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PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION REPORT
HE 80-87-708

HAROWE SERVO CONTROLS INC.
WEST CHESTER, PENNSYLVANIA

JULY 1980

I. SUMMARY

On March 12 and 26, 1980, and again on April 11, 1980, the National Institute for Occupational Safety and Health (NIOSH) conducted a health hazard evaluation at Harowe Servo Controls Inc., West Chester, Pennsylvania, to evaluate the exposures of twelve process operators to trichloroethylene in the passivating area (SIC 3621). A comprehensive walk-through survey and environmental sampling were conducted, ventilation measurements were taken, and non-directed medical questionnaire interviews were performed to determine possible employee exposure to trichloroethylene and the possible health effects of this exposure.

The individual time-weighted average air samples ranged from 0..32 PPM up to 21.0 PPM and the ceiling values ranged from 10.6 PPM to 27.3 PPM. The eight-hour time-weighted averages were 10.8 PPM for the small degreaser operator and 12.3 for the large degreaser operator; the time-weighted average for the area sampling was 12.9 PPM. These values are all within the lowest permissible exposure limits - 25 PPM - 8hr.TWA (NIOSH) and 150 PPM STEL (ACGIH).

Capture velocities at the centers of the large and small degreasing tanks were <25 feet per minute; this is below the acceptable hood design criteria range of 50 to 100 feet per minute.

Employee interviews revealed complaints of eye, skin, and upper respiratory irritation associated with trichlorethylene exposure.

On the basis of data obtained in the investigation, NIOSH determined that no air contaminant hazard existed from exposure to trichloroethylene. However, reports of skin, eye and upper respiratory irritation warrant certain recommendations, listed in the recommendations section on page 5.

II. INTRODUCTION

Under the Occupational Safety and Health Act of 1970*, NIOSH investigates the toxic effects of substances found in the workplace. The United Electrical, Radio and Machine Workers of America (UE), Local 155 requested such an investigation on March 5, 1980, to evaluate the possible effects of trichloroethylene (TCE) upon the process and production operators in the Chem-Finish (passivating) area at Harowe Servo Controls Inc., West Chester, Pennsylvania.

The NIOSH Regional Industrial Hygienist met with the company and union representatives for the opening and closing conferences, walk-through survey and environmental sampling on March 12 and 26, 1980, and again on April 11, 1980.

III. BACKGROUND

The passivating or Chem-Finish area (22 ft. X 26 ft.) involves the degreasing, tumbling and chemical finishing of small AC motor parts. Two Chem-Finish operators work in this area full time and ten other workers use this area intermittently throughout the day. The passivating area has been operating for twenty years. The plant presently puts out three thousand pieces per month.

The particular operations in question are the two degreasing tanks (large and small) which use the solvent trichloroethylene (TCE). The large and small degreasers are approximately 6' X 3' X 4' and 4' X 2' X 4', respectively in size. A 3 foot high platform is located in front of the tanks to allow access to the top opening.

Parts to be cleaned are placed in a metal-mesh basket and are manually suspended in pure condensing solvent vapor which dissolves and washes away contaminants. When the temperature of the parts reaches that of the vapor, condensation and cleaning cease. Upon removal the parts should be dry.

The operation takes place in three steps. Three suspension points are set up in each tank. The first is down in the vapor belt; the second is above the vapor belt; and the third is above the tank. Each suspension is done manually, and takes several minutes each. Ideally, the parts are cleaned and dry by the end of the third step.

The operators must bend over the tank to get to the first and second suspension points.

The operators place the degreased parts on to the center work table. A commercially made trichloroethylene vapor alarm is located just above and behind this table. The gas monitor alarm relies on the oxidation of a metallic oxide substrate (MOS) heated circuit to change its resistance

*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 and Human Services, 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.

proportionately to the concentration of the TCE. It also relies on the passive diffusion and/or air movement through a sampling port in order to pick up an air sample. The monitor has not been proven reliable as confirmed by the NIOSH sampling results. The placement of supposedly "dry" degreased parts in the area of this monitor may have caused some of these spurious excursions of TCE concentration.

IV. EVALUATION DESIGN AND METHODS[1]

Discussions with management involved the collection of information concerning process description, engineering controls, personal protective equipment and clothing, work practices, training programs, monitoring, recordkeeping and medical surveillance for the areas in question. Employee interviews focused in on the job description, work practices, training programs, and any associated health problems.

Personal air samples for trichloroethylene vapors were taken of the two Chem-Finish operators using activated charcoal tubes and portable pumps at a flow rate of 50 cc/minute (TWA samples) and 200 cc/minute (ceiling samples). Time-weighted average (tubes changed about every two hours) and ceiling value (15 minutes) samples were taken throughout the eight-hour work day.

Area samples for trichloroethylene vapors were collected on the top of the in situ vapor monitor (above center work table) using activated charcoal tubes at a flow rate of 50 cc/minute.

A bulk ("perma-clean na") of trichloroethylene was also taken to be used for analysis.

All samples were analyzed using a flame-ionization gas chromatograph; the limit of detection was 0.01 mg per sample.

Air velocity measurements were taken of local exhaust units using a velometer and smoke tubes.

V. EVALUATION CRITERIA[2,3,4]

Exposure to trichloroethylene vapor may cause irritation of the eyes, nose, and throat. The liquid, if splashed in the eyes, may cause burning irritation and damage. Repeated or prolonged skin contact with the liquid may cause dermatitis.

Acute exposure to trichloroethylene depresses the central nervous system to produce sych symptoms as headache, dizziness, vertigo, tremors, nausea and vomiting, irregular heart beat, sleepiness, fatigue, blurred vision, and intoxication similar to that of alcohol. Unconsciousness and death have been reported. Alcohol may make the symptoms of trichloroethylene overexposure worse. If alcohol has been consumed, the exposed worker's skin may become flushed. Peripheral neuropathy has been reported in people who have inhaled excessive amounts of trichloroethylene. Toxicology research indicates that exposure to trichloroethylene may induce liver tumors in mice.

The following environmental standards or criteria were considered in the report:

Source	8Hr.TWA*	Ceiling**
NIOSH	25 PPM	-----
ACGIH	50 PPM	150 PPM-STEL (short term exposure limit)
OSHA	100 PPM	200 PPM Acceptable Ceiling 300 PPM Acceptable Maximum Peak (5 min. in any 2 hours)

*TWA = time-weighted average

**Ceiling = short term exposure limit (15 minute excursion period)
= for OSHA, 15 minute sampling time to be legally enforceable.

VI. RESULTS AND DISCUSSION

Results of the eight-hour time-weighted average and ceiling value personal and area samples were within the environmental criteria/standards for trichloroethylene vapors.

The individual time-weighted average air samples ranged from 0.32 PPM up to 21.0 PPM and the ceiling values ranged from 10.6 PPM to 27.3 PPM. The eight-hour time-weighted averages were 10.8 PPM for the small degreaser operator and 12.3 for the large degreaser operator; the time-weighted average for the area sampling was 12.9 PPM. These values are all within the lowest permissible exposure limits - 25 PPM - 8hr.TWA (NIOSH) and 150 PPM STEL (ACGIH).

Detector tube measurements for trichloroethylene showed readings of 12-15 PPM - ambient/center of room, 20 PPM over the small degreaser (at the breathing zone) and 25 PPM over the large degreaser (at the breathing zone).

Trichloroethylene measurements taken as the basket of parts is manually hoisted from one level to the next in the degreasing tank show 75 PPM - going from the first to the second to the third level - and 25 PPM from third level to final take-out.

Measurements taken at the company's vapor detector alarm showed 12.5 PPM as the ambient concentration throughout the work day.

Ventilation and smoke tube measurements of the large degreaser slot exhaust system revealed < 25 feet/minute - 12" out from slot, 50 feet/minute to 100 feet/minute - 6" out from slot, and 150 to 200 feet/minute - 3" out from slot. Measurement on the small degreaser unit revealed - < 25 feet/minute - 6" from slot (middle of tank), and > 200 feet/minute - 2" from slot.

Capture velocities of 50 to 100 feet per minute are acceptable hood design criteria for degreasing tanks. The upper end of this range is used where disturbing air currents, contaminants of high toxicity, and high production are present.

Cooled air is brought into the Chem-Finish room through louvers located on the ceiling and to the back - right-hand side of the large degreasing tank. The air movement is directed partially towards the degreaser tank causing some turbulence above the tank; it would appear that this may short-circuit the slot ventilation on the tank and upset the vapor belt.

It was observed that no safety glasses or protective gloves were used during the degreasing operations; respiratory protection is provided (1/2 face-piece respirator with organic vapor cartridges - not approved) but is not used by the operators.

Non-directed interviews of four employees using the degreasers regularly revealed - dermatitis - one case; chest tightness - one case; throat irritation - one case; headaches - one case; three of the four employees reported - no symptoms.

On the basis of data obtained in the investigation, NIOSH determined that no air contaminant hazard existed from exposure to trichloroethylene. However, reports of skin, eye and upper respiratory irritation warrant the following recommendations:

VII. RECOMMENDATIONS[6,7]

The following recommendations are intended to minimize worker contact with the trichloroethylene liquid and vapors and its thermal degradation products.

1. Protective gloves (neoprene or PVA plastic) and goggles (acid-type splash-proof) should be used when raising or lowering parts into the degreasing tanks.

2. No smoking, eating, or drinking should be allowed in the Chem-Finish area.

3. Open flames or open heated elements should not be allowed - to prevent formation of toxic hydrogen chloride and/or phosgene gas via contact with TCE vapor.

4. Any spills or leaks and tank clean-out operations should be done using proper personal protective equipment (gloves, coveralls, goggles, booties and approved respiratory protection [where necessary]) and "swept-up" using an absorbing agent or by wet-vacuuming.

5. Ventilation units (local and general) should be monitored and maintained on a regularly scheduled basis. Air velocities should be boosted to 100 feet per minute measured at the center top of the tank.

6. Vapor degreasing tanks should be equipped with a condenser or vapor level thermostat to keep the vapor level below the top edge of the tank by a distance equal to one-half the tank width or 36 inches, whichever is shorter.

7. Where water type condensers are used, inlet water temperatures should not be less than 80°F (27°C) and the outlet temperature should not exceed 110°F (43°C).

8. Degreasers should be equipped with a boiling liquid thermostat to regulate the rate of vapor generation, and with a safety control at an appropriate height above the vapor line to prevent the escape of solvent in case of a malfunction.

9. Tanks or machines of more than 4 square feet of vapor area should be equipped with suitable gasketed cleanout or sludge doors, located near the bottom, to facilitate cleaning.

10. Work should be placed in and removed slowly from the degreaser, at a rate no greater than 11 feet/minute (0.055 m/s), to prevent sudden disturbances of vapor level. Electric or air-driven hoists using link type hoist chairs and a speed governor would be ideal.

11. CARE MUST BE TAKEN TO PREVENT DIRECT SOLVENT CARRYOUT DUE TO THE SHAPE OF THE PART. Maximum rates workloads as determined by the rate of heat transfer (surface area and specific heat) should not be exceeded.

12. Special precautions should be taken where natural gas or other open flames are used to heat the solvent to prevent vapors* from entering the combustion air supply.

13. Heating elements should be designed and maintained so that their surface temperature will not cause the solvent or mixture to breakdown* or produce excessive vapors.

14. Degreasers should be located in such a manner that vapors* will not reach or be drawn into atmospheres used for gas or electric arc welding, high temperature heat treating, combustion air or open electric motors.

15. Whenever spray or other mechanical means are used to disperse solvent liquids, sufficient enclosure or baffling should be provided to prevent direct release of airborne vapor above the top of the tank.

16. An emergency quick-drenching facility should be located in near proximity to the degreaser for use in the event of accidental eye contact with the degreasing liquid.

17. Degreasers should be placed so that draft-induced solvent loss is minimal - away from excessive air currents, open windows or doors, heating and ventilating equipment, or any device causing rapid, uncontrolled air displacement. Normal air curculation is sufficient to dilute "small" quantities of vapor which normally escape from the degreaser. When the degreaser must be placed in an unfavorable location two or three foot baffles on the windward side will divert drafts and protect the vapor level.

18. Dirty or contaminated TCE should be placed in a suitable container and disposal should be in accordance with local and federal environmental regulations.

*Electric arcs, open flames and hot surfaces will thermally decompose halogenated hydrocarbons to toxic and corrosive substances (such as hydrochloric and/or hydrofluoric acid). Under some circumstances, phosgene may be formed.

19. All containers of TCE should be labeled to identify and indicate the hazards involved in its used.

20. Any entry into a degreasing tank should be done with assurance of complete aeration and use of a rescue harness and "buddy-system."

21. Consideration should be given to the use of substitute solvent of lower toxicity such as 1,1,1-trichloroethane or methylene chloride.

VIII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Acknowledgements

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IX. DISTRIBUTION AND AVAILABILITY

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Harowe Servo Controls Inc., West Chester, Pennsylvania
2. United Electrical, Radio and Machine Workers of America, Local 155, Philadelphia, Pennsylvania.
3. NIOSH, Region III
4. OSHA, Region III

For the purpose of informing the approximately 10 employees of the results of the survey, the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) for their perusal.

X. REFERENCES

1. NIOSH Manual of Sampling Data Sheets, 1977 Edition, DHEW, PHS, CDC, NIOSH, March 1977.

2. General Industry, OSHA Safety and Health Standards, 29 CFR OSHA 2206, Revised January 1976.

3. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1979, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

4. Occupational Diseases: A Guide to Their Recognition, DHEW, PHS, CDC, NIOSH, Publication No. 77-181, Revised June 1977.

5. NIOSH Current Intelligence Bulletin 2, June 6, 1975, Trichloroethylene (TCE).

6. Industrial Ventilation, A Manual of Recommended Practice, 15th Edition, American Conference of Governmental Industrial Hygienists, 1978.

7. Modern Vapor Degreasing, DOW Chemical Company, U.S.A., Publication No. 100-5185-172.

Table I
Results of Trichloroethylene Air Samples
Harowe Servo Controls Inc.
West Chester, Pennsylvania
March 26, 1980

	Sample Type	Sampling Time (Minutes)	Job Operation or Location	Concentration (PPM)
Personal (TWA)	HSC-1	115	Chem-Finish Operator	0.32
	HSC-2	139	Small Degreaser	10.2
	HSC-3	121		13.2
	HSC-4	97		21.0
	Time-Weighed Average			10.8
Personal (Ceiling)	HSC-9	15	Chem-Finish Operator	10.6
	HSC-10	15	Small Degreaser	20.5
Personal (TWA)	HSC-5	109	Chem-Finish Operator	12.8
	HSC-6	145	Large Degreaser	8.9
	HSC-7	122		12.3
	HSC-8	95		16.9
	Time-Weighted Average			12.3
Personal (Ceiling)	HSC-11	15	Chem-Finish Operator	27.3
	HSC-12	15	Large Degreaser	26.0
Area (TWA)	HSC-13	98	On top of in situ vapor	11.4
	HSC-14	141	detector above center	11.0
	HSC-15	125	work table	14.5
	HSC-16	90		15.3
	Time-Weighted Average			12.9