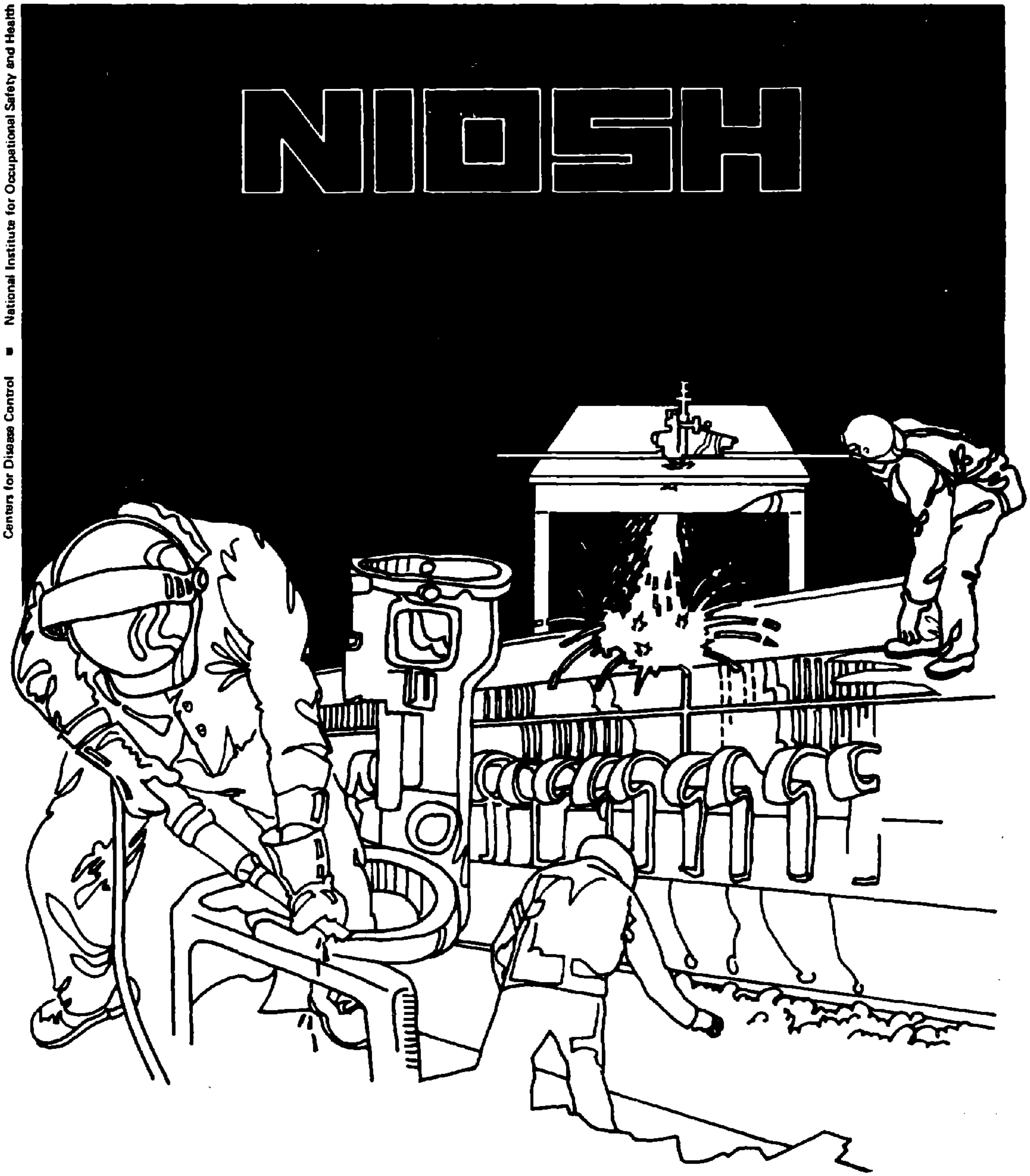
PB90129008

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 88-328-1961
UNITED STATES ARMY
CORPS OF ENGINEERS
ARLINGTON, VIRGINIA

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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	3. Recipient's Accession No. PB90 129008/AS

4. Title and Subtitle Health Hazard Evaluation Report No. HETA-88-328-1961, United States Army Corps of Engineers, Arlington, Virginia

5. Report Date 89/05/00

6.

7. Author(s) Fleeger, A. K.

8. Performing Organization Rept. No. HETA-88-328-1961

9. Performing Organization Name and Address Hazard Evaluation and Technical Assistance Branch, NIOSH, U.S. Department of Health and Human Services, Cincinnati, Ohio

10. Project/Task/Work Unit No.

11. Contract (C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words) In response to a request for technical assistance from the U.S. Army Corp of Engineers (SIC-9999), Arlington, Virginia, a study was made of possible hazardous working conditions at Fort Myer, Fort McNair, and Cameron Station, located in the Washington, D.C. area. These three sites each had polychlorinated-biphenyl (1336363) (PCB) containing transformers. Maintenance workers visually inspected these transformers for leakage and manually felt around the gauges and valves for leaking oil. The employees did not repair the leaks, only report then to the supervisor. No detectable PCBs were noted in seven personal breathing zone samples. Area air samples for PCBs ranged in concentration from not detectable to 4.8 micrograms/cubic meter (microg/m3). Surface wipe samples ranged from not detectable to heavy contamination levels. Many of the transformers were leaking material suspected as containing PCBs. The author concludes that although breathing zone samples did not contain detectable concentrations of PCB, there was a potential for exposure to PCB contaminated surfaces. The author recommends that areas having heavy PCB surface contamination be cleaned up, that employees responsible for conducting clean up procedures wear appropriate personal protective clothing, that additional surface samples be taken following clean up to determine the effectiveness of the procedure, and that employees conduct quarterly inspections of the transformer vaults wearing protective gloves during the checking for leaks.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms NIOSH-Publication, NIOSH-Author, NIOSH-Health-Hazard-Evaluation, NIOSH-Technical-Assistance-Report, HETA-88-328-1961, Region-3, Hazard-Confirmed, Electrical-equipment, Chlorinated-hydrocarbons, Maintenance-workers

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages 17
	22. Security Class (This Page)	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse* OPTIONAL FORM 272(4-77) (Formerly NTIS-35) Department of Commerce

HETA 88-328-1961
MAY 1989
UNITED STATES ARMY CORPS OF ENGINEERS
ARLINGTON, VIRGINIA

NIOSH INVESTIGATORS:
Alan K. Fleeger, M.S.P.H.
James M. Boiano, M.S.

I. SUMMARY

On July 26, 1988, the National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance from the United States Army Corps of Engineers, Arlington, Virginia. The Corps was concerned about the potential health risk to workers exposed to polychlorinated biphenyl (PCB)-contaminated transformers at three Department of Army installations; Fort Myers, Fort McNair, and Cameron Station all in the Washington D.C. area.

An initial environmental evaluation was conducted in October 1988. During the evaluation, one day was spent at each of the three facilities. Air monitoring and surface sampling for PCB contamination was conducted at each facility.

Seven personal breathing zone samples collected for PCB exposures were all non-detected. The NIOSH criterion for personal exposure to PCBs, listed in the 1986 Current Intelligence Bulletin, is less than 1.0 micrograms per cubic meter (ug/m^3) of air, suggested as a lowest feasible limit. Area air samples for PCBs ranged in concentration from non-detected to 4.8 ug/m^3. The highest area sample was collected on the top of a transformer at the Fort Myer Station, located in building 406.

Surface concentrations of PCBs ranged from non-detected to heavy contamination. The surface sample results are reported generically due to analytical difficulties during analysis that may have resulted in a positive bias of some samples. Thirty four of the 42 samples collected were at or below background levels. The highest PCB contamination was collected below the switch of a transformer at the Cameron Station, located in Building 1. Many of the transformers were leaking material suspected as being PCB-containing. NIOSH investigators have recommended that PCB contamination not exceed 100 ug/m^2 (the lowest level feasible considering background contamination) for surfaces in the occupational environment that may be routinely contacted by unprotected skin.

Personal breathing zone samples were all non-detected, however there was a potential for exposure by contact with PCB-contaminated surfaces. This potential hazard can be eliminated via appropriate decontamination procedures. Recommendations are contained in section VII of this report.

KEYWORDS: SIC 9999 (nonclassifiable establishments, electrical transformer decontamination), polychlorinated biphenyls (PCBs),

II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request for technical assistance on July 26, 1988, from the U.S. Army Corp of Engineers, Arlington, Virginia. The Corps was concerned about the potential health risk associated with workers' exposures to polychlorinated biphenyls (PCBs) during the quarterly inspection of the transformers. The Corps identified three Department of Army installations; Fort Myer, Fort McNair, and Cameron Station all in the Washington D.C. area.

An environmental evaluation was conducted on October 17-21, 1988. During the evaluation, which involved one day at each of the three installations air samples and surface wipe samples were collected to determine the level of PCB contamination.

III. BACKGROUND

The department of the Army has five installations in the Military District of Washington D.C. Three of the five installations were identified by the U.S. Corps of Engineers, Operations and Maintenance Division, as having PCB-containing transformers. Fort Myer, Fort McNair, and Cameron Station were the installations identified. Fort Myer is noted for the "Old Guard" which is the infantry that supports the President of the United States. Fort McNair is noted for the "War College" which is responsible for training military officers. Cameron Station is where many administrative and support service operations are located.

Several transformer vaults are located at each of the three installations. A survey to identify the PCB-containing vaults was conducted for the Corps by an independent consulting firm. Bulk samples were collected from each of the transformers and upon laboratory identification, a formal report was issued to the Corps. The data provided by the consulting firm was used by NIOSH to assist in establishing a sampling protocol.

Maintenance employees are responsible for inspecting each of the transformers on a quarterly basis for leaks. The employees visually inspect the transformers for leakage and manually feel around the gauges and valves for leaking oil. Upon detection of a leaking transformer, they are instructed to immediately report the condition to the supervisor. The employees are not required to repair the leaks.

IV. EVALUATION DESIGN AND METHODS

The environmental evaluations consisted of determining potential inhalation exposures to PCBs by collecting full-shift personal breathing zone and general area air samples. Personal breathing zone samples were collected on the maintenance employees during their quarterly inspection of the transformer vaults. Area samples were collected in each of the vaults that were identified by the Corps as containing PCB oils. Also, to determine the potential for dermal exposure to PCBs, a number of wipe samples were obtained from various working surfaces and tools during the evaluation in the same areas as the air samples.

Air samples, general area and personal breathing zone, were collected by drawing air through 150 mg florisil tubes attached to battery-operated sampling pumps at a pre-calibrated flow rate of one liter per minute for the duration of the shift. For analysis, the florisil tubes were separated into their primary and backup sections. Each section, along with the glass wool plug which precedes the front section, was desorbed in one milliliter (ml) of hexane with sonication for one hour. The gas chromatographic analysis was performed on a Hewlett-Packard Model 5890 gas chromatograph equipped with an electron capture detector and accessories for capillary column capabilities. A 30-meter fused silica megabore column coated internally with DB-5 was used with temperature programming from 190°C (held for two minutes) to 230°C at a rate of 5°C/minute. Five percent methane in argon was used as the carrier gas. The injector was operated in the splitless mode. The presence of an Aroclor was determined by comparison with standard samples of Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260 obtained from the EPA. Quantitation was performed by summing the peak heights of the five major peaks of the standards and comparing those sums to those of the same peaks on the sample.

A wet-wipe protocol was used to assess the surface concentrations of PCBs. The surface wipe samples were collected using 3" x 3" Soxhlet extracted cotton gauze pads which had been wetted with 8 ml of pesticide grade hexane. The sampling procedure consisted of marking the boundaries of a 0.25 m^2 area (unless otherwise noted) on the desired surface and wiping this area with the gauze pad. The sample pad was held with a gloved hand; a fresh non-linear polyethylene, unplasticized glove was used for each sample. The surface was wiped in two directions (the second direction was at a 90° angle to the first direction). Each gauze pad was used to wipe only one area. The gauze pad sample was then placed in glass sample container equipped with a Teflon-lined lid.

The gauze samples were prepared for analysis by extraction in 40 ml of hexane with shaking for 30 minutes. The hexane was transferred to a concentrator tube, and the gauze was rinsed twice with 10 ml of hexane. The concentrated hexane eluent was cleaned on a florisil column, and the sample was brought to a final volume of 3 ml. Analysis was preformed on a Hewlett-Packard Model 5730A GC equipped with an electron capture detector. A 25m x 0.31mm fused silica WCOT capillary column, coated internally with DB-5, was used with a temperature range from 210°C (held for two minutes) to 310°C at at rate of 8°C per minute. The presence of an Aroclor was determined using the same procedure as described above.

V. EVALUATION CRITERIA

A. PCB Toxicology

PCBs are chlorinated aromatic hydrocarbons that were manufactured in the United States from 1929 to 1977 and primarily marketed under the trade name Aroclor.[1] They found wide use because they are heat stable; resistant to chemical oxidation, acids, bases and other chemical agents; stable to oxidation and hydrolysis in industrial use; and have low solubility in water, low flammability, and favorable dielectric properties. Additionally, they have low vapor pressure at ambient temperatures and viscosity-temperature relationships that were suitable for a wide variety of industrial applications. PCBs have been used commercially in insulating fluids for electrical equipment, hydraulic fluids, heat transfer fluids, lubricants, plasticizers, and components of surface coatings and inks.[2]

The different PCB mixtures marketed under different trade names are often characterized by a four-digit number. The first two digits denote the type of compound ("12" indicating biphenyl), and the latter two digits giving the weight percentage of chlorine, with the exception of Aroclor 1016. In other commercial preparations the number code may indicate the approximate mean number of chlorine atoms per PCB molecule (Phenoclor, Clophen, Kanechlor) or the weight percentage of chlorine (Fenclor).

Dietary PCB ingestion, the major source of population exposure, occurs especially through eating fish, but PCB residues are also found in milk, eggs, cheese, and meat. PCB residues are detectable in various tissues of persons without known occupational exposure to PCBs. Mean whole blood PCB levels range from 1.1 to 8.3 parts per billion (ppb), while mean serum PCB levels range from 2.1 to 24.2 ppb for persons without known occupational exposure.[3] Mean serum PCB levels among workers in one capacitor manufacturing plant studied by NIOSH ranged from 111 to 546 ppb, or approximately 5 to 22 times the background level in the community. Mean serum PCB levels among workers in transformer maintenance and repair typically range from 12 to 51 ppb, considerably lower than among workers at capacitor manufacturing plants.[4]

PCB toxicity is complicated by the presence of highly toxic impurities, especially the polychlorinated dibenzofurans (PCDFs)[5], which vary in amount depending on the manufacturer,[6] and percent chlorination,[7] and which are found in increased concentrations when PCBs undergo incomplete pyrolysis.[8,9] Also, different animal species, including man, vary in their pattern of biologic response to PCB exposure.[10]

Two human epidemics of chloracne, "Yusho" and "Yu-cheng," resulted from ingestion of cooking oil accidentally contaminated by a PCB heat-exchange fluid used in the oil's pasteurization.[11,12] Although PCBs were initially regarded as the etiologic agent in the Yusho study, analyses of the offending cooking oil demonstrated high levels of PCDFs and polychlorinated quarterphenyls, as well as other unidentified chlorinated hydrocarbons, in addition to PCBs.[13]

The results of individual studies of PCB-exposed workers are remarkably consistent. Among the cross-sectional studies of the occupationally exposed, a lack of clinically apparent illness in situations with high PCB exposure seems to be the rule. Chloracne was observed in recent studies of workers in Italy,[14] but not among workers in Australia,[15] Finland,[16] or the United States.[4,17-19] Weak positive correlations between PCB exposure, or serum PCB levels, and SGOT [14,16-18], GGTP[4,14,18,19], and plasma triglycerides have been reported.[4,20,21] Correlations between plasma triglycerides[22] and GGTP[23] have also been found among community residents with low level PCB exposures. Causality has not been imputed to PCBs in these cross-sectional studies.

The International Agency for Research on Cancer has concluded that the evidence for PCB carcinogenicity in animals and humans is limited. "Certain polychlorinated biphenyls are carcinogenic to mice and rats after their oral administration, producing benign and malignant liver neoplasms. Oral administration of polychlorinated biphenyls increased the incidence of liver neoplasms in rats previously exposed to N-nitrosodiethylamine."[24]

In a mortality study among workers at two capacitor manufacturing plants in the United States[25] a greater than expected number of observed deaths from cancer of the liver and cancer of the rectum were noted. Neither increase was statistically significant for both study sites combined. In a recent update of this study[26], however, with follow-up through 1982, an excess in liver/biliary tract cancer was statistically significant (5 observed vs. 1.9 expected). The excess in cancer of the rectum was still elevated but was not statistically significant. In this mortality study, the personal time-weighted average exposures in 1976 ranged from 24 to 393 ug/m^3 at one plant, and from 170 to 1260 ug/m^3 at the other. During the time period (1940-1976) when most of the workers were exposed, the levels were probably substantially higher. At one of the plants, the geometric mean serum PCB levels in 1976 were 1470 ppb for 42% chlorinated biphenyls and 84 ppb for 54% cholorinated biphenyls.

In a mortality study among workers at a capacitor manufacturing plant in Italy,[27] males had a statistically significant increase in the number of deaths from all neoplasms. When these were analyzed separately by organ system, death from neoplasms of the digestive organs and peritoneum (3 observed vs. 0.88 expected) and from lymphatic and hematopoietic tissues (2 observed vs. 0.46 expected) were elevated. This study was recently expanded to include vital status follow-up through 1982 for all workers with one week or more of employment.[28] In the updated results, there was a statistically significant excess in cancer among both females (12 observed vs. 5.3 expected) and males (14 observed vs. 7.6 expected). In both groups there were statistically non-significant excesses in lymphatic/hematopoietic cancer and a statistically significant excess in digestive cancer among males (6 observed vs. 2.2 expected).

B. Environmental Evaluation Criteria

As a guide to the evaluation of the hazards posed by work place 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 work place 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 work place are: 1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor (OSHA) Permissible Exposure Limits (PELs). Often, the NIOSH recommendations and ACGIH TLVs are lower than the corresponding OSHA PELs. The NIOSH RELs and ACGIH TLVs are usually based on more recent information than are the OSHA standards. The OSHA PELs may also be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits, by contrast, are based primarily 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 those levels specified by an OSHA PEL.

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.

C. PCB Evaluation Criteria

In February 1986, NIOSH reiterated its previous recommendation that exposure to PCB in the workplace not exceed 1 ug/m^3 (based upon the recommended sampling and analytical method in use at the time), determined as a TWA for up to a 10-hour workday, 40-hour workweek.[29] This recommended exposure limit was based on the findings of adverse reproductive effects in experimental animals, on the conclusion that PCBs are carcinogens in rats and mice and, therefore, potential human carcinogens in the workplace, and on the conclusion that human and animal studies have not demonstrated a level of exposure to PCBs that will not subject the worker to possible liver injury[30].

In 1971, based on the 1968 ACGIH TLVs, OSHA promulgated its permissible exposure limits of 1 mg/m^3 for airborne chlorodiphenyl products (PCB) containing 42% chlorine and 0.5 mg/m^3 for chlorodiphenyl products containing 54% chlorine, determined as 8-hr TWA concentrations (29 CFR 1910.1000). The TLVs, which have remained unchanged at 1.0 and 0.5 mg/m^3 through 1988, are based on the prevention of (non-carcinogenic) systemic toxicity.[31] The OSHA PEL and the ACGIH TLV values include a "skin" notation, which refers to the potential contribution to overall exposure by the cutaneous route, including the mucous membranes and eyes, by either airborne or direct skin contact with PCB.

NIOSH recommends that occupational exposures to carcinogens be reduced to the lowest feasible level. Results of several investigations of PCB surface contamination in office buildings indicate that there is a "background" level of surface contamination in the range of 50 to 100 micrograms per square meter (ug/m^2).[32-35] Therefore, for surfaces in the occupational environment that may be routinely contacted by the unprotected skin, NIOSH investigators have recommended that PCB contamination not exceed 100 ug/m^2 (the lowest feasible level considering background contamination).

The risk posed by this level of contamination was assessed by the Environmental Protection Agency (EPA) in its PCB spill cleanup policy.[36] In the "Development" section of the policy (Risks Posed by Leaks and Spills of PCBs), the EPA states that the estimated level of oncogenic risk associated with dermal exposures to 50 ug/m^2 of PCBs on hard, indoor, high-contact surfaces is between 1×10^{-5} and 1×10^{-6} (between 1 in 100,000 and 1 in 1,000,000 excess deaths, usually stated in terms of workers with a 30-year work history). Although the EPA document did not provide a risk estimate for the cleanup criterion it established for high-contact indoor surfaces (1000 ug/m^2), it did state, "EPA also believes that the surface standards of 10,000 ug/m^2 for low-contact outdoor surfaces and 1,000 ug/m^2 for indoor low-contact surfaces (and vaults) and high-contact surfaces in a restricted access industrial facility would not present significant risks to workers or the general population." However, since there is a considerable degree of uncertainty associated with such a risk assessment calculation, EPA also stated that, "...the results of these [EPA] studies indicate that high-contact surfaces such as manually operated machinery may require surface standards more stringent than the 1000 to 10,000 ug/m^2 standards."

VI. RESULTS

Table 1 presents personal breathing zone (PBZ) and area air samples measured at each of the three installations. All seven of the PBZ samples collected were reported as non-detected. Twelve of the fifteen area air samples were also reported as non-detected. The five area samples detecting PCB contamination ranged in concentration from a trace to 4.8 ug/m^3. The highest concentration measured was collected on top of the 750 kilovolt transformer, located in Building 406 at Fort Myers.

Table 2 presents surface contamination results collected at each of the three installations and documents areas where significant leakage was detected from transformers. The results in the table are generically presented by amount of surface contamination by one of the following four categories:

1. "Non-detected" (PCB surface levels were below the analytical Limit of Detection).

2. "Background" (PCB surface levels were present between the analytical LOD and 100 micrograms per square meter (ug/m^2).

3. "Moderate" (PCB surface levels were between 100 and 1000 ug/m^2).

4. "Heavy" (PCB surface levels were found above 1000 ug/m^2).

Of the 42 wipe samples collected, two were reported as non-detected, 32 as background, two as moderate, and six as heavily contaminated. The two highest surface concentrations were collected from transformers at Building 47 (Fort McNair) and at Building 1 (Cameron Station). Significant leakage was observed from both of these transformers, which explains the high PCB surface concentrations.

VII. DISCUSSION

The air monitoring results revealed that the employees are not exposed to an excessive concentration of airborne PCB's during their quarterly inspection. Each of the PBZ samples collected were found to be non-detected. Only three of the worst-case area samples detected concentrations above trace amounts. In addition, the employees are only required to conduct these inspections every three months, minimizing their exposure time in the vaults.

The surface samples presented in Table 2 are reported generically due to difficulties experienced during the analysis. One or more of the wipe samples submitted, contained high amounts of Aroclor 1260. These samples may have contaminated other samples during the analysis, contaminating the needles during the nitrogen blow-down of the system. Unfortunately, the possible contamination of the needles was not detected until after the analysis was completed; therefore remedial measures were not possible. Therefore some of the positive values were suspect for quantitation and the results were generically reported.

We feel reasonably confident, given the potential for positive bias of the samples, that the generically reported surface concentrations are correct. It is appropriate to assume, with a potential positive bias, that any "Non-detected" value is correct and can be reported as such. In addition, the "Background" levels (32 of the samples) can be considered as below 100 ug/m^2, given the positive bias, which may have caused the sample results to be higher than normal. Also, the reported "Moderate" levels were calculated to be just below 1000 ug/m^2, and therefore can be assumed to fall within the 100-1000 ug/m^2 range. Finally, the "Heavily" contaminated samples were all well above 1000 ug/m^2. The "Heavily" contaminated samples ranged in concentration from 2800 to 50,000,000 ug/m^2.

The surface wipe samples revealed that most of the samples are well below the EPA criteria for high contact surfaces (1000 ug/m^2). However, it was noticed that when the employees conducted the quarterly inspections, they were not wearing protective gloves when touching the transformers. This is not a recommended employee work practice, especially when considering that significant contamination was observed on some of the transformers.

VIII. CONCLUSION

NIOSH data suggests that current employee airborne exposures to PCB contamination is minimal during the quarterly inspection of the transformer vaults at the three Department of Army installations, however there is a potential for exposure through PCB-contaminated surfaces.

IX. RECOMMENDATIONS

Based upon these findings the following recommendations are made:

1. Areas demonstrated as having "Heavy" PCB surface contamination or noted as leaking, should be cleaned-up.

2. Any employee responsible for conducting clean-up procedures on the transformers should be required to wear the appropriate personal protective clothing. NIOSH recommends that the workers be supplied with chemical protective clothing and respiratory protection consisting of; a combination Type C supplied-air respirator, with full facepiece, operated in the pressure-demand mode and equipped with an auxillary positive pressure, self-contained air supply.

3. Additional surface samples should be collected by the U.S. Army Corps of Engineers, following clean-up procedures, to ensure that the PCB surface contamination is below or at background levels. The Corps of Engineers may consider hiring additional industrial hygiene support personnel to oversee these testing procedures. The Corps of Engineers presently only has one Industrial Hygienist on staff, responsible for five large U.S. Army installations, which probably is not adequate to oversee each of the clean-up operations.

4. Employees required to conduct quarterly inspections of the transformer vaults should be required to wear protective gloves when they are inspecting the transformers for leaks.

X. REFERENCES

1. Lloyd JW, Moore RM, Woolf BS, Stein HP. Polychlorinated biphenyls. J Occup Med 1976;18:109.

2. Hutzinger O, Safe S, Zitko V. The chemistry of PCBs. Cleveland: The Chemical Rubber Company Press, 1974.

3. Landrigan PJ. General population exposure to halogenated biphenyls. In: Kimbrough RD, ed. Halogenated biphenyls, terphenyls, naphthalenes, dibenzodioxins, and related products. Amsterdam: Elservier/North Holland Biomedical Press, 1980:267.

4. Smith AB, Schloemer J, Lowry LK, et al. Metabolic and health consequences of occupational exposure to polychlorinated biphenyls (PCBs). Br J Ind Med 1982;39:361.

5. Vos JG, Koeman JG. Comparative toxicologic study with polychlorinated biphenyls in chickens, with special reference to prophyris, edema formation, liver necrosis, and tissue residues. Tox App Pharm 1970;17:656.

6. Vos JG, Koeman JH, van der Mass HL, ten Noever de Brauw MC, de Vos RH. Identification and toxicological evaluation of chlorinated dibenzofuran and chlorinated naphthalene in two commercial polychlorinated biphenyls. Fd Cosmet Toxicol 1970;8:625.

7. Bowes GW, Mulvihill MJ, Simoneti BRT, Burlingame AL, Risebrough RW. Identification of chlorinated dibenzofurans in American polychlorinated biphenyls. Nature 1975;94:125.

8. Buser HR, Bosshardt HP, Rappe C. Formation of polychlorinated dibenzofurans (PCDFs) from the pyrolysis of PCBs. Chemosphere 1978;7:109

9. Buser HR, Rappe C. Formation of polychlorinated dibenzofurans (PCDFs) from the pyrolysis of individual PCB isomers. Chemosphere 1977;8:157.

10. Vos JG. Toxicology of PCBs for mammals and for birds. Env. Health Perspect 1969;21:29.

11. Kuratsune M, Yoshimura T, Matsuzaka J, Yamaguchi A. Epidemiologic study on Yusho, a poisoning caused by ingestion of rice oil contaminated with commercial brand of polychlorinated biphenyl. Environ Health Perspect 1972;1:119.

12. Wong CK. PCB poisoning special issue. Clinical Medicine (Taipei). Volume 7, no. 1, 1981.

13. Masuda Y, Duroki H. Polychlorinated dibenzofurans and related compounds in patients with "Yusho." In: Hutzinger O, Frei R W, Merian E, Pocchiari F, eds. Chlorinated dioxins and related compounds. Oxford: Pergamon Press, 1982:561.

14. Maroni M, Colombi A. Arbosti G, Cantoni S, Foa V. Occupational exposure to polychlorinated biphenyls in electrical workers, II. Health effects. Br J Ind Med 1981;38:55.

15. Ouw KH, Simpson GR, Siyali DS. The use and health effects of Aroclor 1242, a polychlorinated biphenyl in the electrical industry. Arch Environ Health 1976;31:189.

16. Karppanen E, Kolho L. The concentration of PCB in human blood and adipose tissue in three different research groups. In: PCB Conference II, Stockholm, 1972. National Swedish Environmental Protection Board, 1973: 124.

17. Fischbein A, Woolf MS, Lilis R, Thornton J, Selikoff IJ. Clinical findings among PCB-exposed capacitor manufacturing workers. Ann NY Acad Sci 1979;320:703.

18. Chase KH, Wong O, Thomas D, Berney BW, Simon RKl. Clinical and metabolic abnormalities associated with occupational exposure to polychlorinated biphenyls (PCBs). J Occup Med 1982;24:109.

19. National Institute for Occupational Safety and Health. Health hazard evaluation report no. HETA 80-007-1520. Cincinnati: National Institute for Occupational Safety and Health, 1984.

20. Lawton RW, Sack BT, Ross MR, Feingold J. Studies of employees occupationally exposed to PCBs. General Electric Research and Development Center, Schenectady, 1981.

21. Crow KD. Chloracne: a critical review including a comparison of two series of cases of acne from chloronaphthalene and pitch fumes. Trans St John's Hosp. Dermatol Soc 1970;56:79.

22. Baker EL Jr, Landrigan PJ, Glueck CJ. Metabolic consequences of exposure to polychlorinated biphenyls in sewage sludge. Am J Epid 1980;112:553.

23. Kreiss K, Zack MM, Kimbrough RD, Needhan LL, Smrek AL, Jones BT. Association of blood pressure and polychlorinated biphenyl levels. JAMA 1981;245:2505.

24. International Agency for Research on Cancer. IARC monographs on the evaluation of the carcinogenic risk of chemicals to humans. Chemicals, Industrial Process, and Industries Associated with Cancer in Humans. IARC Monographs, Volumes 1 to 29. Supplement 4, Lyon, France, 1982: 218.

25. Brown DP, Jones M. Mortality and industrial hygiene study of workers exposed to polychlorinated biphenyls. Arch Environ Health 1981;36:120.

26. Brown DP. Mortality of workers exposed to PCBs. Arch Environ Health 1987 (in press).

27. Bertazzi PA, Zocchetti C, Guercilena S, Foglia MD, Pesatori A, Riboldi L. Mortality study of male and female workers exposed to PCBs. Presented at the International Symposium on Prevention of Occupational Cancer, April, 1981, Helsinki, Finland.

28. Bertazzi PA, Riboldi L, Pesatori A, Radice L, Zocchetti C. Cancer mortality of capacitor manufacturing workers. Am J Industr Med 1987;11:165-76.

29. National Institute for Occupational Safety and Health. Current intelligence bulletin 45 -- polychlorinated biphenyls (PCB's): potential health hazards from electrical fires or failures. Cincinnati, Ohio: National Institute for Occupational Safety and Health [DHHS (NIOSH) publication no. 86-111], 1986.

30. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to polychlorinated biphenyls. Cincinnati, Ohio: National Institute for Occupational Safety and Health [DHEW publication no. (NIOSH) 77-225], 1977.

31. American Conference of Governmental Industrial Hygienists. Documentation of the threshold limit values and biological exposure indices. 5th ed. Cincinnati, Ohio: American Conference of Governmental Industrial Hygienists, 1988.

32. National Institute for Occupational Safety and Health. PCB exposures following fluorescent light ballast burnout. Applied Industrial Hygiene 1987; 3:R-24.

33. National Institute for Occupational Safety and Health. Health hazard evaluation report no. HETA 86-112-1819. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1987.

34. National Institute for Occupational Safety and Health. Health hazard evaluation report no. HETA 86-472-1832. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1987.

35. National Institute for Occupational Safety and Health. Health hazard evaluation report no. HETA 87-166-1835. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1987.

36. U. S. Environmental Protection Agency. Polychlorinated biphenyls spill cleanup policy. 40 CFR 761.120. Federal Register 52(63):10688, April 2, 1987.

XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:	Alan K. Fleeger, M.S.P.H. Industrial Hygienist Industrial Hygiene Section
Other Investigators:	Jim M. Boiano, M.S., CIH Industrial Hygienist Industrial Hygiene Section
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations, and Field Studies
Report Typed By:	Kathy Conway Secretary

XII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are temporarily available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 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. U.S. Army Coprs of Engineer
2. NIOSH, Cincinnati Region
3. OSHA, Region 5

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

Air Sampling Results for Polychlorinated Biphenyls
U.S. Army Corps of Engineers
Fort Myer, Fort McNair, and Cameron Stations
October 17-21, 1988
HETA 88-328

Sample Location	Sample Type	Sample Time (minutes)	PCB Concentration (ug/m^3)
Fort Myer			
-High Voltage Worker	Personal	422	ND
-High Voltage Worker	Personal	428	ND
-High Voltage Foreman	Personal	510	ND
-Top of Volt switch Bldg 313	Area	424	1.1
-Top of Transformer Bldg 402	Area	462	ND
-Top of Transformer Bldg 410	Area	447	Trace
-Top of Transformer Bldg 403	Area	411	ND
-Top of Transformer Bldg 406	Area	418	4.8
Fort McNair			
-Top of Transformer C Bldg 52	Area	426	ND
-Top of Transformer K War Col	Area	427	ND
-Top of Transformer H Bldg 59	Area	420	ND
-Top of Transformer E Bldg 41	Area	413	ND
-Top of Transformer D Bldg 47	Area	406	Trace
-Electrician	Personal	370	ND
-Electrician	Personal	462	ND
Cameron Station			
-Top of Transformer Bldg 5	Area	415	ND
-Top of Transformer Bldg 1	Area	429	0.8
-Top of Transformer Bldg 4	Area	414	ND
-Top of Transformer Bldg 3	Area	408	ND
-Top of transformer Bldg 8	Area	406	ND
-Electrician	Personal	415	ND
-High Voltage Worker	Personal	413	ND

*ND = Non-detected
*Trace = Analytical result between the LOD and LOQ

TABLE 2

Surface Concentrations of Polychlorinated Biphenyls
U.S. Army Corps of Engineers
Fort Myer, Fort McNair, and Cameron Stations
October 17-21, 1988
HETA 88-328

Sample Location	PCB Contamination	Leak Observed
Fort Myers		
-Transformer Name Plate Bldg 241	Background	Yes
-Electric Shop North Bench Top Bldg 312	Background	No
-Break Room Lunch Table Bldg 312	Background	No
-10 Inch Crescent Wrench	Background	No
-Screw Driver	Background	No
-High Voltage Truck Steering Wheel	Background	No
-High Voltage Truck Front Seat	Background	No
-Transformer Name Plate Bldg 313	Moderate	Yes
-Low Voltage Switch Bldg 313	Background	Yes
-Transformer Switch Gear Case Bldg 402	Background	No
-Transformer Main Panel Bldg 410	Background	Yes
-Transformer Main Switch Bldg 403	Background	No
-Transformer Main Panel Bldg 406	Background	No
Fort McNair		
-Transformer C Between Gauges	Background	No
-Transformer K Between Gauges	Background	No
-Transformer H Above Cooling Coils	Background	No
-Transformer H Circuit Breaker	Background	No
-Transformer H Switch Handle	Non-detected	No
-Transformer H Dyking Floor	Background	No
-Transformer Room Door Handle	Background	No
-Transformer K Main Panel	Moderate	Yes
-Transformer E Name Plate	Background	No
-Transformer D Between Gauges	Heavy	Yes
-Chevy Van Steering Wheel	Background	No
-Crescent Wrench	Background	No
-Channel Locks	Background	No
-Pliers	Background	No
Cameron Station		
-Transformer Main Panel Bldg 5	Heavy	No
-Transformer Main Panel Bldg 1	Heavy	Yes
-Transformer Gauges Bldg 1	Heavy	Yes
-Transformer Gauges Bldg 4	Heavy	Yes
-Transformer Name Plate Bldg 3	Background	Yes
-Transformer Switch Handle Bldg 3	Heavy	Yes
-Transformer Gauges Bldg 8	Background	No
-Transformer Switch handle Bldg 9	Background	Yes
-Pliers	Background	No
-Channel Locks	Background	No
-Screw Driver	Background	No
-Electric Shop Floor	Background	No
-Electric Shop Bench Top	Background	No
-Teco Truck Steering Wheel	Non-detected	No
-Teco Truck Drivers Seat	Background	No