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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. 75-197-289

THE FOXBORO COMPANY
FOXBORO, MASSACHUSETTS

MAY 1976

I. TOXICITY DETERMINATION

The following determinations have been made based upon environmental air samples collected on February 4-5, February 25-26, and March 11, 1976, confidential employee interviews, evaluation of ventilation systems, evaluation of work procedures and available toxicity information:

1. The printing operation using lead in the Print Shop does not constitute a health hazard.

2. Employees exposures to nuisance dust in the Polish and Snag Department did not pose a health hazard at the concentrations measured during this evaluation.

3. Exposures to oil mist in the milling operations do not constitute a health hazard.

4. Welders were not exposed to toxic concentrations of welding fumes. Brazers exposures to fluorides and solderers exposures to lead and zinc chloride did not pose a health hazard.

5. Exposures to MEK and epoxy resin in the Epoxy Room did not constitute a health hazard.

6. The spray painting operations as conducted in the spray paint booth did not constitute a health hazard.

7. The operator of the degreaser located adjacent to the plating room may be exposed to toxic concentrations of perchloroethylene. The remaining degreasers do not pose a health hazard.

8. Workers in the plating room may be exposed to potentially toxic levels of sodium hydroxide. The diversey chromating process and the Summa process do not constitute a health hazard.

9. The instrument calibrator was not exposed to toxic levels of mercury.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

a) The Foxboro Company, Foxboro, Massachusetts
b) U. S. Department of Labor - Region I
c) NIOSH - Region I

For the purpose of informing the approximately 50 "affected employees", the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

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 an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from the employer regarding employees exposure to dust, welding fumes, chlorinated hydrocarbons, paint solvents, lead, oil mist, mercury, and plating solutions.

IV. HEALTH HAZARD EVALUATION

A. Plant Process - Conditions of Use

The Neponset Plant of The Foxboro Company in Foxboro, Massachusetts is engaged in the fabrication of process control instrumentation. The facilities which house the plant consist of several multistory, connected buildings. Each building contains several departments, each responsible for conducting a particular phase of the process. As part of the overall production process the following operations are conducted in respectively designated areas: printing, polishing and sanding, milling, welding, brazing and soldering, resin coating and joining, spray painting, cleaning, plating and instrument calibration.

1. Printing

The Print Shop is located in a separate building from the main plant. Among the printing machines are two linotype typesetting machines. These typesetters make use of a lead ingot which is continuously being heated to produce molten lead which is used to make the line of type in the form of a solid metal slug. Only one of the typesetters is typically in use, with one operator in the area. The typesetter has local ventilation at the lead pot. Ventilation measurements showed that the velocity at the duct was 800 fpm and approximately 150-175 fpm directly over the lead pot.

2. Polishing and Sanding

Department 550 is known as the Snag and Polish Department. Most of the work in the area deals with the polishing and burring of stainless steel or aluminum control cases. The department contains six polishing jacks or belt sanders, a double roll shoe machine and a movable stroke sander. Ventilation is provided (AAP Roto-Clone System) at each work station (150 fpm) including a gravity fall system.

3. Milling

The machine shop consists of several departments which are involved in milling operations. Two vertical milling machines (Bullards) are located in Department 573. Another smaller milling machine which performs finishing work is also in this area. Five additional vertical milling machines are in Department 504. Also located in Department 504 are five A Spindle chuckers. A variety of soluble oils are used in these machines. The type of oil used is dependent on the material being milled and the speed at which the machine is operating.

4. Welding, Soldering and Brazing

Department 641 contains three welding booths, two of which are used daily. One booth is equipped for Heliarc welding and the other for MIG welding. Approximately ninety-five percent of the welding is done using stainless steel welding wire. Each individual booth has local ventilation. The Heliarc welding booth has a face velocity at the duct greater than 800 fpm. Ventilation measurements revealed 50 fpm air movement at the work bench and from 50-150 fpm on the welding pedestal. The MIG welding booth had a similar ventilation system but due to the placement of the duct essentially no air movement occurs at the actual worksite.

Five welding booths also are located in Department 607. The majority of the welding is performed on stainless steel parts. Each booth is equipped with a flexible duct for local ventilation purposes. The ventilation system is always "on" but the ducts are only placed over the work area for heavier welding. The ducts have a face velocity of approximately 400 fpm but only negligible air movement is measured at the work area when the ducts are in position for use.

Two people in Department 607 are involved in the brazing of small parts. Most of the parts are stainless steel with approximately 10% of the work involving the brazing of beryllium. When brazing is performed, a flux is generally used. One flux called Aircosil, is a paste flux containing fluorides. The other flux which is commonly used contains zinc chloride.

There are four designated soldering stations and four induction heating brazing units located in Department 611. Three induction heating units are in operation. The paste flux, Aircosil, which contains fluorides is used during the brazing. Each unit has a flexible duct for local ventilation located approximately four inches above the heating unit.

Measurements showed the air movement to be from 50 to 150 fpm at the heating level. Four employees in this department also are involved with soldering on a daily basis. The materials used consist of a filler of 50% lead and 50% tin and a paste flux containing zinc chloride. No local ventilation is provided.

5. Resin Coating and Joining

Department 611 also contains the epoxy room. In the epoxy room, epoxy resins are used to cement pieces together or for coating small parts. Each employee mixes the substances as they are needed and applies the resin by use of syringes or brushes. Cleaners include methyl ethyl ketone, acetone and alcohols.

Plastic parts also are joined together by the use of MEK. An ink pad is saturated with MEK on which plastic parts are placed before being joined. The ink pad is placed beside a flexible duct for ventilation purposes. There are five workers employed in the epoxy room.

6. Spray Painting

Departments 551, 552 and 553 contain the spray painting operations. As the parts enter the area, they first pass through a bonderizer. The bonderizer is a metal treating operation which cleans and etches the parts before they are painted by use of a phosphate-chromate system. After leaving the bonderizer, the parts are sprayed with a zinc chromate primer and then an organic based paint. The zinc chromate primer has a n-butyl alcohol, xylene, MEK and cellosolve acetate base. The paint base may contain toluene, isopropanol, n-butyl acetate, iso-butyl acetate, ethyl acetate, xylene, n-butyl alcohol and sec-butyl alcohol depending on the particular paint being used. All spray painting is performed in booths which have 500 gallon water curtains and measured face velocities of 150-175 fpm. There are eight paint booths with 11 painters, two of which apply the primer. The painters are supplied with Flexa-Prine Paint Masks which have a washable foam filter. However, no respirators are provided which are effective for organic vapors.

A small paint mixing room is located adjacent to the spray area. One worker is responsible for mixing the paints and spends approximately one half hour out of every hour in the mixing room. A similar paint mixing room is located on the lower level of the building and it also has one mixer operator.

7. Cleaning

Located in the machine shop are three Blakeslee methylene chloride degreasers. The degreasers are enclosed and load and unload from a central location, with the parts being taken through the degreaser on a chain conveyor. The degreasers are equipped with cooling coils and have local ventilation at the loading and unloading point. Another degreaser is located in a different section of the machine shop. This degreaser contains perchloroethylene and is used by several workers during the shift for short periods of time.

A small trichloroethylene degreaser is located in Department 611. It is used periodically by various people for cleaning small parts. Two degreasers are located in the plating room. A small methylene chloride degreaser is located adjacent to the plating lines and used as necessary for cleaning small parts. A larger perchloroethylene degreaser is located beside the plating area. The majority of the parts cleaned in this area are cleaned at this degreaser with one worker being responsible for its operation.

Another trichloroethylene degreaser is in use outside the clean room. The degreaser is used by several employees as needed for cleaning parts.

8. Plating

The plating room is located in Department 554. The plating room contains two fully automatic cadmium and chromate plating machines as well as several hand plating operations. The plating department, therefore, contains tanks of sodium hydroxide, sodium cyanide, nickel, sulfuric acid, nitric acid, hydrochloric acid and chromic acid. Ventilation is provided at most of the tanks which contain caustic materials. The slot velocities range from 400-500 fpm with air movement from 50-75 fpm at the tank edges. Also considered as part of the plating room is the Koline Process which involves the use of molten potassium and sodium hydroxide nitrates. Also contained in the area is a phenol tank and an Oakite pickle containing acids. These tanks were not in use at the time of this survey.

A special Diversey chromating process is located in Department 620. The process consists of a sodium hydroxide tank, a deoxidizer tank containing nitric acid, sulfuric acid, phosphoric acid, and fluorides and a chromate conversion coating tank which consists of fluorides and chromic acids. One worker is involved in this operation.

An operation known as the Summa process is located in Department 607. This process uses acids for cleaning and coating parts. One employee works on the process approximately four hours per day.

9. Instrument Calibration

Department 601 contains the flow assembly. Two to ten instruments pass through this department per day depending on the type of instrument. One to two employees are involved with adding measured quantities of mercury (6.5 to 12 lbs) to the instruments as a measuring media and then calibrating the instrument. A similar mercury filling procedure is performed in Department 660. This procedure, however, is a completely closed system under vacuum. Exposure is limited to filling the supply reservoir with mercury.

B. Evaluation Design

An initial survey was conducted on February 4-5, 1976. This survey included obtaining background information, conducting a walk-through survey in those areas where the alleged hazards were present, conducting confidential employee medical interviews, and collecting breathing zone samples in three of the nine areas of the evaluation.

A follow-up survey was conducted on February 25-26, 1976. This survey included collecting breathing zone and area samples in locations which had not previously been sampled and conducting confidential medical interviews.

Samples for oil mist were taken in the machine shop on March 11, 1976.

C. Environmental Evaluation Methods

During the initial survey the printing operation was evaluated by collecting a breathing zone and an area sample on AA filters at 1.5 liters per minute with an MSA pump. The samples were analyzed for lead by atomic absorption.

The polishers' and grinders' exposure to nuisance dust was determined by collecting breathing zone samples on pre-weighed VM-1 filters at 1 liter per minute.

Exposure to oil mist was measured by collecting samples on VM-1 filters at 1.5 liters per minute with an MSA pump. Samples were analyzed by weight and fluorescence.

Welders' exposure to welding fumes was determined by collecting breathing zone samples on VM-1 filters at 1.5 liters per minute. Filters were tared to determine total welding fumes. Two of the welders' exposures were monitored by collecting samples inside the welding helmets. This was accomplished during the follow-up survey by utilizing modified welding helmets.

The solderers' exposure to lead and zinc chloride was determined by utilizing AA filters which were analyzed for the specific metals by atomic absorption.

The brazers' exposure to fluorides (from a fluoride containing flux) was determined by collecting samples in an impinger containing sodium acetate. These samples were then analyzed by a specific ion electrode.

The spray painting operation was evaluated by collecting samples in the painters' breathing zone. The samples were collected on charcoal tubes and analyzed by gas chromatography for those substances listed in Tables 6 and 7. Each sample was collected for a four hour period: two samples for each painter.

The parts cleaning operations were evaluated by collecting area samples adjacent to the degreasers. Where one operator was responsible for the operation of the degreaser, breathing zone samples were taken. The samples were collected on charcoal tubes and analyzed by gas chromatography.

All samples collected in the plating room were area samples. Filter samples (nickel, chromic acid, sodium hydroxide, sulfuric acid and cadmium samples) were collected at 1.5 liters per minute. Impinger samples (cyanide, nitric acid and hydrochloric acid samples) were collected at a flow rate of 1 liter per minute.

Analyses of these samples were by the following methods: nickel and sodium by atomic absorption, sulfuric acid by emission spectroscopy, cadmium by atomic absorption, cyanide by specific ion electrode, nitric acid by a colorimetric technique and hydrochloric acid by a turbidimetric method.

One area and one personal sample for mercury was collected using iodine impregnated charcoal tubes for mercury vapor. Analysis for mercury was performed using a tantalum boat technique.

D. Evaluation Criteria

1. Physiological Effects

The following is a brief summary of the adverse effects resulting from excessive exposure to each of the substances of concern:

Lead - Inhalation of lead fumes may result in lead poisoning. Signs and symptoms may include abdominal pain with tenderness, constipation, headache, weakness, muscular aches and cramps, loss of appetite, nausea, vomiting, weight loss, anemia with pallor and lead lines.

Nuisance Dust - Nuisance dusts have little adverse effects on the lungs and do not produce significant disease or toxicity when exposures are kept under reasonable control. These dusts are biologically inert in that when inhaled the architecture of the alveoli remains intact: little or no scar tissue is formed: and any reaction provoked is potentially reversible. Excessive concentration in workroom air may reduce visibility, cause unpleasant accumulations in the eyes, ears, nose, and secondarily cause injury to the skin due to vigorous cleansing procedures necessary for their removal.

Oil Mist - Exposure to oil mists will cause mucous membrane irritation and a chemical pneumonitis from direct contact of the liquid or aerosol with pulmonary tissue. Frequent and prolonged contact with the skin will lead to skin irritation and dermatitis. Due to the low order of toxicity, the Threshold Limit Value (TLV) is recommended as an index of good industrial practice as well as to prevent the relatively minor changes in the lungs that may occur from exposure.

Welding Fumes - Inhalation of excessive amounts of welding fumes may result in metal fume fever. Some of the symptoms of metal fume fever include chills and fever, which rarely exceeds 102° F, upset stomach and vomiting, dryness of the throat, cough, weakness and aching of the head and body. Such symptoms often occur some hours later and usually last only one day.

Fluorides - The inhalation of fluoride fumes and gases may produce respiratory and eye irritation. Nose bleeds also may occur at higher concentrations. If fluoride intake exceeds fluoride excretion rate for a sufficiently long period of time, chronic bone damage may occur.

Zinc Chloride Fume - Exposure to zinc chloride fume can cause damage to the mucous membranes of the nasopharynx and respiratory tract. Exposed persons have experienced a pale gray cyanosis. Inhalation may produce a severe pneumonitis resulting from irritation of the respiratory tract. Zinc chloride is caustic and can cause ulceration of exposed surfaces of the skin.

Epoxy Resins - Epoxy resins are practically nontoxic perorally, and no physiological systemic effects result from inhalation of their vapors or absorption through the skin. The solid resins are relatively harmless. Some of the resins may be mildly irritating on repeated contact. The resins do present a major dermatitis problem and some cause sensitization.

Methyl Ethyl Ketone (MEK) - Industrial exposures to MEK are mainly those of inhalation and skin and eye contact. Skin absorption, while it may occur, is not considered to present a problem. Exposure to vapors of this agent may produce mucous membrane irritation, skin irritation, and dermatitis. More prolonged exposure may result in nausea, vomiting, headache, paresthesia and narcosis.

Toluene - Prolonged excessive exposure to this agent may acutely cause headache, weakness, fatigue, unconsciousness, loss of coordination, nausea, vomiting, anorexia, acute dermatitis and irritation of skin and mucous membranes.

Xylene - Excessive exposure to xylene may cause dermatitis, irritation of mucous membranes, nausea, vomiting, anorexia and heart burn. Dizziness, incoordination and a staggering gait may also occur.

Ethyl Acetate - Prolonged and excessive exposure to this agent may result in dermatitis, mucous membrane irritation and respiratory tract irritation and narcosis.

Sec-Butyl Acetate - Sec-butyl acetate is primarily an irritant but also possess narcotic effects. Symptoms of intoxication include irritation of eyes and mucous membranes followed by incoordination, fatigue, weight loss and narcosis.

Isopropyl Alcohol - Isopropyl alcohol causes mild irritation of the eyes, nose and throat. The most important toxic action of isopropyl alcohol is narcosis.

N-Butyl Alcohol - Exposure to this substance may result in irritation of the nose, throat and eyes, the formation of translucent vacuoles in the superficial layers of the cornea, headache, vertigo and drowsiness.

Methylene Chloride - The toxic effect is predominantly narcosis. Symptoms of excessive exposure may be vertigo, weakness, headache, difficulty in speech, and possible blurred vision. Methylene chloride is only mildly irritating to the skin but the problem may be accentuated by its being sealed to the skin by tight clothing or shoes.

Perchloroethylene - Irritation of the eyes, nose and throat may be observed after exposure to high concentrations of this substance. There are also some indications of nausea and gastrointestinal upset. The major response to perchloroethylene at high concentrations is central nervous system depression. Changes in the liver and kidneys also are observed following chronic exposure.

Trichloroethylene - The predominant physiological response from exposure to trichloroethylene is one of central nervous system depression. Visual disturbances, mental confusion, fatigue and sometimes nausea and vomiting are observed.

Nickel - No major health problems are normally connected with nickel plating: "nickel itch," a rash caused by contact with the nickel plating solution is the most common problem.

Chromic Acid - Exposure to chromic acid produces irritation and injury to the nasal passages and other respiratory symptoms.

Sodium Hydroxide - Characteristic irritation of nasal tissue frequently causes sneezing. The greatest hazard is that of rapid destruction of any tissue upon contact with concentrated solutions. Dermatitis may result from contact with dilute solutions.

Sulfuric Acid - Sulfuric acid mist is a strong irritant and the inhalation of concentrations of around 3 mg/cu. meter causes a choking sensation. Sulfuric acid also attacks the enamel of the teeth.

Cadmium - The ingestion of cadmium salts induces salivation, choking attacks, persistent vomiting, abdominal pains, tenesmus and diarrhea, vestigo and loss of consciousness. The most serious exposure, however, results from the inhalation of cadmium fumes.

Cyanide - Poisoning may occur by absorption through the skin, by ingestion and by inhalation. Exposure to low concentrations may result in early symptoms of weakness, headache, confusion, occasional nausea and vomiting. Generally there is no change in pulse rate and the respiration rate is increased in the beginning and becomes slow in later stages.

Nitric Acid - Nitric acid is a strong irritant. Continued exposure to the vapor and/or mist is suspected of causing chronic bronchitis and possible chemical pneumonitis.

Hydrochloric Acid - Hydrochloric acid is seldom inhaled in concentrations high enough to cause serious intoxication because of its irritant nature.

Mercury - Acute intoxication from inhaling mercury vapor may occur at high concentrations. The condition is characterized by a metallic taste, nausea, abdominal pains, vomiting, diarrhea, and headache. After a few days, the salivary glands swell, stomatitis and gingivitis develop, and a dark line of HgS forms on the inflamed gums. The teeth may loosen and ulcers may form on the lips and cheeks. The chronic form of mercurialism is characterized by psychic and emotional disturbances. Symptoms include loss of ability to concentrate, depression, headache, fatigue, weakness and loss of memory.

2. Environmental Standard

To assess the concentrations of air contaminants found in the place of employment, three primary sources of criteria were used: (1) occupational health standards as promulgated by the U.S. Department of Labor (29 CFR Part 1910.1000); (2) recommended and proposed threshold limit values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH)(1975); and (3) NIOSH criteria for recommended standards for occupational exposure to substances (Criteria Documents).

In the following tabulation of criteria, appropriate values are presented with references.

Substance	Permissible Exposures (8-hour Time Weighted Average)
[1]Lead, inorg., fumes and dusts	0.15 mg/M^3 *
[2]Total Nuisance Dust	10 mg/M^3
[3]Oil Mist	5 mg/M^3
[4]Welding Fume	5 mg/M^3
[5]Fluorides	2.5 mg/M^3
[6]Zinc Chloride Fume	1 mg/M^3
[7]MEK	200 ppm **
[8]Toluene	100 ppm
[9]Xylene	100 ppm
[10]Ethyl Acetate	400 ppm
[11]Sec-Butyl Acetate	200 ppm
[12]Isopropyl Alcohol	400 ppm
[13]N-Butyl Alcohol	50 ppm
[14]Methylene Chloride	200 ppm
[15]Perchloroethylene	100 ppm
[16]1,1,1 Trichloroethylene	100 ppm
[17]Nickel	1 mg/M^3
[18]Chromic Acid and Chromates	0.1 mg/M^3
[19]Sodium Hydroxide	2 mg/M^3
[20]Sulfuric Acid	1 mg/M^3
[21]Cadmium	0.05 mg/M^3

[22]Cyanide	5 mg/M^3
[23]Nitric Acid	5 mg/M^3
[24]Hydrochloric Acid	7 mg/M^3
[25]Mercury	0.05 mg/M^3

[1]Reference: The NIOSH 1972 criteria document and the 1975 ACGIH TLV. The current Occupational Safety and Health Administration (OSHA) standard is 0.2 mg/M^3.

[2]Reference: The 1975 ACGIH TLV. The current OSHA standard is 15 mg/M^3.

[3]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[4]Reference: The 1975 ACGIH TLV.

[5]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[6]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[7]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[8]Reference: The NIOSH 1973 criteria document and the 1975 ACGIH TLV. The current OSHA standard is 200 ppm.

[9]Reference: The NIOSH 1975 criteria document, the 1975 ACGIH TLV and the current OSHA standard.

[10]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[11]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[12]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[13]Reference: The 1975 ACGIH TLV intended change. The current OSHA standard is 100 ppm.

[14]Reference: The 1975 ACGIH TLV. The current OSHA standard is 500 ppm.

[15]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[16]Reference: The NIOSH 1973 criteria document, the 1975 ACGIH TLV and the current OSHA standard.

[17]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[18]Reference: The 1975 ACGIH TLV and the current OSHA standard. The NIOSH 1973 criteria document is 0.05 mg/M^3.

[19]Reference: The NIOSH 1975 criteria document, the 1975 ACGIH TLV and the current OSHA standard.

[20]Reference: The NIOSH 1974 criteria document, the 1975 ACGIH TLV and the current OSHA standard.

[21]Reference: The 1975 ACGIH TLV. The current OSHA standard is 0.1 mg/M^3.

[22]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[23]Reference: The NIOSH 1976 criteria document, the 1975 ACGIH TLV and the current OSHA standard.

[24]Reference: The 1975 ACGIH TLV and the current OSHA standard.

[25]Reference: The NIOSH 1973 criteria document and the 1975 ACGIH TLV. The current OSHA standard is 0.1 mg/M^3.

* Units of measured concentrations are:
(a) mg/M^3 - milligrams of substance per cubic meter of air
(b) ug/M^3 - micrograms of substance per cubic meter of air
** (c) ppm - parts of gas or vapor per million parts of air

TLV's or standards for substances are established at levels designed to protect workers occupationally exposed on an 8-hour per day, 40-hour per week basis over a working lifetime. Because of wide variation in individual susceptibility, some workers may experience discomfort at or below the designated levels. Thus, an evaluation of the work place cannot be based entirely upon comparisons made against such TLV's or standards, as various TLV's and standards do not represent absolute protection of all workers.

E. Evaluation Results and Discussion

1. Printing

Two samples, one personal breathing zone and one area, for lead were collected in the Print Shop. No lead was detected on either sample. The limit of detection was 0.001 mg Pb/sample.

2. Polishing and Sanding

Five personal breathing zone samples were collected to measure total dust concentrations in the Snag and Polish Department. Sampling sites and concentrations are shown in Table 1. The highest concentration measured was 0.79 mg/M^3. The measured values are very low compared to the TLV of 10 mg/M^3 for total nuisance dust. Of the five employees who were interviewed, four reported no complaints and one noted occasional eye and nose irritation.

3. Milling

Personal breathing zone samples were collected on seven employees involved in milling operations on February 5, 1976. The samples were analyzed by fluorescence for oil mist. The results indicated concentrations ranging from 1.92 mg/M^3 to 31.7 mg/M^3. Because of the high concentrations, the results seemed questionable. Investigation into the analysis technique revealed that the concentrations were based on a point reading compared to that of a standard which had been made up of the oils used in the individual machines. A separate standard was required for each type of oil because different oils fluoresce to different levels. Because of the close proximity of the milling machines, operators were exposed not only to oil mist from their individual machines but also to oil mist from those machines which were adjacent to them. As a result, individual samples actually had a mixture of oils on them but were being compared to standards made up of one type of oil.

Additional samples were taken on ten employees on March 11, 1976. The samples were analyzed for total weight and for oil mist by fluorescence. For the analysis by fluorescence, a range was scanned rather than a single point to determine the type and quantity of oil which was present on the filter. The results are given in Table 2. One sample shows a concentration of 1.32 mg/M^3 for total particulate with the highest oil mist concentration being 0.33 mg/M^3. (The TLV for oil mist is 5 mg/M^3). Interviews with ten of the operators indicated that one employee experienced occasional nose and throat irritation, another occasional skin rash and a third reported skin rash and throat irritation from time to time. The remaining seven employees reported no health problems. Therefore, on the basis of the environmental data collected on March 11 and on employee interviews, it was determined that oil mist was not toxic at the concentrations measured within the worksite at the time of this evaluation.

4. Welding, Soldering and Brazing

Welding fume concentrations were measured outside the welding helmets on three welders in Department 607. The results are given in Table 3. Concentrations were found to be low (0.15, 0.10 and 0.22 mg/M^3) compared to the recommended TLV (5 mg/M^3). (Due to the low welding fume concentration, the samples were not analyzed for nickel and chromium content.) Welding fume concentrations were measured inside the helmet of the two welders in Department 641. One sample showed a concentration of 5.53 mg/M^3 which exceeds the recommended TLV. However the TWA concentration for that welder (3.15 mg/M^3) is below the TLV. In addition, interviews with the five welders revealed no health problems. It was therefore determined that no health hazard was present. (It should be noted that the highest exposures to welding fumes occurred at the MIG welder. As stated previously, the placement of the ventilation duct at this welder was such that essentially no air movement was occurring at the worksite. This situation was brought to the attention of the Company on the February 24 visit and recommended changes had been completed by the March 11 visit. The changes which were made should reduce the exposure to welding fumes at this worksite.)

Two personal breathing zone samples were collected on the brazers in Department 607 and two samples on the induction brazers in Department 611 to measure exposure to fluoride from the brazing flux. The results are shown in Table 4. The levels measured are below those believed to cause adverse health effects. Interviews with the induction brazers revealed that all experienced some type of skin irritation on their hands. Therefore, although environmental levels are below those believed to cause respiratory irritation, minor problems appear to result from direct skin contact with the flux. Employees should follow work practices which avoid direct skin contact.

Personal breathing zone samples were collected on the four solderers in Department 611. Samples were analyzed for lead and zinc chloride. No levels of lead were detected. (Table 5) The levels of zinc chloride were also well below the existing standard.

5. Resin Coating and Joining

Two personal breathing zone samples were collected on the employee joining plastic parts by the use of MEK. No detectable levels of MEK were found. Six employees who work in the epoxy room were interviewed. Two workers reported occasional headaches and one dry skin from the use of solvents. There were no reported cases of dermatitis. Due to the small quantities of epoxy resins used and the relative lack of adverse symptomology, no further investigation was deemed necessary.

6. Spray Painting

Personal breathing zone samples were collected on eight painters and two paint mixers and analyzed for organic solvents. Area samples also were taken in the paint mixing room. As can be seen from Tables 6 and 7, organic vapor concentrations were very low. No levels of chromate were found on samples taken beside the bonderizer. Therefore, based on the criteria outlined in Part D, it was determined that no health hazard existed and present engineering controls are considered to be adequate. Of the ten employees interviewed, one painter stated he had experienced some lung congestion in the past after cleaning the paint booths. It should be noted that the masks provided to the painters are not effective for organic vapors. It is therefore recommended that organic vapor respirators be provided and used for such maintenance procedures or anytime the painters feel the use of a respirator is necessary.

7. Cleaning

The parts cleaning operations were evaluated by collecting area samples adjacent to the degreasers. Personal breathing zone samples were collected in the two locations where one employee was responsible for the operation of the degreaser. The sample locations and results are given in Table 8. All concentrations are below the recommended levels for the respective solvents except the area samples collected on the perchloroethylene degreaser located adjacent to the plating room. The two area samples showed concentrations of 103 ppm and 241 ppm of perchloroethylene. The personal breathing zone samples on the degreaser operator were considerably less (11 ppm) and below the level believed to cause adverse health effects. (The 8-hour time weighted average concentration for perchloroethylene is 100 ppm. Perchloroethylene also has an acceptable ceiling concentration of 200 ppm.) The degreaser operator, however, did report experiencing frequent headaches and occasional dizziness. The data therefore indicates that although the degreaser operator's exposure for 8-hours is below the level believed to cause adverse health effects, he may be experiencing short-term high level exposures to perchloroethylene. This is consistent with the operators work practices in that the operator actually spends little time working directly over the degreaser. Therefore it was determined that short-term exposures to excess levels of perchloroethylene may exist.

8. Plating

Area samples for eight substances were collected in the plating room. The substances and concentrations are listed in Table 9. No levels of nickel, sulfuric acid, nitric acid or cadmium were detected. Only low levels of cyanide, hydrochloric acid and chromic acid were reported. Sodium hydroxide levels were found to be 0.2 mg/M^3 and 5.9 mg/M^3. The standard for sodium hydroxide is 2 mg/M^3.) The sodium hydroxide samples were collected on the aluminum etch line. Review of the interviews conducted with seven of the employees in the plating room revealed six of the seven reported occasional irritation to the nose (runny nose) and sneezing, of which four related the symptoms to the aluminum etch line. No other problems were reported. Exposure to sodium hydroxide is characterized by irritation of the nasal tissue frequently causing sneezing. It was therefore determined that a potentially toxic exposure to sodium hydroxide may exist on the aluminum etch line. It is recommended that the present single slot ventilation system on this line be replaced by one which contains several slots and reaches to chest height of the workers. Such a system should reduce exposure by increasing the capture at chest level after the parts are removed from the tanks.

Four area samples were taken on the diversey chromating process. The results are given in Table 10. No levels of nitric acid or chromic acid were detected. Low levels of sodium hydroxide and fluoride were reported. It should be noted that the system was "on" at the time of the sampling but was not being used. The operator reported no health problems but had only worked on the process for three weeks. The previous operator had experienced watery blisters on the arms and stomach. He was transferred from the area and has not experienced problems since that time.

Samples collected at the Summa Process showed no detectable levels of acids.

9. Instrument Calibration

The personal breathing zone and area samples collected in Department 601 showed no detectable levels of mercury. The limit of detection was 0.3 ug/sample.

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TABLE 1

Total Dust Concentration

Polishing and Sanding, Department 550

The Foxboro Company
Foxboro, Massachuestts

February 5, 1976

Sample Location	Sample Number	Sampling Period	Sample Volume (liters)	Total Particulate Concentration (mg/M^3)
Belt Sander	V1155	0725-1437	648	0.26
Stroke Sander	V1165	0725-1438	649	0.79
Snagging	V1195	0728-1437	643	0.26
Oscillator	V1177	0729-1437	642	0.34
Belt Sander	V1164	0723-1438	652	0.20

TABLE 2

Milling

Oil Mist Concentrations

The Foxboro Company
Foxboro, Massachusetts
March 11, 1976

Sample Location	Department	Sample Number	Sampling Period	Sample Volume (liters)	Total Particulate Concentration (mg/M^3)	Oil Mist Concentration (mg/M^3)
Bullard 1902301	573	V1507	0711-1440	673	0.34	0.24
Control 1903702	573	V1433	1030-1438	372	0.19	0.19
A Spindle Chucker 1302103	504	V1474	0729-1448	658	0.40	0.33
A Spindle Chucker 1302102	504	V1589	0720-1446	669	0.07	0.03
Bullard 1702401	504	V1592	0724-1450	669	0.06	0.06
Bullard 1702501	504	V1508	0727-1449	663	0.38	0.26
Bullard 1702304	504	V1544	0730-1449	658	0.09	0.06
Milling 1276	507	V1559	0707-1436	673	1.32	*
Auto Screw Machine 0600503	507	V1545	0715-1441	669	0.04	*
Milling 0621104	507	V1541	0703-1436	679	0.32	*

*Satisfactory results could not be obtained by fluorescence
Limit of detection 0.02 mg/sample

TABLE 3

Welding Fume

The Foxboro Company
Foxboro, Massachusetts

February 24-25, 1976

Sample Location	Sample Number	Sampling Period	Sample Volume (liters)	Total Weight (mg/M^3)
*Heliarc Welder	V1560	0710-1120	262	0.11
	V1521	1210-1430	165	0.36
*MIG Welder	V1568	0715-1120	292	1.20
	V1513	1210-1430	150	5.53
Welder (Dept. 607)	V1556	0645-1425	690	0.14
Welder (Dept. 607)	V1492	0647-1425	589	0.10
Welder (Dept. 607)	V1590	0649-1425	586	0.22

*Measurements made inside of welding helmet.

TABLE 4

Fluoride

Brazing, Department 607 and 611

The Foxboro Company
Foxboro, Massachusetts

February 25, 1976

Sample Location	Sample Number	Sampling Period	Sample Volume (liter)	Fluoride Concentration (ug/M^3)	Total Fluoride (ug/M^3)
Brazer	IM-8	0710-1440	377	3.2	3.2
	HA-5			N.D.	
Brazer	IM-9	0718-1440	366	N.D.	11
	HA-6			11	
Induction Brazer	IM-6	0652-1442	462	5.0	13
	HA-3			8.0	
Induction Brazer	IM-7	0654-1442	468	27	70
	HA-4			43	

N.D. - Not Detected; Limit of detection 0.4 ug/ml

TABLE 4

Fluoride

Brazing, Department 607 and 611

The Foxboro Company
Foxboro, Massachusetts

February 25, 1976

Sample Location	Sample Number	Sampling Period	Sample Volume (liter)	Fluoride Concentration (ug/M^3)	Total Fluoride (ug/M^3)
Brazer	IM-8 HA-5	0710-1440	377	3.2 N.D.	3.2
Brazer	IM-9 HA-6	0718-1440	366	N.D. 11	11
Induction Brazer	IM-6 HA-3	0652-1442	462	5.0 8.0	13
Induction Brazer	IM-7 HA-4	0654-1442	468	27 43	70

N.D. - Not Detected; Limit of detection 0.4 ug/ml

TABLE 5

Lead and Zinc Chloride

Soldering, Department 611

The Foxboro Company
Foxboro, Massachusetts

February 25, 1976

Sample Location	Sample Number	Sampling Period	Sample Volume (liter)	Lead Concentration (mg/M^3)	Zinc Chloride Concentration (mg/M^3)
Solderer	AA-9	0643-1441	717	N.D.*	0.002**
Solderer	AA-10	0645-1440	712	N.D.	0.036
Solderer	AA-11	0647-1441	711	N.D.	0.008
Solderer	AA-12	0650-1440	705	N.D.	0.002

* N.D. - Not Detected; Limit of detection 0.002 mg/sample
** Limit of detection 0.001 mg/sample

TABLE 6

Organic Vapor Concentrations
Spray Painting

The Foxboro Company
Foxboro, Massachusetts

February 24, 1976

Job	Sample Location	Sample Number	Sample Volume (liter)	Toluene (ppm)	Xylene (ppm)	Iso-propanol (ppm)	Sec-Butyl Acetate (ppm)	Ethyl Acetate (ppm)	N-Butyl Alcohol (ppm)	MEK (ppm)
Painter	Line 1, Booth 2	CT-3	10.6	0.51	0.22	N.D.	N.D.	N.D.	0.62	N.D.
		CT-4	12.6	0.21	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Painter	Line 2, Booth 3	CT-5	12.9	0.42	N.S.	N.S.	0.17	N.D.	0.77	N.D.
		CT-6	10.9	0.92	0.63	N.D.	0.40	N.D.	0.61	N.D.
Painter	Rotates Booths	CT-7	9.8	0.41	N.D.	N.D.	0.22	N.D.	N.D.	N.D.
		CT-8	12.5	0.43	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Painter	Line 1, Booth 4	CT-9	7.2	0.23	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
		CT-10	8.0	0.10	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Painter	Line 2, Booth 2	CT-13	38.6	0.35	0.18	N.D.	N.D.	N.D.	0.17	N.D.
		CT-14	44.5	1.15	0.41	0.27	0.15	N.D.	0.15	N.D.
Painter	Line 1, Booth 3	CT-15	11.0	0.49	0.21	N.D.	N.D.	N.D.	N.D.	N.D.
		CT-16	14.7	0.73	0.31	N.D.	N.D.	N.D.	N.D.	0.23
Paint Mixer	Second Floor	CT-17	9.6	4.22	0.96	N.D.	N.D.	N.D.	0.69	N.D.
		CT-18	1.6	5.06	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Paint Mixer		CT-19	10.6	0.51	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
		CT-20	10.6	0.76	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Area	Paint Mixing Room	CT-21	10.2	3.31	1.13	N.D.	N.D.	N.D.	0.32	N.D.
		CT-22	14.6	3.14	0.79	N.D.	N.D.	N.D.	0.45	N.D.

TABLE 7

Organic Vapor Concentration
Spray Painting

The Foxboro Company
Foxboro, Massachuestts

February 24, 1976

Job	Sample Location	Sample Number	Sample Volume (liter)	N-Butyl Alcohol (ppm)	Xylene (ppm)	MEK (ppm)	Cellosolve Acetate (ppm)
Primer	Line 1, Booth 1	CT-1	11.8	N.D.*	N.D.	N.D.	N.D.
		CT-2	12.7	0.35	0.36	N.D.	N.D.
Primer	Line 2, Booth 1	CT-11	11.1	N.D.	N.D.	N.D.	N.D.
		CT-12	13.5	N.D.	N.D.	N.D.	N.D.

*N.D. - Not Detected: Limits of detection 0.01 mg/sample

TABLE 8

Organic Vapor Concentrations
Degreasers

The Foxboro Company
Foxboro, Massachusetts

February 24, 1976

Location	Sample Number	Sampling Period	Sample Volume (liter)	Chemical	Concentration (ppm)
Blakeslee Degreaser Operator	CT-27	0720-1051	8.7	Methylene Chloride	11
	CT-28	1051-1425	9.1	Methylene Chloride	17
Blakeslee Degreaser Area	CT-29	0721-1053	10.7	Methylene Chloride	26
	CT-30	1053-1430	11.0	Methylene Chloride	20
Plating Roor Degreaser (Area)	CT-33	0756-1057	11.0	Methylene Chloride	103
	CT-34	1057-1440	14.2	Methylene Chloride	67
Department 611 Degreaser (Area)	CT-41	0700-1048	12.0	1,1,1 Trichloroethylene	29
	CT-42	1048-1445	9.4	1,1,1 Trichloroethylene	6
Degreaser Outside Clean Room (Area)	CT-43	0730-1051	9.4	1,1,1 Trichloroethylene	27
	CT-44	1051-1435	10.7	1,1,1 Trichloroethylene	15
Machine Shop Area	CT-25	0714-1048	11.1	Perchloroethylene	3
	CT-26	1048-1425	11.7	Perchloroethylene	3
Degreaser Beside Plating Room (Area)	CT-35	0759-1059	10.4	Perchloroethylene	103
	CT-36	1059-1430	11.4	Perchloroethylene	241
Degreaser Operator Beside Plating Room	CT-31	0810-1105	8.0	Perchloroethylene	11
	CT-32	1105-1430	8.5	Perchloroethylene	11

Limit of detection 0.01 mg/sample

TABLE 9

Plating Room Concentrations

The Foxboro Company
Foxboro, Massachusetts

February 24, 1976

Location	Sample Number	Sampling Period	Sample Volume (liter)	Chemical	Concentration
Copper Cyanide Tank	IM-1	0740-1443	423	Cyanide	11.2 ug/M^3
Nickel Line	IM-2	0740-1440	420	Cyanide	N.D.*
Auto Plater	IM-3	0742-1445	423	Hydrochloric Acid	8.8 ug/M^3
Pickling Tank	IM-4	0742-1441	419	Hydrochloric Acid	62 ug/M^3
Pickling Tank	IM-5	0743-1441	418	Nitric Acid	N.D.
Large Auto Plater	AA-3	0745-1444	628	Cadmium	N.D.
Small Auto Plater	AA-4	0745-1445	630	Cadmium	N.D.
Aluminum Etch (Left Side)	HA-1	0730-1443	649	Sodium Hydroxide	0.2 mg/M^3
Aluminum Etch (Right Side)	HA-2	0730-1444	651	Sodium Hydroxide	5.9 mg/M^3
Soak Cleaner	AA-5	0749-1442	619	Sulfuric Acid	N.D.
Bright Dip	AA-6	0749-1441	618	Sulfuric Acid	N.D.
Auto Plater	PVC-2	0750-1446	624	Chromic Acid	7.5 ug/M^3
Bronze Line	PVC-3	0749-1446	625	Chromic Acid	1.1 ug/M^3
Nickel	AA-7	0735-1444	643	Nickel	N.D.
Nickel	AA-8	0735-1441	639	Nickel	N.D.

*N.D. - Not Detected
Cyanide - Limit of detection 0.01 ug/ml
Hydrochloric Acid - Limit of detection 0.2 ug/ml
Nitric Acid - Limit of detection 0.2 ug/ml
Cadmium - Limit of detection 0.001 mg/sample
Sodium Hydroxide - Limit of detection 0.006 mg/sample
Sulfuric Acid - Limit of detection 0.2 mg/sample
Chromic Acid - Limit of detection 0.0002 mg/sample
Nickel - Limit of detection 0.002 mg/sample

TABLE 10

Diversey Chromating Process

The Foxboro Company
Foxboro, Massachusetts

February 25, 1976

Chemical	Sample Number	Sampling Period	Sample Volume (liter)	Concentration
Sodium Hydroxide	HA-7	0705-1500	712	0.008 mg/M^3
Nitric Acid	IM-11	0705-1500	475	N.D.
Fluoride	IM-12	0705-1500	475	0.83 ug/M^3
Chromic Acid	PVC-4	0705-1500	712	N.D.