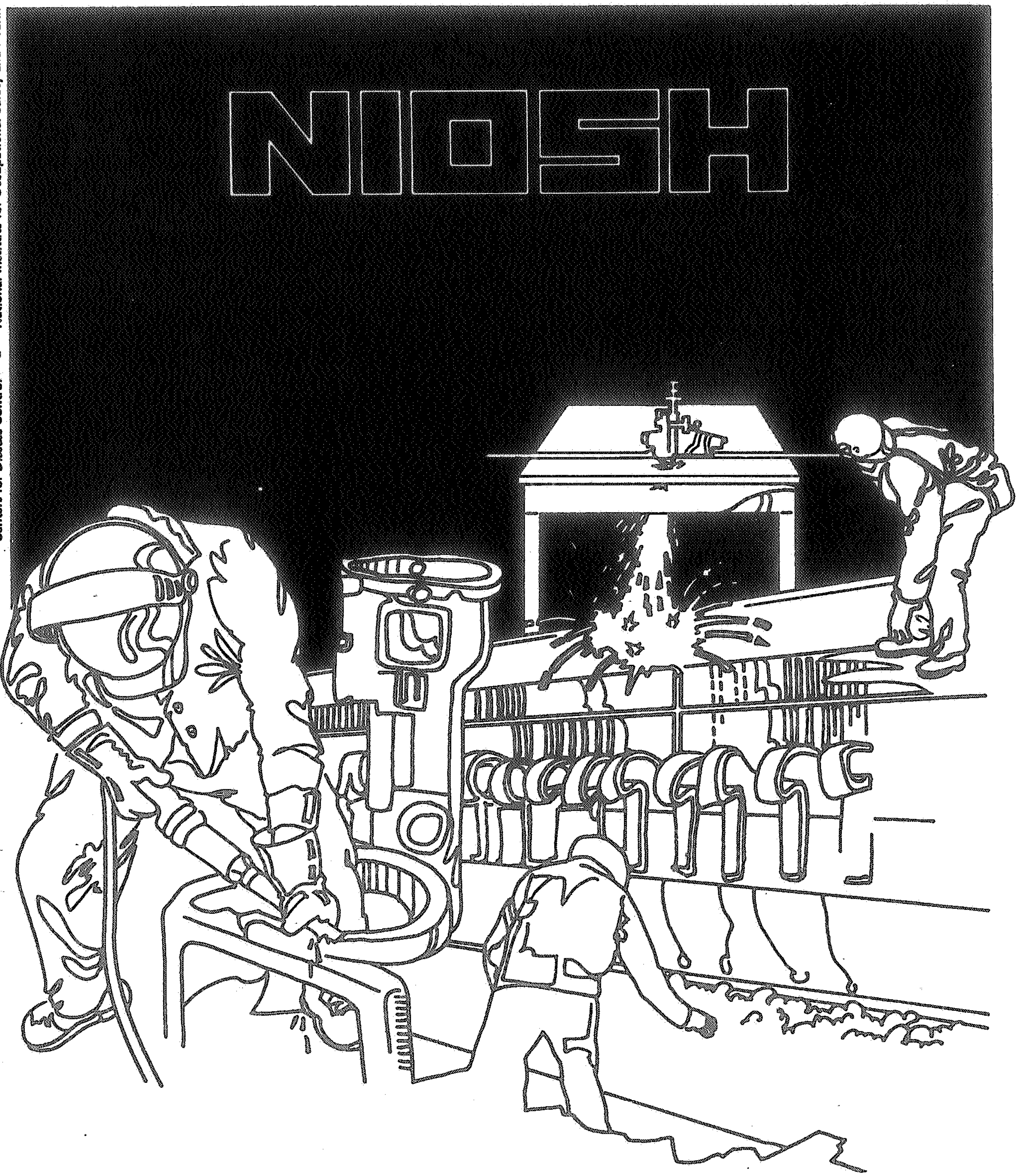
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 83-170-1346
XOMOX CORPORATION
CINCINNATI, OHIO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 83-170-1346
AUGUST 1983
XOMOX CORPORATION
CINCINNATI, OHIO

NIOSH INVESTIGATOR:
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I. SUMMARY

On March 1, 1983, the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate occupational exposures to 1,1,1-trichloroethane and isopropanol in the actuator and valve assembly departments at the Xomox Corporation, Cincinnati, Ohio. Approximately 35 employees in these two departments use 1,1,1-trichloroethane and isopropanol for degreasing metal parts.

On April 19, 1983, NIOSH personnel conducted an initial investigation during which detector tube measurements for 1,1,1-trichloroethane and isopropanol were collected at degreasing operations. These results indicated airborne 1,1,1-trichloroethane concentrations ranging from 50 to 100 ppm in both assembly departments and an isopropanol concentration of 100 ppm in the valve assembly department.

On April 21 and 22, a follow-up investigation was conducted during which 14 personal samples were collected, existing conditions and work practices were observed, and 28 first shift employees were interviewed to obtain medical and work histories. Results from the personal samples indicated that 1,1,1-trichloroethane exposures ranged from 9.3 to 129 ppm and that isopropanol exposures ranged from 0.9 to 4.7 ppm in both departments. None of the resultant employee exposures to either of the degreasing solvents were in excess of the current environmental criteria for 1,1,1-trichloroethane and isopropanol of 350 ppm and 400 ppm respectively.

Observation of work practices indicated that direct skin contact with the degreasing solvents could occur frequently due to the infrequent use of gloves. Other poor work practices such as improper respirator use and opening contaminated valves returned for repair without appropriate precautions were also observed.

Results from the interviews indicated that 20 employees (71%) reported experiencing dry, cracked, and inflammed skin (primarily on the hands) as a result of direct skin contact with degreasing solvents. This was most severe in employees who rarely or never wore gloves. Other reported problems included occasional dizziness and/or drowsiness (43%), headaches (21%), and upper respiratory complaints (18%) possibly due to the acute inhalation of solvent vapor.

Personal sampling did not establish that an inhalation hazard to 1,1,1-trichloroethane and isopropanol existed in the actuator and valve assembly departments at the Xomox Corporation in Cincinnati, Ohio. However, observation of work practices and results from employee interviews indicated that direct skin contact with these degreasing solvents was frequent and resulted in dry, cracked, and inflammed skin. Recommendations to prevent direct skin contact with 1,1,1-trichloroethane and isopropanol and to minimize occasional acute vapor exposure are presented in Section VIII on this report.

KEYWORDS: SIC 3494 (Valves and Fittings), 1,1,1-trichloroethane, isopropanol, degreasing operations

II. INTRODUCTION

On March 1, 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from an employer representative of the Xomox Corporation in Cincinnati, Ohio. NIOSH was asked to evaluate workers' exposures to 1,1,1-trichloroethane and isopropanol (used as degreasing solvents) in the actuator and valve assembly departments.

On April 19, 1983, NIOSH personnel conducted an initial investigation during which a walkaround tour of the actuator and valve assembly departments was made to obtain detailed information concerning the process operations (including solvent use) and to obtain direct-reading measurements of 1,1,1-trichloroethane and isopropanol vapor.

On April 21 and 22, 1983, NIOSH personnel conducted a follow-up investigation of the actuator and valve assembly departments during which personal and bulk samples were collected, existing conditions and work practices were observed, and employees were interviewed. A letter describing NIOSH's activities during these investigations and including preliminary recommendations for the control of solvent exposures was forwarded to the Xomox Corporation on May 5, 1983.

III. BACKGROUND

The Xomox Corporation manufactures a wide variety of sizes and types of Teflon®-lined valves for commercial use. The actuator and valve assembly departments employ approximately 35 workers that operate on two shifts.

Five different sizes of actuators are made with 80 percent of the total production comprised of the three smallest sizes. The actuator assembly process involves the assembling and sealing of a paddle within two actuator body halves. The completed actuators are then leak-tested and degreased. Any actuators failing the leak test are disassembled and degreased. 1,1,1-Trichloroethane is used as the degreasing solvent throughout the actuator assembly department. One large agitated tank is used for degreasing the actuators failing the leak test. One small tank and one large pan are used for degreasing the smaller finished actuators (the pan serves as the wash and the tank serves as the rinse). Another large pan is used for degreasing the larger finished actuators. Additionally, small benchtop cans of 1,1,1-trichloroethane are used by individual assemblers to clean actuator parts during the assembly process as necessary.

The valve assembly department is sub-divided into separate production areas according to valve size. These are: the stock valve line, the large valve line, small valve assembly, high performance butterfly valve assembly, and special assembly. All valves are hand-assembled except for those produced on the stock valve and large valve lines which are predominantly machine-assembled. The valve assembly process begins with the assembling of the valve body (usually consisting of more than 20 individual parts). The valve body is then sleeved with a Teflon® liner, the top is inserted, and the cover bolted on. The completed valve is then leak tested (usually by the assembler). 1,1,1-Trichloroethane is the predominant solvent used for part degreasing in the valve assembly department. Isopropanol is used for degreasing also, but to a much lesser extent. The use of isopropanol as a degreaser is affected by the requirements of certain customers that specify its use during valve production. Because of this, a consistent use pattern for isopropanol cannot be established. 1,1,1-Trichloroethane is contained in three large agitated tanks, three small tanks, and one large pan located at convenient points in the valve assembly department and used for routine degreasing. Isopropanol is contained in one small tank degreaser and is used sporadically. Additionally, small benchtop cans of 1,1,1-trichloroethane are used by individual assemblers to clean valve parts during the assembly process as necessary.

IV. METHODS AND MATERIALS

During the initial investigation on April 19, 1983, direct-reading detector tube measurements were obtained at 1,1,1-trichloroethane and isopropanol degreasing tanks in the actuator and valve assembly departments using a National Draeger Model 31 Multi-Gas Detector Pump and the appropriate detector tubes. All the detector tube measurements were obtained at a height above the degreasing tanks roughly equivalent to the breathing zone of the workers. Three detector tube measurements were obtained in the actuator assembly area for 1,1,1-trichloroethane. Three detector tube measurements were also obtained in the valve assembly area: two for 1,1,1-trichloroethane and one for isopropanol. These measurements were made to obtain vapor concentration working ranges for each solvent which were later used in adjusting personal sampling volumes during the follow-up investigation.

During the follow-up investigation on April 21 and 22, 1983, a total of 14 personal samples were collected on charcoal tubes using SKC Model 222-3 low flow pumps calibrated at 50 milliliters per minute. Seven of these were collected on employees in the actuator assembly department with the remaining seven collected on employees in the valve assembly department. All 14 samples were analyzed for 1,1,1-trichloroethane and isopropanol by gas chromatography using NIOSH Method P&CAM 127[1] with modifications to the desorption process and instrument operating conditions. One bulk sample each of unused 1,1,1-trichloroethane and isopropanol were also collected and used as standards in the analysis of the 14 personal samples. In addition, brief private interviews were conducted with a total of 28 first shift employees from the actuator and valve assembly departments. A standardized questionnaire was used to record each employee's medical and work history.

V. EVALUATION CRITERIA

A. Environmental Criteria

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

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

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

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

B. Toxic Effects of 1,1,1-Trichloroethane

Acute or short-term exposure to high concentrations of 1,1,1-trichloroethane vapor may cause irritation of the eyes, central nervous system depression, headache, dizziness, drowsiness, incoordination, nausea, irregular heart beat, and unconsiousness. Prolonged exposure to very high concentrations may result in death.[2,3]

Chronic or long-term exposure to 1,1,1-trichloroethane liquid may cause drying, cracking, scaling, and inflammation of the skin,[2,3] Additionally, reproductive abnormalities have been noted in studies of animals exposed to high concentrations of 1,1,1-trichloroethane.[2,4]

NIOSH currently recommends that exposure to 1,1,1-trichloroethane be limited to a ceiling level of 350 parts per million (ppm) averaged over a 15-minute period.[3] The ACGIH recommends that 1,1,1-trichloroethane exposure be limited to 350 ppm as an 8-hour TWA.[5] The current OSHA standard for 1,1,1-trichloroethane is also 350 ppm as an 8-hour TWA.[6]

C. Toxic Effects of Isopropanol

Acute or short-term exposure to high concentrations of isopropanol vapor may cause irritation of the eyes, nose, and throat, headache, drowsiness, and incoordination. In addition, swallowing isopropanol may cause gastrointestinal pain, cramps, nausea, vomiting, diarrhea, unconsciousness, and death.[2,7]

Chronic or long-term exposure to isopropanol liquid may cause drying and cracking of the skin.[2,7]

NIOSH currently recommends that exposure to isopropanol be limited to 400 ppm as a 10-hour TWA.[7] The ACGIH recommends that isopropanol exposure be limited to 400 ppm as an 8-hour TWA.[5] The current OSHA standard for isopropanol is also 400 ppm as an 8-hour TWA.[6]

VI. RESULTS

Results from the detector tube measurements obtained during the initial investigation indicated airborne 1,1,1-trichloroethane concentrations ranging from 50 to 100 ppm in both the actuator and valve assembly departments and an isopropanol concentration of 100 ppm in the valve assembly department. These approximate concentrations were considered in limiting the total volume of the personal samples collected during the follow-up investigation to avoid sample overloading.

Personal samples (approximating a complete shift) collected on assembly employees during the follow-up investigation indicated that 1,1,1-trichloroethane exposures ranged from 31 to 129 ppm in the actuator assembly department and from 9.3 to 47 ppm in the valve assembly department. Isopropanol exposures ranged from 0.9 to 1.9 ppm in the actuator assembly department and from 0.9 to 4.7 ppm in the valve assembly department. These results are presented in more detail in Table 1. All seven of the employees sampled in the actuator assembly department reported using 1,1,1-trichloroethane routinely during the sampling period. None of these actuator department employees reported using isopropanol. Four of the seven employees sampled in the valve assembly department reported using small amounts of 1,1,1-trichloroethane occasionally during the sampling period. Two of these employees (in the small valve assembly area) also reported using very small amounts of isopropanol. The two employees in the stock valve assembly area and the employee performing hydro-testing did not use either solvent during the sampling period. The assembly employees' exposures to the two degreasing solvents were consistent with the frequency of solvent use reported by the employees. 1,1,1-Trichloroethane exposures were consistently higher in the actuator assembly department where it was used routinely. Exposures to isopropanol were quite low in both the actuator and valve assembly areas since it was used rarely. None of the resultant employee exposures to either of the degreasing solvents (as presented in Table 1) are in excess of the current complete-shift environmental criteria for 1,1,1-trichloroethane and isopropanol of 350 ppm and 400 ppm respectively.

All of the large and small degreasing tanks used in the actuator and valve assembly departments had hinged lids to help suppress solvent vapor emissions when closed. Most of these tanks were used properly and the lids were closed when not in use. A few tanks, however, had lids which remained open during extended periods of inactivity allowing the unnecessary evolution of solvent vapor. None of the degreasing pans or benchtop cans used had formal lids and remained open. One pan used for the final degreasing of assembled actuators had a make-shift cardboard cover that was used normally at lunch and at the end of the workshift. None of the degreasing operations were provided with local exhaust ventilation. General dilution ventilation was provided in both the actuator and valve assembly departments.

Observation of work practices during actuator and valve assembly indicated that direct skin contact with the degreasing solvents could occur frequently. Only a few of the employees wore gloves routinely when using the degreasing solvents. Several employees wore gloves when using the degreasing tanks but not when using solvent-soaked shop towels for degreasing parts at the workbenches. Many employees never wore gloves. Generally, there seemed to be poor user acceptance of the PVC gloves provided by the company because they became distorted and hardened (thereby reducing flexibility) after only a few uses in contact with the solvents.

Several poor work practices were also observed during the follow-up investigation. A few employees were observed eating, drinking and smoking after using degreasing solvents without washing their hands first. This could add to the employees' total solvent exposure via the route of ingestion. Also, the spray painter located at the rear of the valve assembly department was not utilizing his half face-piece respirator properly. Only one headstrap was fastened which would reduce the effectiveness of the face-piece seal and result in little or no protection. Additionally, a small valve contaminated with chlorine gas was returned to Xomox for repair and was opened in the valve assembly department. The small amount of chlorine gas escaped, fortunately without injury to the employees involved. Without the appropriate precautions, a situation such as this with larger valves returned for repair could pose a serious health hazard.

Private interviews with employees provided more detailed information concerning job-related health problems. A total of 28 first shift employees in the actuator and valve assembly departments were interviewed. Twenty-five (89%) of these employees reported having experienced, at least once, symptoms consistent with degreasing solvent exposure. Twenty employees (71%) have experienced dry, cracked, or inflammed skin resulting from direct contact with the degreasing solvents. These skin problems were most severe in employees who rarely (or never) used protective gloves. Twelve employees (43%) reported experiencing dizziness and/or drowsiness, 6 (21%) reported headaches, and 5 (18%) reported upper respiratory problems at times while using the degreasing solvents. 1,1,1-Trichloroethane was reported as being the most widely used degreasing solvent and was also implicated as the cause of most of the health-related complaints. Additionally, a majority of the employees interviewed acknowledged that they routinely used 1,1,1-trichloroethane to wash up.

VII. DISCUSSION AND CONCLUSIONS

Personal sampling did not establish that an inhalation hazard to 1,1,1-trichloroethane and isopropanol existed in the actuator and valve assembly departments at the Xomox Corporation plant in Cincinnati, Ohio. However, the personal interviews indicated that short-term exposures to these solvents may possibly be high enough at times to produce actue heath effects such as dizziness, drowsiness, and headaches. These effects can be experienced even though the TWA solvent exposures are below the current environmental criteria.

Based on observation of existing work practices, direct skin contact with the degreasing solvents, most notably 1,1,1-trichloroethane, is frequent. The recurring skin problems reported by the employees such as dry, cracked, and inflammed skin on the hands are a result of this direct skin contact. Work practices should be modified to prevent direct skin contact with the degreasing solvents.

Observation of work practices also indicated a couple of other deficiencies that should be corrected. The existing respiratory protection program is not effectively enforced and/or monitored to prevent improper usage that could lead to overexposure and injury. The failure to decontaminate valves sent back for repair could result in a very serious injury or even death. Both of these problems also need to be addressed.

VIII. RECOMMENDATIONS

Recommendations one through four were presented to the Xomox Corporation in a letter dated May 5, 1983. They are repeated here for reference along with four additional recommendations to help minimize exposure to the degreasing solvents (1,1,1-trichloroethane and isopropanol) and to correct two other potentially significant problems observed during the investigation.

1. Keep all containers of degreasing solvents covered when not in use (including the small cans on assembly department workbenches).

2. Use safety cans with lids for the storage of solvent-soaked dirty shop towels until they are picked up for cleaning.

3. Discontinue the employees' use of degreasing solvents to remove grease and oil from their hands prior to washing. A good quality waterless hand cleaner will do the same job without drying out the skin.

4. Encourage the use of gloves for employees using the degreasing solvents. The PVC gloves currently used do not provide adequate hand protection for the employees. Nitrile rubber gloves have been shown to provide the best protection for 1,1,1-trichloroethane and isopropanol and should be used instead. Additionally, these gloves should be purchased in sizes to fit the individual employees. Using appropriately sized gloves will allow the employees to perform more tedious hand work and increase user acceptance. Any safety supply house should be able to direct you in the purchase of this type of glove.

5. Discourage eating, drinking, and smoking by the employees at their workstations.

6. Consider replacing the organic-based degreasing solvents with water-based degreasing compounds. There are several currently available commercially and may be worth investigating.

7. Establish a comprehensive respiratory protection program for those operations (such as spray painting) requiring the use of a respirator which meets the OSHA General Industry standard on Respiratory Protection, 29 CFR 1910.134.[8] Correct monitoring of a program such as this will prevent respirator misuse.

8. Establish a decontamination protocol for valves sent back for repair that would prevent accidential exposures to potentially hazardous materials.

IX. REFERENCES

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6. Occupational Safety and Health Administration. OSHA safety and health standards. 29 CFR 1910.1000. Occupational Safety and Health Administration, revised 1980.

7. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to isopropyl alcohol. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1976. (DHEW publication no. (NIOSH) 76-142).

8. Occupational Safety and Health Administration. OSHA General Industry Standard on Respiratory Protection. 29 CFR 1910.134. Occupational Safety and Health Administration, Revised 1980.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Xomox Corporation, Cincinnati, Ohio
2. NIOSH, Region V
3. OSHA, Region V

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

TABLE 1

PERSONAL SAMPLING RESULTS FOR 1,1,1-TRICHLOROETHANE AND ISOPROPANOL

XOMOX CORPORATION
CINCINNATI, OHIO
HETA 83-170

April 21, 1983

Department	Sample Description				Contaminant Concentration in PPM	
	Job Description	Time of Sampling	Sample Duration (minutes)	Sample Volume (liters)	1,1,1-Trichloroethane	Isopropanol
Actuator Assembly	Paddle Preparation	0738-1439	421	22	32	1.1
Actuator Assembly	Actuator Building	0730-1438	428	22	36	1.3
Actuator Assembly	Body Portion Assembly	0728-1438	430	23	37	0.9
Actuator Assembly	Vane Assembly	0724-1436	432	22	67	1.9
Actuator Assembly	Cycle Testing	0732-1439	427	22	41	1.5
Actuator Assembly	Cycle Testing	0733-1437	424	22	31	0.9
Actuator Assembly	Actuator Final Cleaning	0725-1428	423	22	129	1.3
Valve Assembly	Stock Valve Line Assembly	0831-1442	371	17	11	1.4
Valve Assembly	Stock Valve Line Assembly	0832-1442	370	19	9.8	1.5
Valve Assembly	Large Valve Line Assembly	0811-1444	393	19	15	0.9
Valve Assembly	Small Valve Assembly	0803-1441	398	19	28	0.9
Valve Assembly	Small Valve Assembly	0805-1443	398	20	47	4.4
Valve Assembly	Small Valve Assembly	0804-1442	398	21	20	4.7
Valve Assembly	Hydro-Testing	0840-1448	368	19	9.3	0.9
Evaluation Criteria:		NIOSH[3,7]			350 (c)	400
		ACGIH[5]			350	400
		OSHA[6]			350	400

Limit of detection for both 1,1,1-trichloroethane and isopropanol was 0.01 milligrams per sample.

(c): ceiling limit

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