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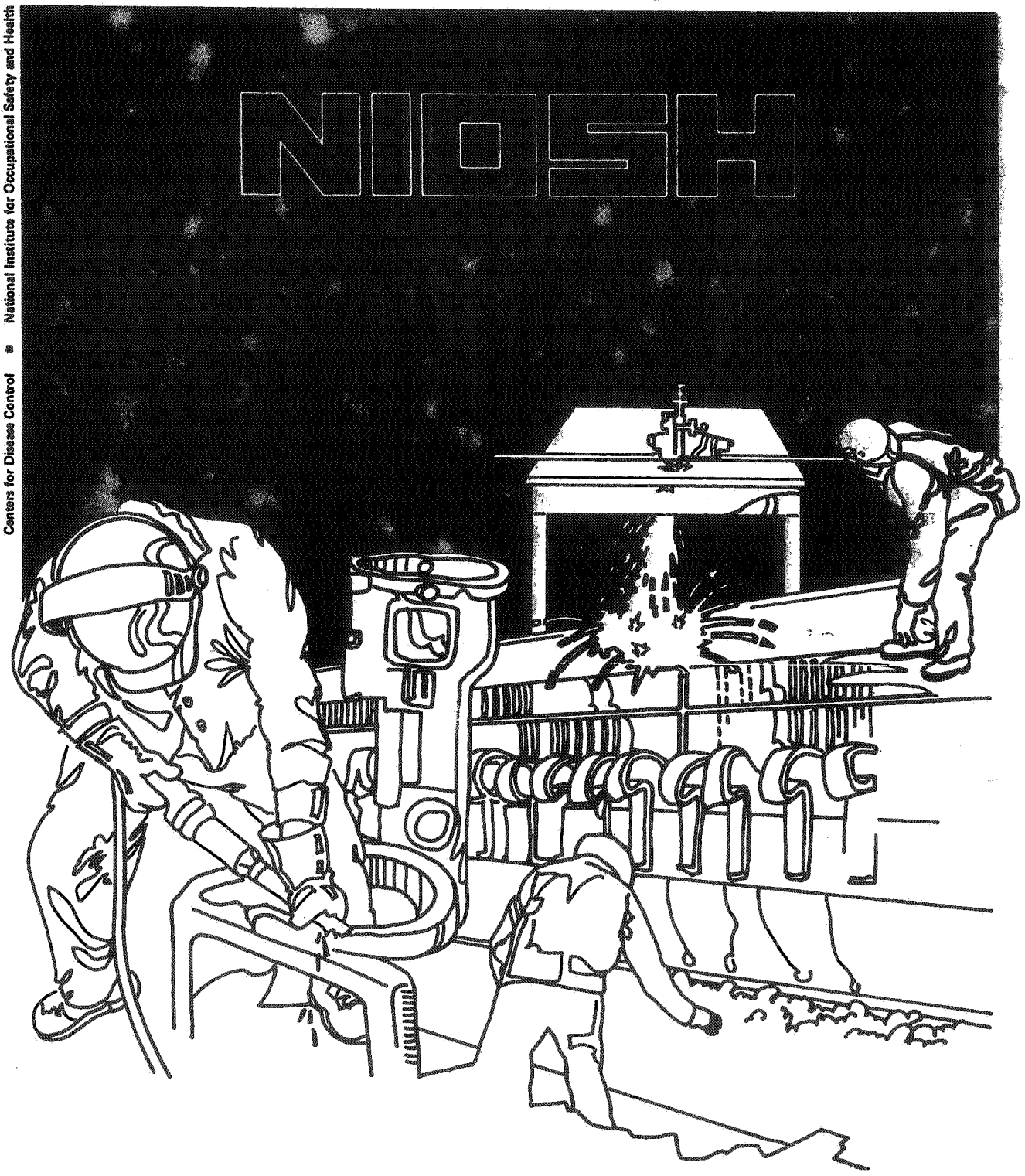

Health Hazard Evaluation Report

HETA 81-415-1385
HIGH VOLTAGE
MAINTENANCE CORPORATION
MENTOR, 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.

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HIGH VOLTAGE MAINTENANCE CORP.
MENTOR, OHIO

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I. SUMMARY

In September 1981 the National Institute for Occupational Safety and Health (NIOSH) was requested to evaluate exposures to polychlorinated biphenyls (PCBs) and to chlorinated benzenes and ethanes for electricians at High Voltage Maintenance (HVM) Corporation, Mentor, Ohio. The Company services electrical power transformers and capacitors on a contract basis with the work performed both in the field and at the Mentor facilities.

The environmental evaluation conducted November 2 and 3, 1981, at the Mentor facilities consisted of air sampling for 1,1,1-trichloroethane, PCBs and tri-and tetrachlorobenzenes, and of surface wipe sampling for PCBs. The personal breathing zone concentrations of 1,1,1,-trichloroethane measured during cleanup of PCB-contaminated surfaces (eg. floor, equipment and tools) ranged from 908 to 3519 mg/m^3 (669 to 2110 mg/m^3 15-minute time-weighted average); the NIOSH recommended standard is 1900 mg/m^3 15-minute TWA. The personal breathing zone concentrations of PCBs (Cl_2 to Cl_7 homologs) measured during pumping of askarel from one storage container to another to simulate the transfer to a tanker truck ranged from 32.4 to 81.3 ug/m^3 (8.5 to 21.3 ug/m^3 8-hour TWA); the NIOSH recommended standard is 1 ug/m^3 8-hour TWA. The corresponding trichlorobenzene and tetrachlorobenzene exposures to these workers ranged from 184.7 to 592.7 ug/m^3 (48.5 to 155.6 ug/m^3 8-hour TWA) and 127.6 to 510.7 ug/m^3 (33.5 to 134.1 ug/m^3 8-hour TWA), respectively. The ACGIH TLV for trichlorobenzene is 40,000 ug/m^3; there is no criterion for tetrachlorobenzene. Wipe testing showed significant PCB (reported as Aroclor 1260) surface contamination in eating (3 to 220 ug/100 cm^2) and office (2 to 77 ug/100 cm^2) areas and on respiratory protective equipment (1 to 200 ug/100 cm^2). Data gathered by NIOSH elsewhere suggest that upper limit background for PCB on surfaces is 0.5 ug/100 cm^2. These surface contamination data demonstrate that a significant potential exists for exposure to PCBs by dermal and gastrointestinal routes of entry.

The medical evaluation, conducted on October 19 and 20, 1981, consisted of a questionnaire survey of 21 workers and blood analysis for serum PCB and liver enzyme concentrations. Fifteen (94%) of 16 workers exposed to transformer fluid reported experiencing burning eyes, nine (56%) reported burning skin, and eight (50%) reported skin rash related to transformer maintenance work. The mean concentration of PCB in blood of exposed workers (58 ppb, range 25 to 127 ppb) was nearly four times that of unexposed workers (15 ppb, 6 to 28 ppb), and was approximately twice the level (30 ppb) considered to represent the upper limit in persons not occupationally exposed. Six (38%) workers showed elevated gamma glutamyl transpetidase and/or alamine amino transferase, but there was no significant association with blood PCB levels.

On the basis of the data collected, NIOSH concludes that workers were exposed to potentially toxic concentrations of airborne 1,1,1-trichloroethane and PCBs. Significant PCB contamination of work surfaces demonstrate a potential for continued exposure to PCBs via skin contact and ingestion. PCB blood levels also indicate excessive absorption of PCBs. Recommendations for decontamination of the buildings and exposure controls are offered in Section VIII of this report.

KEYWORDS: SIC 3610 (Electric Transmission and Distribution Equipment), polychlorinated biphenyls, PCBs, 1,1,1-trichloroethane, trichlorobenzene, tetrachlorobenzene, blood PCB, liver enzymes.

II. INTRODUCTION

In September 1981 the National Institute for Occupational Safety and Health (NIOSH) received a request from Local Union 673, International Brotherhood of Electrical Workers (IBEW), at the High Voltage Maintenance (HVM) Corporation in Mentor, Ohio, to investigate exposures of electricians to polychlorinated biphenyls (PCBs) and chlorinated benzenes during servicing and maintenance of electrical power distribution equipment. The IBEW requested that the investigation include an evaluation of exposures during work performed (a) at the Mentor, Ohio, facilities, and (b) that at several companys contracting with HVM Corporation for on-site maintenance and repair of high voltage electrical equipment. The latter aspect of the request was not completed because the management at HVM Corporation was reluctant to cooperate with NIOSH efforts to accompany the electricians to other sites. However, the recommendations offered in Section VIII of this report also apply to these field activities.

NIOSH distributed a letter report for this investigation on September 24, 1981, following the preleminary visit to HVM Corporation on September 11, 1981. In January 1982, NIOSH distributed Interim Report No. 1, which presented the results of the environmental survey conducted November 2-3, 1981. In April, 1982, NIOSH distributed Interim Report No. 2, which presented the results of the medical survey conducted October 19-20, 1982.

III. BACKGROUND

High Voltage Maintenance Corporation is engaged in the testing and maintenance of electrical power distribution equipment, including transformers, circuit breakers, relays and cables. The Mentor facilities employ approximately 26 persons, of whom 18 are electricians.

The Company services the electrical equipment on a contract basis in a number of industries, primarily in Ohio and surrounding states. The work is primarily performed in-the-field, though some is performed at the Mentor facilities. The work performed in the field involves various transformer tests (such as testing the insulation fluid to determine its electric strength, resistance and PCB concentration) and repairs. The repairs include bushing replacement, re-gasketing, draining and retrofilling of transformers containing PCBs.

The Mentor facilities consist of an electrical maintenance shop and a warehouse. The electrical shop is responsible primarily for high-current testing and re-building of high voltage circuit breakers. The warehouse serves for temporary storage of electrically faulted

PCB-contaminated equipment (transformers and capacitors) and PCB-containing fluids prior to disposal at a hazardous waste facility. The PCB-containing fluid is stored in 55-gallon drums in a diked area of the warehouse.

IV. STUDY DESIGN AND METHODS

A. Environmental

The environmental evaluation consisted of (a) air sampling for PCBs, tri-and tetrachlorobenzenes, and 1,1,1-trichloroethane, and (b) surface (wipe) sampling for PCBs.

Airborne PCB homologs (Cl_2 through Cl_7 chlorine isomer groups) and tri- and tetrachlorobenzene isomers were collected on Florisil ^{R} (150 mg., 30/40 mesh) sorbent using calibrated constant-flow vacuum pumps operating at flowrate of 1.0 L/min. The PCB and chlorinated benzenes were desorbed from the Florisil ^{R} with hexane and analyzed by gas chromatography/mass spectrometry (GC/MS) in accordance with NIOSH P&CAM Method 244.[1] The airborne PCB concentrations are reported as micrograms of total PCBs (Cl_2-Cl_7 isomer groups) per cubic meter of air sampled (ug/m^3). The chlorinated benzene concentrations are reported as micrograms of total trichlorobenzenes or total tetrachlorobenzenes per cubic meter of air sampled (ug/m^3). The 1,1,1-trichloroethane was collected on activated charcoal (150 mg, 30/40 mesh) sorbent using calibrated constant-flow vacuum pumps operating at a flowrate of 0.6 L/min. The 1,1,1-trichloroethane was desorbed from the charcoal with carbon disulfide and analyzed using a gas chromatograph equipped with a flame ionization detector in accordance with NIOSH Method P&CAM 127.[1] The 1,1,1-trichloroethane concentrations are reported as milligrams per cubic meter of air sampled (mg/m^3).

Surface (wipe) samples were obtained from various horizontal surfaces and respirators in the maintenance shop and warehouse. The samples were obtained by applying moderate pressure to the backs of pesticide quality, cyclohexane moistened Whatman No. 50 smear tabs and wiping an area of approximately 100 square centimeters. A fresh, disposable polyvinyl chloride glove was worn for each wipe sample to prevent cross contamination of the samples. After wiping the surface, the smear tab was folded face-inward, then folded inward once more, and then sealed in a 30-ml glass vial with a polyethylene-lined screw cap. The samples were extracted with toluene and analyzed using a gas chromatograph equipped with an election capture detector according to NIOSH Method P&CAM 244.[1] The surface PCB concentrations are expressed in micrograms of PCB per 100 square centimeters ($ug/100\ cm^2$).

B. Medical

The medical evaluation consisted of an interviewer-administered questionnaire designed to obtain information regarding the prevalence of symptoms associated with exposure to PCBs and 1,1,1-trichloroethane. Demographic data, information on smoking history, alcohol consumption and work history also were obtained. The questionnaire was administered to the electricians and a comparison group of workers from HVM's administration office. Blood samples were obtained for measurement of serum PCB's and liver enzymes (gamma glutamyl transpetidase - GGT, alamine aminotransferase - ALT, and aspartate amino transferase - AST).

V. EVALUATION 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.

A. Polychlorinated Biphenyls

Data obtained from animal experimentation suggest that the acute toxicity of PCBs is low.[2] Animal toxicity studies have, however, shown that PCBs may decrease immunity and increase susceptibility to infection, are carcinogenic in rodents, and impair fertilization in female rodents and rhesus monkeys.[2-4]

PCBs have been demonstrated to have the following toxic effects in humans:[2,5]

1. Chloracne: a persistent skin eruption, similar to acne but more severe and with different distribution.

2. Eye, nose, and throat irritation

3. Swelling of the miebomian glands in the upper eyelid

4. Gastrointestinal disturbances

5. Skin rashes, thickening, and hyperpigmentation

6. Mild liver toxicity, which may be manifested as fatigue, abdominal pain, nausea, vomiting, loss of appetite, jaundice, and edema

7. Abnormalities in offspring of women heavily exposed (by ingestion of contaminated cooking oil)

8. A variety of other symptoms, including weakness, headaches, cough, numbness and pain in extremities, swelling and pain in joints

While mixtures of PCBs tested in mice and rats have consistently been shown to induce liver tumors, no study has been performed which adequately addresses the question of carcinogenicity of PCBs in humans. Materials which have been demonstrated to cause cancer in animals should, however, be treated as potential human carcinogens, and it would be judicious to limit exposure to those materials to the minimum level possible.

Dietary PCB exposure, the major source of population exposure, occurs especially through eating fish, but PCB residues are also found in milk, eggs, cheese, and meat. It has been estimated that the average daily dietary intake of PCBs does not exceed 10 micrograms.[5] Although there are no widely accepted normal values for serum PCB concentrations, levels can be compared to published values both for occupationally exposed groups and community groups without any known unusual exposure. Previously published studies have demonstrated that PCBs can be found in the serum of most non-occupationally exposed persons. Such studies have reported serum PCB values ranging from 0 to 42 parts per billion (ppb), with mean concentrations ranging from 2.1 to 24.4 ppb.[6] In the largest study involving 616 individuals, the range of serum PCB was 0-29 ppb.[7] Based on these findings in a group without unusual exposure to PCBs, a reasonable acceptable upper limit value for serum PCB would appear to be around 30 ppb.

Higher PCB serum levels have been found among occupationally exposed groups. A study measuring PCB serum levels in populations with and without occupational exposure in Bloomington, Indiana found the following levels:[8]

	Mean serum PCB (ppb)
Sludge workers	17.4
Workers with occupational exposure	75.1
Workers' families	33.6
Community controls	24.4

No chloracne or PCB-related systemic symptoms were found in that study.

More recently, Maroni et al. reported results of PCB measurements done on whole blood of 80 electrical workers exposed for many years to PCB mixtures in a plant in Italy.[9] They reported that mean PCB recovery from serum is approximately 60% of the recovery from whole blood. Their results were as follows:

	ppb (Mean - SD)	Range
60 currently exposed workers	377±258	88-1319
17 past exposed workers	292±161	94-631
3 workers without occupation exposure	110±31	88-146

NIOSH recommends that occupational exposure to PCBs be limited to 1 ug/m^3 as a time-weighted average, for up to a 10-hour workday.[10] The current Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL) for chloroinated biphenyls are 1,000 ug/m^3 for 42% chlorine mixture and 500 ug/m^3 for 52% chlorine mixtures, as 8-hour time-weighted averages. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) for chlorinated biphenyls is the same as the OSHA PEL.

Although laboratory experiments [11] and industrial studies [12] have documented cutaneous absorption of PCBs, there is no established health criterion for exposure to PCBs on surfaces. Data collected in non-manufacturing buildings in urban areas suggest an upper limit background PCB surface concentration of 0.5 ug/100 cm^2 (range <0.01 to 0.5, mean 0.09, S.D.+ 0.08).[13] In view of NIOSH's usual carcinogen policy towards known or suspected carcinogen, i.e., that "safe" or "threshold" levels for carcinogens cannot be established given the present state of scientific knowledge, and since NIOSH believes that PCBs are potential carcinogens,[10] we are not suggesting or establishing 0.5 ug/100 cm^2 as a "safe" level of exposure for PCBs on surfaces, but are merely suggesting that 0.5 ug/100 cm^2 may be upper limit background and therefore might be used as an upper limit quideline for determining if surfaces are unacceptably "contaminated".

B. Trichlorobenzene

Trichlorobenzene is irritating to the eyes, mucous membranes of the upper respiratory tract, and the skin. Prolonged or repeated contact with liquid chlorinated benzenes may cause skin burns. Skin exposure to trichlorobenzene can cause irritation but does not cause chloracne or acne-like dermatitis. Animals exposed to non-lethal doses of trichlorobenzene develop pathological changes in the kidney, brain and mucous membranes.[14] The ACGIH TLV (1982) for trichlorobenzene is 40 mg/m^3 8-hour TWA. There is neither an OSHA PEL or a NIOSH recommended criterion for trichlorobenzene.

C. 1,1,1-Trichloroethane

Acute exposure to 1,1,1-trichloroethane is known to cause drowsiness, dizziness, weakness, and loss of coordination.[15] Eye irritation has been reported to occur in controlled human exposures to 3000 mg/m^3. NIOSH recommends that exposures be limited to a ceiling of 1900 mg/m^3 averaged over a 15-minute period.[15] The ACGIH recommends a Short-Term-Exposure-Limit of 2,450 mg/m^3 averaged over a 15-minute period. The OSHA PEL is 1900 mg/m^3 expressed as a 8-hour TWA.

VI. RESULTS

A. Environmental

Table I presents the exposure concentrations to airborne PCBs and chlorinated benzenes by two test technicians involved in transferring approximately 550-gallons of askarel via a pneumatic pump from one storage container to another. The procedure was performed to simulate the exposure situation that may exist during the transfer of the askarel from 55-gallon storage drums to a tanker truck for ultimate disposal at a hazardous waste facility. The assimilated askarel transfer represented approximately 20% (550-gallons) of the maximum volume (3100-gallons) that would be pumped to a tanker truck. The personal breathing zone concentration of PCBs (Cl_2-Cl_7 homologs) measured for the actual exposure period (2.1 hours) ranged from 32.4 to 81.3 ug/m^3 (8.5 to 21.3 ug/m^3 8-hour TWA). Both light (Cl_2-Cl_4) and heavy (Cl_5-Cl_7) PCB homologs were present. The heavy homologs appeared to be Aroclor 1260.

The corresponding trichlorobenzene exposures by these workers ranged from 184.7 to 592.7 ug/m^3 (48.5 to 155.6 ug/m^3 8-hour TWA). The tetrachlorobenzene exposures ranged from 127.6 to 510.7 ug/m^3 (33.5 to 134.1 ug/m^3 8-hour TWA). The trichlorobenzenes were represented by the 1,2,4- and 1,2,3-isomers and the tetrachlorobenzenes by 1,2,4,5- and either 1,2,3,4- or 1,2,3,5-isomers. The ACGIH TLV for trichlorobenzene is 40000 ug/m^3 8-hour TWA; there is no criterion for tetrachlorobenzenes.

Table II presents the PCB (reported as Aroclor 1260) analyses for the wipe samples obtained on various work surfaces and personal protective equipment in the warehouse and HVM maintenance shop. The surface contamination levels in the lunch areas ranged from 3 to 200 ug/100 cm^2 (mean 67; S.D.$\pm$82). This included a

concentration ranging from 3 to 16 ug/100 cm^2 on the top surface of the lunch tables; 4 to 94 ug/100 cm^2 on the top surface of the refrigerators; 120 to 220 ug/100 cm^2 on the floor of the lunch area. Concentrations from surfaces (desk, window sill) in the secretarial area for the warehouse ranged from 2 to 6 ug/100 cm^2. Concentrations from the exterior surface of respirators ranged from 1 to 200 ug/100 cm^2 (mean 55.5; S.D.+96.4). The storage shelf located in the lunch area of the warehouse where three of the four respirators tested were stored showed a surface contamination level of 21 ug/100 cm^2. Data collected by NIOSH suggest that background levels of PCBs on surfaces range from <0.01 to 0.5 ug/100 cm^2.[13] The surface contamination levels measured clearly exceed background surface levels.

Table III presents the airborne concentrations of 1,1,1-trichloroethane measured in the breathing zone of electricians during three routinely performed cleanup activities. First, a concentration of 3519 mg/m^3 (2110 mg/m^3 15-minute TWA) was measured during washing of askarel-contaminated pump valves in a 2-gallon container. Second, a concentration of 3046 mg/m^3 (816 mg/m^3 15-minute TWA) was measured during wiping of the shop floor, where several drums containing askarel had leaked. Third, a concentration of 908 mg/m^3 (609 mg/m^3 15-minute TWA) was measured during washing of an askarel pumping hose. The workers performing the first two work activities reported eye irritation.

B. Medical

1. Questionnaire

A total of 21 employees participated in the study. Of these, 16 were electrical transformer maintenance workers and five were employed in the business office. These five workers did not directly work with PCBs and therefore served as a comparison group. The mean age among maintenance workers was 31 years, and among controls, 30 years. The mean length of employment was 3.7 years among maintenance workers and 3.4 years among controls. All maintenance workers were males; three of the five controls were males.

At the time of the investigation, all of the 16 maintenance workers reported experiencing at least one of the following symptoms over the past year: burning of skin (resulting from contact with transformer fluids or from exposure to "vapors/mists"), swelling of the eyes, eye discharge, loss of

appetite, weight loss, nausea and/or vomiting, fatigue or dizziness (Table IV). Nine (56%) of the 16 workers interviewed reported two or three of the above symptoms; five (31%) workers reported four or more. Among the five unexposed workers interviewed, three (60%) reported one symptom, and two reported none of these symptoms.

The most frequently reported symptom among the exposed workers was "burning of the eyes when exposed to the vapors/mists", which was reported by 15 (94%) of the 16 transformer workers. Burning of the skin and skin rash was reported by nine (56%) and eight (50%) of workers respectively. Eye and skin irritation has been previously reported to be associated with human exposure to PCBs and PCB-fluid components and to chlorinated benzenes.[14,18]

Five of the transformer maintenance workers exhibited some type of skin problem at the time of the interview. Three of these had a eczematous rash (maculo-papular) on their forearms. One of these three had a similar rash on his abdomen. One of these workers reported consulting a dermatologist regarding "six sebaceous cysts which required excision". The dermatologist was contacted by NIOSH and responded that his client "may have had an acute eczematous eruption on his hands from PCBs." He made no mention of sebaceous cysts at the time of the NIOSH evaluation, no HVM employee exhibited the characteristic skin lesions of chloracne (straw-colored non-inflammatory cysts).

2. Serum PCB Levels

The blood PCB levels for 20 of 21 workers tested are summarized below:

	No. of Workers	Mean	Range	+.S.D.
Exposed Workers	16	58 ppb	25-127 ppb	30.7 ppb
Unexposed Workers	4*	15 ppb	6-28 ppb	9.9 ppb

*One person who reported prior occupational exposure to PCBs was excluded from the analysis.

The serum PCB levels correctly identify those workers exposed and unexposed to PCBs. The mean blood PCB level for the exposed workers (58 ppb) was approximately twice the level (30 ppb) considered to represent upper limit background in non-occupationally exposed persons and almost four times the mean level of the unexposed workers in this study. The significance of these blood PCB concentrations with respect to chronic health effects is not known, since a safe level of body accumulation has not been determined. The blood PCB levels of these workers are comparable to the levels seen in other studies of transformer maintenance and repair workers.[16]

The relationship between blood PCB level and length of employment was evaluated by means of a ranked correlation coefficient. Although there appeared to be a trend between PCB levels and length of employment, the correlation was not statistically significant (r_s=.405, P>.05).

3. Serum Enzyme Levels

The analysis for liver enzyme levels: gamma glutamyl transpeptidase (GGT), alanine amino transferase (ALT), and aspartate amino transferase (AST), showed 6 workers with elevated ALT and/or GGT levels, two with elevated ALT and five with elevated GGT.

The six employees with elevated liver enzyme levels had a mean PCB level of 59 ppb as compared with a mean of 54 ppb for exposed workers with normal liver enzyme levels.

The liver enzyme levels were evaluated in relation to blood PCB levels by the use of the Spearman's Correlation Coefficient. A non-significant correlation was found between all three parameters (GGT, ALT and AST) of liver function and PCB levels. Rs values ranged from .19 to .387, p>.05.

VII. CONCLUSIONS

Workers involved in various cleanup activities in the warehouse were exposed to airborne concentrations of 1,1,1-trichloroethane exceeding the NIOSH recommended standard with resultant symptoms of eye irritation. Airborne PCB concentrations measured during exposure conditions approximating actual transfer operations indicate that significant exposures to PCBs may occur during the pumping of askarels from 55-gallon containers to a tanker truck for ultimate disposal at a

hazardous waste facility. Surface wipe testing showed significant PCB contamination (1 to 220 ug/100 cm^2) in eating and office areas and on personal protective equipment, thus demonstrating the potential for appreciable exposure to PCBs by skin contact and ingestion.[9,17] In addition, these data demonstrate that PCB contamination has spread beyond the immediate PCB handling/work areas where unprotected workers and non-workers could be unknowingly exposed to PCBs.

Ninety-four percent (15/16) of the exposed workers reported experiencing burning eyes, and 56% (9/16) and 50% (8/16) reported burning skin and skin rash, respectively, from exposure to transformer fluids and/or vapors/mists. These symptoms have been associated with both the PCB and chlorinated benzenes contained in the fluids.[14,18,19] The mean concentration of PCB in blood of exposed workers (58 ppb) was significantly different than that of unexposed workers (15 ppb) and was approximately twice the level considered to represent upper limit background in persons not occupationally exposed. Although a trend was indicated between PCB levels and length of employment, there was no statistically significant correlation (r_s=.405, p>.05). Six workers had one or more elevated liver enzyme levels, but their mean PCB level was only slightly higher than that of exposed workers with normal liver enzymes (59 vs 54 ppb). The significance of these blood PCB concentrations with respect to chronic or future health effects is not known.

VIII. RECOMMENDATIONS

1. The surface contamination data demonstrates that a significant potential exists for exposure to PCBs by dermal and gastrointestinal routes of entry. All contaminated surfaces should be decontaminated with the emphasis first directed at cleaning the eating areas. Commercially available non-ionic and alkaline synthetic detergents have been used to effectively decontaminate most surfaces.

2. A respiratory protection program should be established according to OSHA standard 29 CFR 1910.134. (A copy of the "OSHA Standard Method for Determination of Respiratory Protection Program Acceptability" accompanied the January 1982 Interim Report.) Immediate attention should be directed at the cleaning (1910.134(b)(5)and(f)(3)) and storage (1910.134(b)(6)and(f)(5)(i-iii)) requirements of the Standard.

3. An alternate decontaminating fluid should be used by warehouse personnel to cleanup PCB spills and for cleaning PCB-contaminated tools and equipment. Alternate fluids include deodorized kerosenes and the synthetic detergents mentioned above.

4. Air sampling should be conducted to evaluate exposures to PCBs during pumping of askarels from 55-gallon storage drums to the tanker truck. Unless these airborne exposures are found to be sufficiently low, the workers should wear a NIOSH-approved full-face respirator with organic vapor cartridge and high efficiency pre-filter.

5. Personal hygiene (e.g. hand washing, changing clothes, etc.), routine clean-up of work areas, and contamination control should be stressed for employees working with PCBs and other hazardous substances.

6. Employee education about the importance of personal hygiene when eating and smoking should be stressed. Employees should be instructed not to eat, drink or smoke at the work sites in order to avoid ingestion of PCBs.

7. Pre-employment and yearly medical examinations should be provided for all workers exposed to PCBs. The exams should include a comprehensive medical and work history with special emphasis on hepatic (liver) function and skin condition.

8. Workers should be encouraged to report all persisting skin conditions to a physician.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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

1. Vice President, High Voltage Maintenance Corporation
2. Chairman, Safety Committee, Local Union 673, International Brotherhood of Electrical Workers.
3. International Vice President, 4th District, International Brotherhood of Electrical Workers.
4. NIOSH, Region IV
5. OSHA, Region IV

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 I

Personal Breathing Zone Concentrations of PCBs and Chlorinated Benzenes

HIGH VOLTAGE MAINTENANCE CORPORATION
MENTOR, OHIO
HETA 81-415
November 3, 1981

Sample Description	Sample Duration (Hours)	PCB Homologs % of Total PCB Cl_2-Cl_4	PCB Homologs % of Total PCB Cl_5-Cl_7	Airborne Concentration - ug/m^3 PCBs Cl_2-Cl_7	Airborne Concentration - ug/m^3 Total Chlorobenzenes Trichloro-	Airborne Concentration - ug/m^3 Total Chlorobenzenes Tetrachloro-
Test Technician 1: Transfer of askarel via pneumatic pump from one 55-gallon drum to another - receiving end.	2.1	25	75	81.2(21.2)*	592.7(155.6)	510.7(134.1)
Test Technician 2: Transfer of askarel via pneumatic pump from one 55-gallon drum to another - pumping end.	2.1	67	37	32.4(8.5)	184.7(48.5)	127.6(33.5)
8-hour TWA Exposure Criteria				1[a]	40000[b]	None

* Denotes the calculated 8-hour Time-Weighted Average (TWA).
[a] NIOSH recommended permissible exposure limit.
[b] ACGIH Threshold Limit Value. Neither NIOSH or OSHA have exposure criteria.

TABLE II

Surface (Wipe) Concentrations of PCBs*

HIGH VOLTAGE MAINTENANCE CORPORATION
MENTOR, OHIO
HETA 81-415
November 3, 1981

Sample Location	Micrograms of PCB per 100 Square Centimeters Surface Area
Personal Protective Equipment	
Warehouse: Exterior surface of full-face cartridge respirator	10
Warehouse: Exterior surface of half-face cartridge respirator	1
Warehouse: Exterior surface of half-face cartridge respirator	11
Warehouse: Storage shelf where the above three respirators were stored	21
Maintenance Shop: Exterior surface of air-line supplied respirator	200
Eating Areas	
Warehouse: Top surface of lunch table - left quadrant	16
Warehouse: Top surface of lunch table - right quadrant	13
Warehouse: Top surface of refrigerator - center	93
Warehouse: Floor	120
Warehouse: Floor	220
Maintenance Shop: Top surface of lunch table - center	3
Maintenance Shop: Top surface of refrigerator - center	4
Office Areas:	
Warehouse: Top surface of secretary's desk	6
Warehouse: Top surface of window sill	2
Warehouse: Floor	77

*Reported as Aroclor 1260; Aroclors 1016, 1242, 1248, or 1254 were not present (detection limit of 0.05 ug/sample).

TABLE III

Personal Breathing Zone Exposures to 1,1,1-Trichloroethane

HIGH VOLTAGE MAINTENANCE CORPORATION
MENTOR, OHIO
HETA 81-415
November 3, 1981

Sample Description	Length of Sample Minutes	Air Concentration - mg/m3	
		Actual*	15-Minute TWA
Electrician: washing askarel pump valves	9	3519	2110
Electrician: wiping askarel from floor	4	3046	816
Electrician: washing	11	908	669
NIOSH Criterion			1900

*Concentration measured during actual exposure period.

TABLE IV

Symptoms Reported by Electricians

HIGH VOLTAGE MAINTENANCE CORPORATION
MENTOR, OHIO
HETA 81-415
October 19-20, 1981

	Number and (%) of the 16 respondents
Burning of eyes	15 (94%)
Burning of skin	9 (56%)
Skin rash	8 (50%)
Dizziness	7 (44%)
Acne	5 (31%)
Nausea/Vomiting	4 (25%)
Eye Discharge	2 (13%)
Decreased Appetite	2 (13%)
Stomach ache	1 (13%)
Headaches	2 (13%)
Darkening of Skin	1 (6%)
Swelling of Eyelids	1 (6%)