workers.

II. INTRODUCTION

On June 13, 1979 a request for a health hazard evaluation was received from employees of the GTE Sylvania Plant, Standish, Maine, who reported elevated levels of urinary copper in workers examined by a private physician.* Each had operated a Sealex machine which seals copper thermal protection devices into glass tubes. They were concerned that their high urinary copper levels and numerous symptoms were caused by copper exposure in their workplace.

Note: This report is in two parts. The first part (Section IV) is concerned with copper exposure and toxicity. The second part (Section V) is a report of a follow-up study evaluating the lead exposure identified during the initial investigation.

III. BACKGROUND

The GTE Sylvania Plant has been operating for 12 years and maintains five production lines in one large production area (See Figure 1).

Production Lines	Years of Operation
Glass Enclosed Circuit Protectors (SB, SL, SW)	12
Automobile Flashers	8
Circuit Breakers (CB)	12
Electric Choke (EC)	1
Early Fuel Evaporatory (EFE)	1

*Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorized 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 major product is an electrical circuit protector sealed in glass. Three types are made, referred to as SB, SW and SL. They are approximately 1/4" x 1" and differ mainly in the size of the electrical components. The circuit breaker is heat-sealed in a glass tube in a "Sealex machine" so that two copper-coated, nickel-iron alloy leads protrude from one end. The integrity of the bond at the glass/copper wire interface is critical and is successfully maintained only by using potash soda lead glass tubing which has the same thermal co-efficient of expansion as the wire. The glass contains 20-30 percent lead and is used at the rate of 80,000 pounds per month.

The circuit protectors are assembled on Sealex machines in Area A (Figure 1). Glass tubing is cut, heated, and loaded on the machines, and the electrical components are sealed in place. Other product lines are assembled in Areas B and C of the production floor.

The plant operates three shifts, six days per week. There are 601 employees (503 production, 98 adiministration) of whom approximately 75% are female; 54% are employed on the first shift, during which the major products are assembled, tested, packed and shipped. Those working on the second and third shifts are primarily responsible for keeping the production lines going. The age range of employees is 18-65 and the average length of service of the current workforce is six years.

IV. EVALUATION OF COPPER TOXICITY METHODS AND RESULTS

A. Methods

An initial industrial hygiene survey of the plant and evaluation of the workers' complaints were carried out on July 31 - August 1, 1979.

1. Industrial Hygiene Methods

Initial efforts were directed towards determining if there was a significant exposure to airborne copper using area sampling techniques. Sampling equipment was positioned in 10 areas with the most potential for copper exposure, i.e., where copper coated wire reached elevated temperatures.

Other potential exposures evaluated were lead isopropanol (sprayed onto heated contacts to cool them) and organic vapors (from heated oil baths where the devices are tested).

NIOSH standard sampling and analytical methods were used to measure the airborne concentrations of the contaminants.[1-3] A sample of the glass tubing used in the thermal-protectors was pulverized, digested in acid and analyzed for lead content.[1]

2. Medical

The three requesters were interviewed and questioned about their complaints. A specimen of venous blood and a 24-hour collection of

urine was obtained from each for lead and copper analyses. Additional information was also obtained from plant management personnel, the corporate medical director, the medical consultant to the plant and the physician attending the affected workers.

B. Results

1. Industrial Hygiene Results

a. Copper and Lead

Concentrations of copper and lead measured in area samples are shown in Table 1.

Airborne copper was found in 1 of the 10 samples. This sample was obtained close to a handwelding operation in Area C (Figure 1) at a distance of 18 inches from the points of weld. The level found (26 ug/M^3) was 25% of the current OSHA copper fume standard of 100 ug/M^3. Except for the small-scale welding, copper heated in the manufacturing process does not reach the temperature necessary to generate copper fume.

The level of airborne lead found ranged from 25 to 306 ug/M^3. The highest levels were over the SB Sealex machines (in Area A). Airborne concentrations were much lower in samples taken in Areas B and C.

b. Isopropanol and Other Hydrocarbons

Airborne concentrations of isopropanol ranged from less than 1 to 11.0 ppm (Table 2). The only other organic vapor present in detectable quantities was methyl chloroform, the highest level of which was 20 ppm (Table 3). Although organic vapors were not detected in levels above current health standards, the level of solvent fumes emitting from the baths in the oil room can occasionally increase, depending on the temperature of the bath and age of the oil.

The main production area is ventilated by conditioned air via 13 units mounted on the roof. Each of these area units has individual intakes and exhausts. Although the production area is one large area, each air handling unit would tend to recirculate the air directly beneath it. Typically, 50% of the conditioned air is recirculated in the summer and as much as 90% recirculated in the winter. The recirculation of air, and the possibility of lateral spread of fumes from cross drafts, may explain the high levels of lead found in areas at a distance from the Sealex machines, i.e., in Areas B and C.

Management estimated that there were six air changes per hour based on the assumption that the air handlers moved 91,000 cubic feet per minute in the main production area of 880,000 cubic feet (40,000 square feet x 22 feet of height). If recirculaton of air was not considered in these calculations the air changes per hour could be from three in the summer to less than one in the winter.

2. Medical

The first two workers (Subjects A and B) described many symptoms that had been investigated extensively over the previous three years. Their complaints were dissimilar and were not compatible with the reported effects of acute or chronic exposure to copper. The third (Subject C), had previously suffered a back injury at work and still had back pain, but had no symptoms not referable to this inquiry.

The Corporate Medical Director, Plant Physician, and Plant Nurse reported no recent increase in unusual illness among workers and especially among Sealex machine operators. However, on occasions operators had complained of "heat, fumes, and dizziness" while working.

Results of tests of blood and urine samples obtained at the time of the interview, as well as tests performed prior to our investigation are presented in Table 4. The urine-copper excretion levels reviewed ranged from 60-168 ug/24 hour. These are higher than the accepted 15-50 ug/24-hour normal range.[8,9,10,12] The samples analyzed by a NIOSH contract lab were reported as "less than" values; therefore, the results are inconclusive. The analytical method used, direct aspiration into an atomic absorption unit, did not have the degree of sensitivity necessary to determine 24-hour copper-excretion levels down to the normal range. The testing was not repeated because there was no significant occupational exposure to copper. Serum copper levels were within the normal range in all three subjects. Blood lead levels were also well below 40 ug/dl, ranging from 12.0-17.5 ug/dl.

C. Discussion

1. Copper Toxicity

There are few reports of toxic effects following chronic exposure to copper in the workplace, and most authors agree that copper is a relatively non-toxic substance. Acute copper poisoning with gastrointestinal symptoms and multi-system involvement may occur following ingestion of copper in the salt form,[5] and symptoms similar to metal fume fever have been reported in workers inhaling copper fume and dust.[6] Contact dermatitis and eye irritation have also been reported. However, there have been no reports of symptoms associated with increased urinary excretion of copper in those exposed to the metal in the workplace.

No guidelines exist for evaluating patients with possible chronic copper intoxication. In cases where the source of the complaint is unclear the 24-hour urinary copper excretion, in conjunction with blood copper estimations, is thought to be a reliable index of copper exposure.

The 24-hour excretion of copper in the urine of normal individuals reported in eight studies in the literature (with more than 20 subjects

studied) ranges from a mean of 11 to greater than 140 micrograms ug/24-hour.[7] The mean value of the results of these studies is up to 50 ug/24-hours.

Other values given as the normal range of 24-hour copper excretion are:

Normal Range of Copper in Urine ug/24-hour	Source (Reference Number)
15-30	8
15-50	9
15-50	10
0-60	11
15-50	12

One laboratory considers 60-140 ug/liter to be a normal copper concentration in urine.[13] However, they do not specify whether this applies to a random specimen or a 24-hour collection.

The OSHA health standards for exposure to copper dust and mist state that levels of less than 1000 ug/M^3 are not normally harmful. Copper fume (much smaller particle size) is permissible in concentrations up to 100 ug/M^3.[14] There is no recommended NIOSH standard for copper exposure.

2. Isopropanol

Ispropanol is a colorless liquid used by the pharmaceutical industry in numerous preparations such as skin lotions, cosmetics, mouth washes, and disinfectants. It is widely used as a rubbing alcohol. The vapors are mildly irritating to the upper respiratory system, and are potentially narcotic in high concentrations. The current OSHA standard and NIOSH recommendation is 400 parts per million (ppm).

3. Methyl Chloroform

Methyl chloroform as a liquid or vapor may be irritating to the eyes and repeated skin contact may produce dry, scaly, and fissured dermatitis due to its defatting properties. Dizziness, incoordination, drowsiness, increased reaction time, unconsciousness and death can result from overexposure depending on the inhaled concentration. The current OSHA standard and NIOSH recommendation is 350 ppm.

D. Conclusions

The 24-hour urinary-copper excretion levels measured previously in three workers were elevated. The reason for this remains unexplained, however, it does not appear to be the result of occupational exposure to copper at their workplace. Furthermore, based on review of available literature, it is unlikely that the elevated urine copper levels are the cause of their medical problems.

From these findings it was concluded that there was no significant airborne exposure to copper in the workplace and that the symptoms of affected workers were not compatible with the known features of copper toxicity.

A report containing the results of the Initial Survey, Interim Report #1, was forwarded in October 1979. It was recommended that the feasibility of a substitute for the leaded-glass be evaluated. Furthermore, because unacceptably high levels of airborne lead were measured in the initial survey, a second study of the plant to evaluate lead exposure was carried out on November 14-15, 1979.

V. STUDY OF LEAD EXPOSURE, NOVEMBER 14-15, 1979

A. Methods

The results of the initial survey were used to determine a sampling strategy for the follow-up study. Personal breathing zone air sampling and blood lead levels were used to evaluate the exposures of employees to airborne lead.

A comprehensive list of the workforce was not available at the time of the survey. Therefore, a list of workers on the first shift of the day of the survey was compiled by the supervisors of each section. Two hundred and fourteen workers were enumerated and 88 volunteers were interviewed and had blood taken as follows:

Work Area	# Enumerated	# Seen	%	Male	Female
Area A	74	29	(39)	5	24
Area B	77	33	(43)	2	31
Area C	63	26	(41)	3	23
	214	88	(41)	10	78

B. Results

The mean concentration of lead in breathing zone samples taken from workers in Areas A, B, and C are shown in Figure 2 and tabulated in Table 5. Individual exposures ranged from "not detectable" (less than 5 ug/M^3) to 113 ug/M^3. The highest levels were obtained from those employees who either operate or maintain the SB Sealex machines in Area A; the nine Sealex employees were exposed to levels above 50 ug/M^3 (ranged from 78-113 ug/M^3). The workers in Areas B and C had lower mean concentrations of inspired lead, but the difference was not statistically significant.

Elevated airborne lead concentrations were found only in the main production area. Areas serviced by other air handling units such as the cafeteria and offices were not contaminated with significant amounts of airborne lead.

The distribution of blood lead levels in the employees by job category, is presented in Figure 3. The highest levels were found among those workers in Area A, close to the hot glass and Sealex machines (mean level 37.6 ug/dl, SD = 13.4, See Table 6). Those working further away in Areas B and C tended to have lower levels (means 25.7 ug/dl, SD = 5.5, and 26.8 ug/dl, SD = 6.9, respectively). The highest lead levels were found in four Sealex mechanics (mean 53 ug/dl) and 11 Sealex operators (mean 45 ug/dl). Automount operators working in Area A (but not with hot glass) had a lower mean level of 31 ug/dl. Three workers from the die room (which is next to the Sealex area, but enclosed) had much lower levels (mean 20 ug/dl.).

Other groups working in the plant had mean blood lead levels that were progressively lower with distance of work from the Sealex machines. All but two of the 59 workers tested from Areas B and C had lead levels that are considered to be within acceptable limits, i.e., less than 40 ug/dl (mean 26 ug/dl, SD = 3.47).

C. Discussion

Lead Toxicity

Inhalation of lead dust and fumes is the major route of lead exposure in industry. A secondary source of exposure may be from lead dust contamination on food, cigarettes, or other objects. Once absorbed lead is excreted from the body very slowly. The absorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood forming organs (bone marrow). These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, kidney damage, mental deficiency, or slowed reaction times. Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.

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

The applicable OSHA standard for exposure to airborne inorganic lead is 50 ug/M^3[14]. An action level of 30 ug/M^3 has been set as the concentration at which an environmental monitoring and medical surveillance program must be instituted (See Recommendations, Page 9). The proposed OSHA regulation on lead absorption will eventually require blood lead levels to average less than 50 ug/dl[14].

Elevated levels of airborne lead and blood lead levels in workers indicated that a health hazard existed in the plant from exposure to lead fume. On January 27, 1980 the company was informed of this and engineering controls were recommended.

Note: The blood-lead levels of the three workers with elevated urine copper ranged from 12.0-17.5 ug/dl. All three had been away from the work environment for many months - ample time for the blood leads to have returned to normal. It is reasonable to assume that their blood levels would have been similar to those found in the other Sealex operators tested (40-60 ug/dl) at the time they left work. Although these levels indicate increased lead absorption, they have not been associated with the medical problems experienced by the three affected workers.

VI. RECOMMENDATIONS

1. A substitute for the leaded-glass should be identified as soon as possible.

2. Engineering controls should be implemented to remove the lead fume at the points of generation. The exhaust outlet(s) that will expell the contaminant to the outside should be positioned to prevent re-entry via the intakes of the existing systems.

3. Until the exhaust systems are installed, exposures can be controlled by using respirators and/or personnel management techniques. While respirators are the least satisfactory means of controlling exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned and maintained. Since most of the Sealex operators are women and it may be difficult to get a good fit with a respirator, administrative controls can be used as an alternative. This involves rotating workers to another job away from the lead fumes for part of the work day. The aim of such programs is to reduce the average exposure to less than 50 ug/M^3.

4. It is also recommended that a blood lead monitoring program and medical surveillance be made available to all the employees in the main production area. These programs as well as personnel monitoring and exposure control techniques are fully explained in Reference 14. (A copy of this reference was forwarded to management and others involved in the submission of the request for this evaluation on January 17, 1980.)

5. The hood system servicing the oil baths should be evaluated to insure that it is balanced and otherwise operating as designed. The oil should be changed as soon as necessary. If the higher temperatures cause release of irritable concentrations of solvent perhaps a number of baths on the end of each line could be reserved for high temperature testing and the exhaust system increased over these baths either by a supple- mental exhaust or more complete enclosures.

6. Once exhaust units over the hot-glass processes are installed, the improved system should be evaluated using personal breathing zone techniques. NIOSH is available and could support such a follow-up effort upon request.

VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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VIII. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available, upon request, from NIOSH, Division of Technical Services, Publications Dissemination, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

1. Requesters
2. GTE Sylvania Plant, Standish, Maine
3. Employee Representative
4. U.S. Department of Labor, Region I
5. NIOSH, Region I

For the purpose of informing the 500 affected employees, the employer shall promptly "post" for a period of 30 calender days the Determination Report in a prominent place(s) near where the affected employees work.

IX. REFERENCES

1. NIOSH Manual of Analytical Methods, Second Edition, Volume 1, P & CAM #173, General Procedure for Metals, pg 173-1, April 1977.

2. NIOSH Manual of Analytical Methods, Second Edition, Volume 2, Method No. S65, Isopropyl Alcohol, pg 56 F1, April 1977.

3. NIOSH Manual of Analytical Methods, Second Edition, Volume 1, P & CAM 127, Organic Solvents in air, pg 127-1, April 1977.

4. Cohen, S.A., "A Review of Health Hazards of Copper Exposure", Journal of Occupational Medicine 9.621.1974.

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14. 29 CFR Part 1910. Occupational Safety and Health standard; Occupational Exposure to Lead; Appendices to Standard, Vol. 44, No. 206, October 23, 1979.

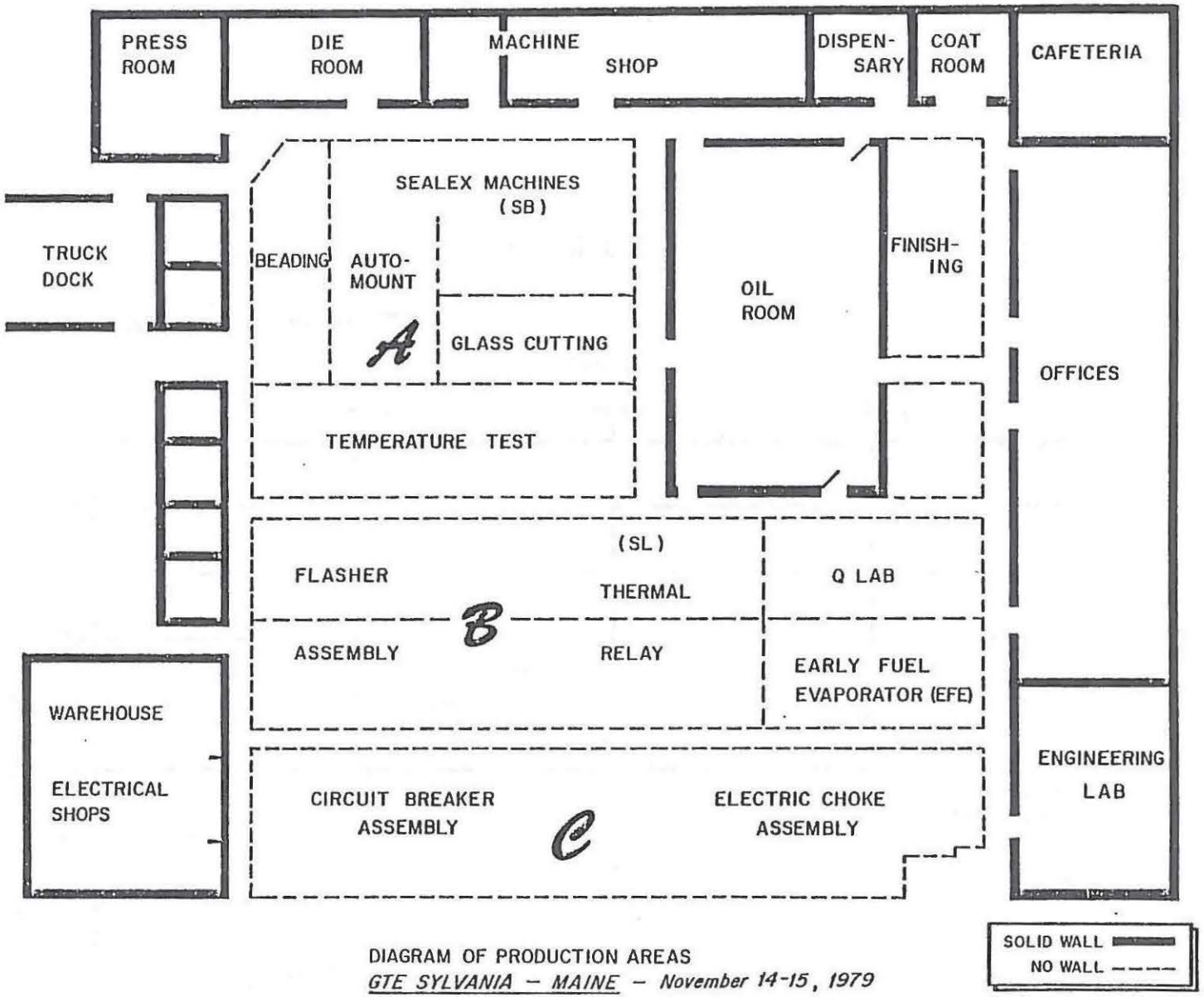

DIAGRAM OF PRODUCTION AREAS
GTE SYLVANIA – MAINE – November 14-15, 1979

FIGURE 1

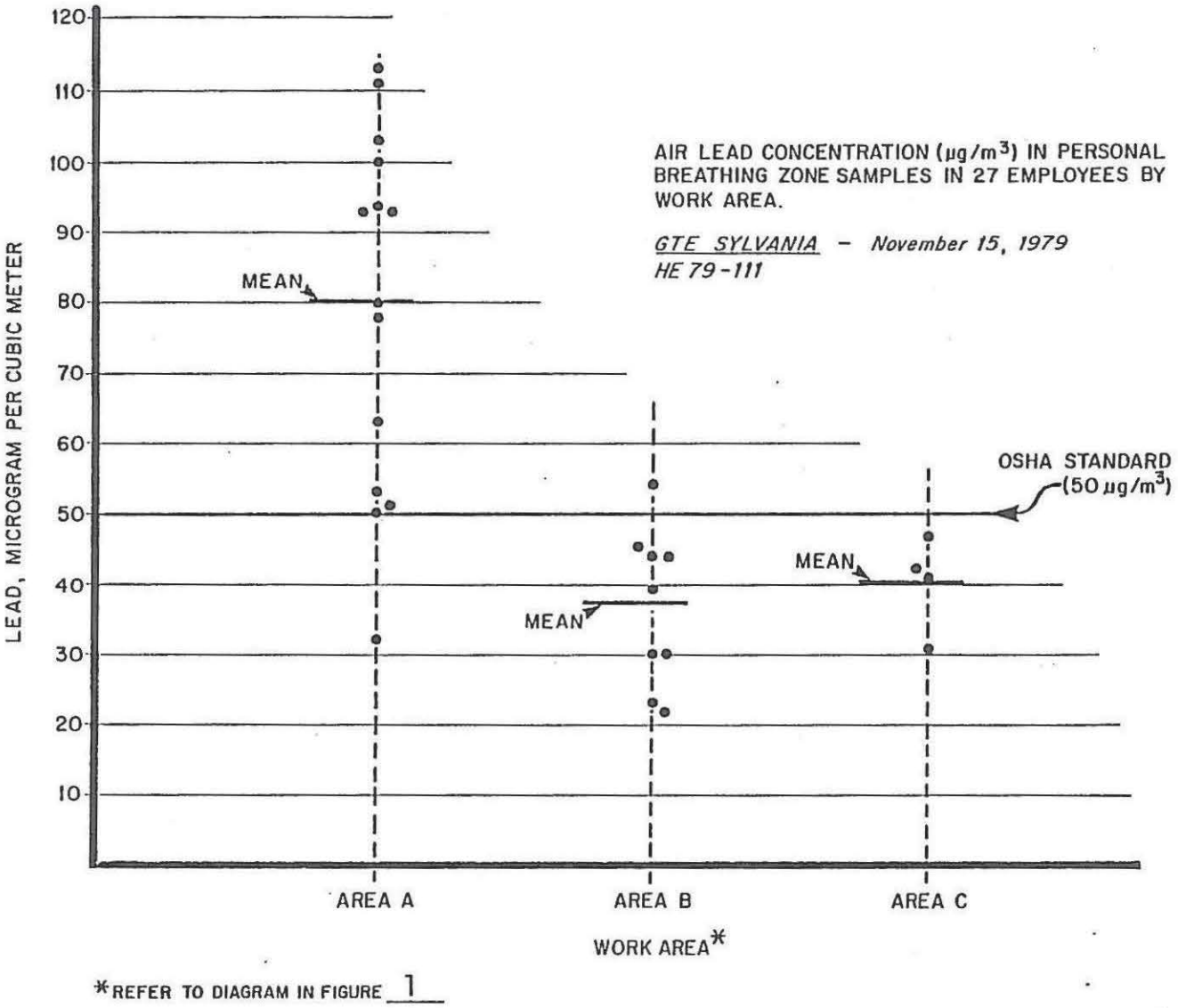
AIR LEAD CONCENTRATION (µg/m³) IN PERSONAL BREATHING ZONE SAMPLES IN 27 EMPLOYEES BY WORK AREA.
GTE SYLVANIA - November 15, 1979
HE 79-111
LEAD, MICROGRAM PER CUBIC METER
120
110
100
90
80
70
60
50
40
30
20
10
MEAN
MEAN
MEAN
OSHA STANDARD (50 µg/m³)
AREA A
AREA B
AREA C
WORK AREA*
*REFER TO DIAGRAM IN FIGURE 1

FIGURE 2

DISTRIBUTION OF BLOOD LEAD LEVELS IN WORKERS
BY JOB CATEGORY AND WORK AREA.

GTE SYLVANIA - MAINE - November 14 - 15, 1979

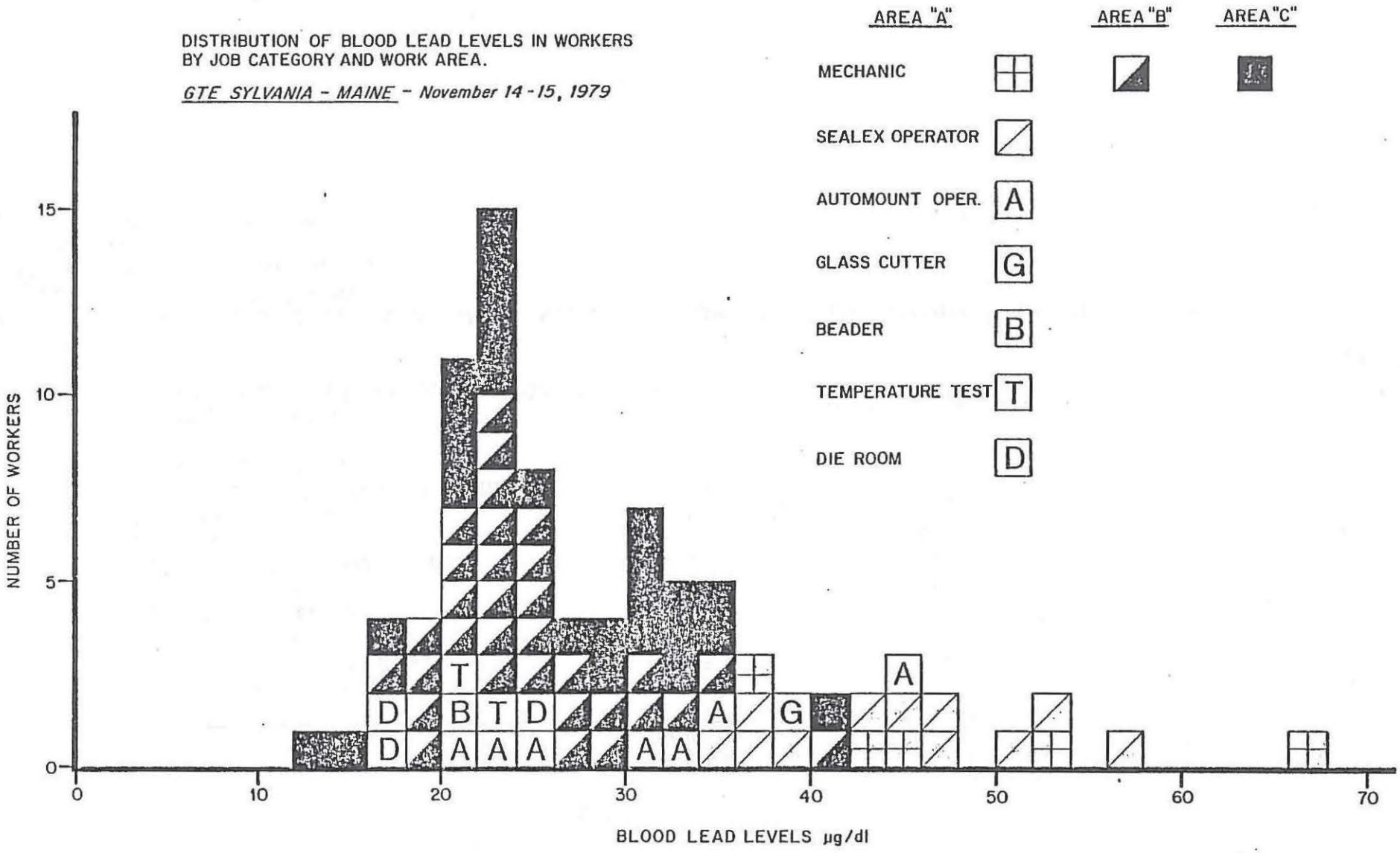

FIGURE 3

TABLE 1

INITIAL VISIT
AIRBORNE LEAD AND COPPER
(AREA SAMPLES)(1)
HE 79-111

GTE SYLVANIA

FIELD NO.	LOCATION	SAMPLING Time(min)	SAMPLE VOLUME (liters)	Pb ug/M3(2)	Cu ug/M3
AA-1	Sealex 3/4 (2 feet above)	325	488	306	ND(3)
AA-2	Sealex 1/2 (2 feet above)	325	488	245	ND
AA-3	Shelves by #8 (seal-up)	313	470	53	ND
AA-4	Sealex 9 (2 feet above)	317	475	105	ND
AA-5	Oil Room (line D, #2)	314	471	47	ND
AA-6	Oil Room (SL Box oven top)	311	466	54	ND
AA-7	EFE (PTC-Fillcan)	308	462	78	ND
AA-8	SL Hand weld 3/4	290	435	62	26
AA-9	CB Dyeline - PMB Bimetal Machine	295	442	25	ND
AA-10	Automount #1 (above)	300	450	100	ND
	Limit of Detection		3 micrograms per sample		
	OSHA Standard (8-Hour Time-Weighted Average)			50	1000(4) 100(5)

(1) These results are area samples and do not necessarily represent personal exposures. Results are time-weighted averages for the period of sampling.
(2) ug/M3 - micrograms of contaminant per cubic meter of air.
(3) ND - not detectable.
(4) Copper in dust and mist form.
(5) Copper fume.

TABLE 2

INITIAL VISIT
ISOPROPANOL
HE 79-111

GTE SYLVANIA

FIELD NO.	LOCATION	SAMPLING Time(min)	SAMPLE VOLUME (liters)	ISOPROPANOL conc. (ppm)(1)
CTA-1	Sealex 3/4 (above)	325	12.9	2.2
CTA-2	Sealex 1/2 (above)	325	0.4	< 1.0
CTA-3	Shelves by #8 (sealex)	313	12.1	3.7
CTA-4	Sealex 9 (2 feet above operator)	317	13.8	2.4
CTA-5	Oil Room, Line D #2	314	12.6	4.2
CTA-6	Automount 1 (above)	295	10.4	2.4
CTA-7	EFE (Pill to can)	308	10.6	11.4
CTA-8	Automount 10 (above)	305	11.4	1.8
CTA-9	Oil Room (SL Box oven)(top)	311	12.3	7.3
	Limit of Detection			< 1.0
	NIOSH Recommendation (8-Hour Time-Weighted Average)			400
	OSHA Standard (8-Hour Time-Weighted Average)			400

(1) Results are Time-Weighted Averages (TWA) for the period of sampling.

TABLE 3

INITIAL VISIT
HYDROCARBON ANALYSES
HE 79-111

GTE SYLVANIA

The only component present in quantities high enough to be detected was methyl chloroform

FIELD NO.	LOCATION	SAMPLE VOLUME (liters)	METHYL CHLOROFORM conc. (ppm)(1)
CT-1	Sealex 3/4 (above)	12.9	2
CT-2	Sealex 1/2 (above)	0.4	5
CT-3	Shelves by 8 (sealex)	12.1	3
CT-4	Sealex 9 (2 ft above operator)	13.8	2
CT-5	Oil Room, Line D, #2	12.6	4
CT-6	Automount 1 (above)	10.4	2
CT-7	EFE, (Pill to can)	10.6	20
CT-8	Automount 10 (above)	11.4	2
CT-9	Oil Room, (SL Box oven)(top)	12.3	7
	Limit of Detection	.01 mg/sample	
	NIOSH Recommendation (8-Hour Time-Weighted Average)		350
	OSHA Standard (8-Hour Time-Weighted Average)		

(1) ppm - parts of contaminant per one million parts of air.
Results are time-weighted averages for the total period of sampling.

TABLE 4

URINARY COPPER (PER 24-HOURS), SERUM COPPER, AND BLOOD LEAD LEVELS MEASURED IN THREE WORKERS
GTE SYLVANIA, STANDISH, MAINE

A. Boston Medical Lab Data (Prior to NIOSH Investigation)

	24-Hour Urinary Copper (ug)	Serum Copper (ug)	Blood Lead (ug/dl)
Normal Range	15-50 ug	87-153	< 40
Subject A			
7-16-76	168	110	--
9-1-76	66	---	--
5-3-79	60	---	--
Subject B			
4-17-79	104	---	--
5-15-79	127	---	--
6-1-79	---	176	--
Subject C			
4-19-79	165	---	--
6-7-79	103	---	--

B. Utah Biomedical Test Lab (Specimens taken 1 August 1979)

Subject A	< 85*	90	13.5
Subject B	< 100	130	12.0
Subject C	< 85	140	17.5

*Limit of detection 50 ug/l. On a 2 liter 24-hour urine sample the lower limit would be 100 ug/24-hour.

TABLE 5

FOLLOW-UP SURVEY
AIRBORNE LEAD RESULTS
GTE SYLVANIA
HE 79-111

November 14-15, 1979

Plant Area[1]	Job/Position	Type[2] Sample	Sampling[3] Time Minutes	Sampling Volume Cubic Meter	Airborne Lead Concentration Micrograms per Cubic Meter
SB	Sealex, Mech.	P	429	0.64	78
SB	Sealex Opr. #6	P	442	0.63	103
SB	Sealex Opr. #10	P	433	0.65	94
SB	Sealex Opr. #8	P	424	0.64	111
SB	Sealex Opr. #7	P	422	0.63	113
SB	Sealex Opr. #4	P	444	0.67	93
SB	Sealex Opr. #9	P	381	0.57	93
SB	Sealex Opr. #3	P	418	0.63	100
SB	Sealex, Mech.	P	403	0.60	80
SB	Horiz. Glass Opr.	P	402	0.60	50
SB	Beader, Mech.	P	373	0.57	63
SB	Beader, Opr.	P	355	0.53	53
SL	Wafer, Opr.	P	398	0.60	32
SL	Wafer, Opr.	P	378	0.57	51
SB	Sealex Mach. 3/4	A[4]	387	0.58	224
Flasher	Base Mech Opr.	P	332	0.50	54
EFE	Testing	P	326	0.49	39
Q Lab	Q.C. Opr.	P	297	0.45	44
SL	Calibrator	P	310	0.47	30
Flasher	Coil Opr.	P	307	0.46	30
Oil Rm	Line C1 Opr.	P	307	0.46	44
Oil Rm	Line D2 Opr.	P	295	0.44	46
SB	Temp. Test Opr.	P	285	0.43	(See Note
SB	Temp. Test Opr.	P	290	0.44	23
--	NIOSH Team Member	P	270	0.41	22
EC	Assemble/Rivet Opr.	P	343	0.51	41
CB	Rotary 102 Opr.	P	356	0.53	47
CB	Base Mach #3 Opr.	P	354	0.53	42
Finishing	Packer	P	327	0.49	31
Elect. Shop	Technician	P	240	0.36	N.D.[6]
Die Room	Blade Tester	P	295	0.44	11
Eng. Lab	Application Eng.	P	268	0.40	N.D.
Mach. Shop	Machinist	P	259	0.39	44
Cafeteria	--	A	385	0.58	5
Office Area	--	A	383	0.57	N.D.

1. Refer to sketch (Figure 1) for inplant locations.
2. P - Personal Breathing Zone Samples; A - Area Samples.
3. Pumps were run to a time indicated at a flow rate of 1.5 liters per minute.
4. Hung on pipes about 2 feet above and in center of Sealex 3/4 unit.
5. Filter paper missing in sampling unit, no analysis possible.
6. N.D. - Not Detectable. Limit of detection is 3 micrograms per sample, therefore N.D. results esentially mean less than 5 micrograms per cubic meter.

TABLE 6

FOLLOW-UP SURVEY
BLOOD LEAD AND INSPIRED AIR LEAD LEVELS IN WORKERS
GTE SYLVANIA, MAINE
NOVEMBER 14-15, 1980

	Blood Lead ug/dl			Inspired Air Lead ug/M^3		# Workers
	n	Mean	SD	Mean	SD	Samples
Area A	(29)	37.6	13.4	80.2	29.1	13
(Mechanics 52.8)						
(Sealex Operators 45.1)						
(Automount 31.0)						
(Die Room 20.0)						
Area B	(33)	25.7	5.5	46.5	12.0	12
Area C	(26)	26.8	6.9			