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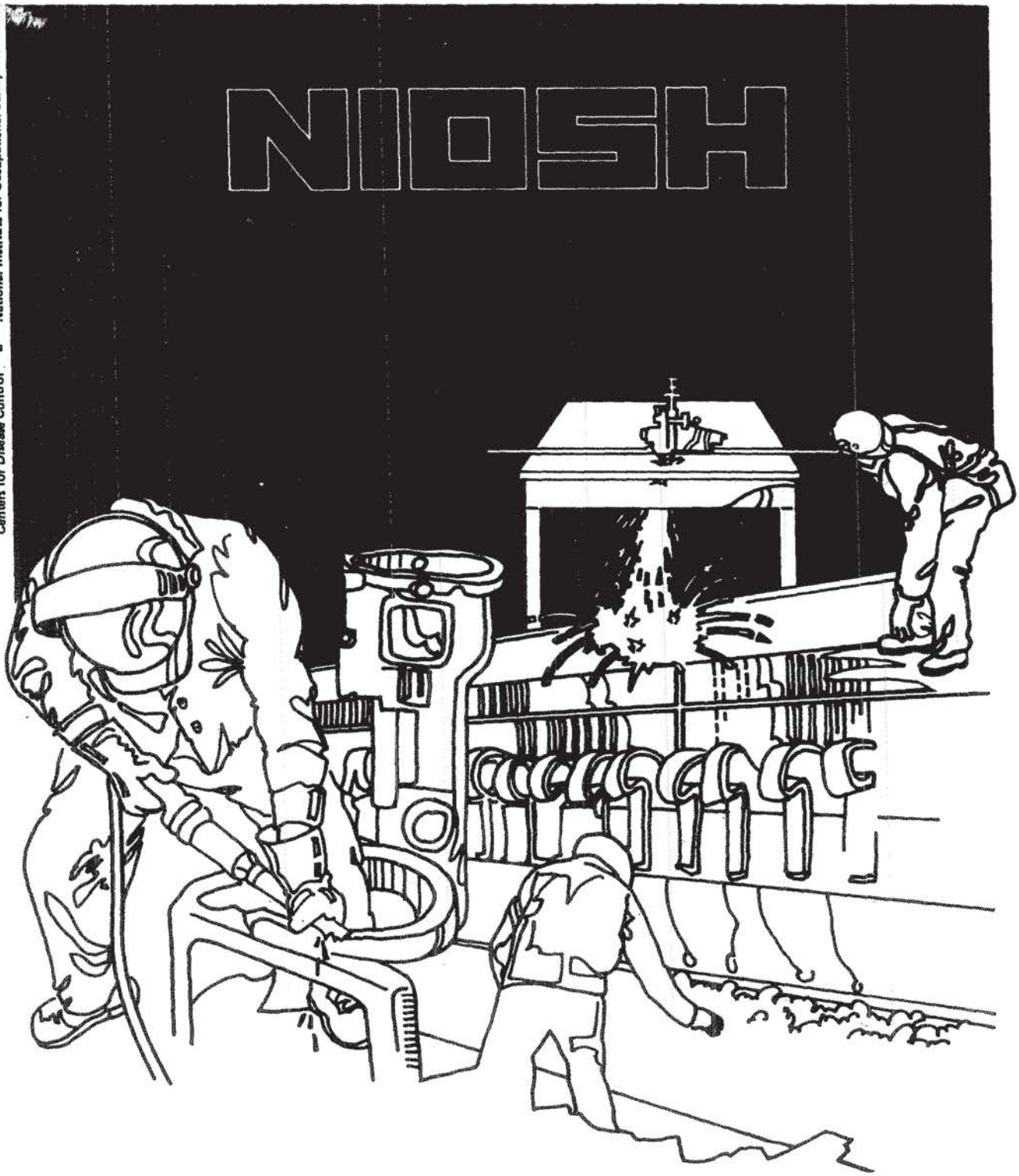

Health Hazard Evaluation Report

HETA 81-204-1160
MOWBRAY ENGINEERING COMPANY
GREENVILLE, ALABAMA

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 81-204-1160
AUGUST 1982
MOWBRAY ENGINEERING COMPANY
GREENVILLE, ALABAMA

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I. SUMMARY

On February 19, 1981, the Center for Environmental Health (CEH) of the Centers for Disease Control requested assistance from the National Institute for Occupational Safety and Health (NIOSH) to evaluate occupational exposures to polychlorinated biphenyls (PCB's) at the Mowbray Engineering Co., a transformer maintenance shop in Greenville, Alabama. The Centers had been contacted by the Environmental Protection Agency after soil levels of greater than 300 parts per million were found in a swamp adjacent to the shop and into which the shop had drained transformer oil between the mid-1950's and 1974.

On March 18 and 19, 1981, NIOSH representatives visited Mowbray Engineering. The NIOSH industrial hygienist collected nine personal and general work area samples, seven wipe samples for PCB's at various locations in the facility, and one sample for tri- and tetrachlorobenzene. The NIOSH physician performed directed medical interviews and limited physical exams on twelve then-current employees, of whom eight worked full or part-time only in the maintenance shop area. At a later date, in August 1981, a representative of the state health department collected blood samples from four of the six production employees then still working at the plant.

No PCB's were detected in air samples at the detection limit of 0.05 ug/sample. PCB levels ranging from below the detection limit to 1.9 ug/ 100 cm^2 were found in the wipe samples. Air levels of tri- and tetrachlorobenzene were below detection limits (0.03 and 0.2 mg/M^3, respectively).

Eye discharge and conjunctival injection were associated with longer duration of employment, but other physical findings such as pingueculae (small wing-shaped tissue accumulations at the margin of the cornea) and blackheads showed no relationship to employment duration. Serum PCB levels ranged from 6 to 52 parts per billion (ppb), with a mean of 22.5 and a median of 16. Thus three of four values were within the range of those found in "unexposed" populations (less than about 30 ppb), and one value was in the low range for occupationally exposed groups examined in other studies.

Based on the data collected in this study, workers do not appear to be exposed to excessive levels of PCB's. However, we have recommended that workers reduce skin exposure to transformer oil as much as possible, and that any container suspected of containing PCB's not be processed.

KEYWORDS: PCB's, transformers, waste oil, eye discharge, PCB serum levels.

I. INTRODUCTION

On February 19, 1981, the Chronic Diseases Division, Center for Environmental Health, Centers for Disease Control (CDC), requested assistance from the National Institute for Occupational Safety and Health (NIOSH) to evaluate potential workplace exposures to polychlorinated biphenyls (PCB's) at the Mowbray Engineering Co. in Greenville, Alabama. The Chronic Diseases Division had been contacted by the Environmental Protection Agency (EPA) after high levels of PCB's were measured in a swamp and in its draining creek across the road from the Mowbray Co.

II. BACKGROUND

Since the early 1940's, the Mowbray Engineering Co. has drained, repaired, and refilled electrical transformers. The company was located in downtown Greenville until the mid 1950's, when it moved to its present location in a residential area on the outskirts of the Greenville business district. From the time of its move until 1974, Mowbray disposed of the used transformer oil into a drain on its property leading to a city-installed drain pipe, which in turn emptied into a swamp across the street. Runoff from the swamp drains into Hawkins Creek.

In 1974, Mowbray began selling the transformer oil as waste oil. The company installed a 3000 gallon storage tank, and except for occasional small spills, has drained all oil into the tank. In 1978, Mowbray contracted to sell its used transformer oil to the Alabama Power Co. Since the power company recycles the oil, it does not accept oil "contaminated" with greater than 50 parts per million (ppm) PCB's, and periodic assays done on the contents of the storage tank found all levels to be less than 50 ppm.

A 20-gallon oil spill in 1980 prompted the state health department to take soil samples in the swamp. These did not exceed 50 ppm, and the EPA took no action. After a swamp fire which burned for 4 days, a Greenville resident inquired further into the spill in January 1981. The health department again obtained soil samples from the swamp and found that they ranged from 2.1 to 389 ppm, while sediment from Hawkins Creek yielded levels less than 5 ppm. Because of high PCB levels in the swamp, the EPA initiated action to clean up the site. The EPA invited the CDC to assist in evaluating possible community health effects, and the CDC in turn requested NIOSH's evaluation of health effects in Mowbray workers.

The owner and manager of the company indicated that they had only occasionally handled "fire resistant" (PCB-containing) oils. Although they reported that transformers in the past did not bear information about PCB content, and that they had never formally distinguished between transformers containing fire-resistant oils and those that did not, their experience indicated that fire-resistant oils tended to be in large transformers which the company repaired infrequently.

NIOSH representatives visited the plant on March 18 and 19, 1981. An inspection of the premises revealed that the plant is a small building located on a fenced lot. Both transformers awaiting overhaul and transformers to be used as scrap are stored outside, and dozens of discarded, empty transformers are scattered through the underbrush on a wooded portion of the lot.

In the main building, a single-room office in the front adjoins a very small area which the men call the coffee room, which in turn opens into the workshop. The shop is a tin-roofed building about 150 feet by 50 feet divided into three large rooms and two small side rooms.

The workers bring transformers in from the rear to the front work room, where the process of "breaking down" a transformer usually begins. The bolts and top are first removed, and then the open transformer is wheeled to the center room, where a worker inserts a hose into the oil and pumps most of it out. The case is then taken back to the front room, where the coil is winched out. The employees work on the coil and casing, repairing or replacing parts as needed. Parts and cases are rinsed with mineral spirits in a tub in the center room. During the process of moving transformer parts from one room to another, oil frequently drips on the floor.

At the end of the day, the men place the transformer coils in a large box oven that stands at one side of the center room. The coils are left in the oven overnight at 525 degrees Fahrenheit so that any moisture in the coils can "cook out". In the morning, the oven is opened and the coils removed. Smoke and steam leak out around the oven doors during the "cooking out" process, and they billow unvented into the air when the doors are opened to remove the coils. After removing coils from the oven, the men then replace the dried coils in their cases, add enough fresh oil to cover the coils, and test the transformer. If the transformer functions normally, the worker reassembles the case and takes the transformer into a side room where it is spray painted in a ventilated booth.

Throughout "breaking down" and servicing, workers have intimate contact with transformer oil. Bare hands and arms are continually oil-coated, and no exhaust ventilation exists for any part of the plant except the spray booth. No one wears protective clothing or respirators. Some of the men eat lunches in the shop. The opportunities for uncontrolled exposure through breathing, skin absorption, and even ingestion, are remarkable.

NIOSH decided to proceed with an investigation to assess current exposures and to look for evidence of absorption in the workers. An Interim Report was issued in April 1981, and letters containing personal laboratory results were sent out in February 1982.

III. METHODS

A. Environmental

Nine environmental air samples were collected in the breathing zone of workers (personal samples) and in the general work area

(area samples), including above the oven. Four of the nine florisil tube samples were equipped with 13 millimeter "AA" Millipore membrane pre-filters to measure PCB-laden dust exposures in addition to vapor phase PCB's. Personal sampling pumps pre-calibrated at 200 cubic centimeters per minute were used for sample acquisition. Samples were analyzed by the NIOSH contract laboratory which used Aroclors 1016, 1242, 1248, 1254, and 1260 as standards.

Seven wipe samples were obtained from various locations at the facility for determination of PCB contamination. Areas approximately 10X10 cm^2 were rubbed with Whatman paper swipes and immediately placed into glass vials. Care was taken to avoid cross contamination during sample acquisition. These samples were also submitted for analysis.

Five transformer oil bulk samples obtained from transformers of various ages, plus recycled and "new" oils, were analyzed for PCB content. Analytical standards were again based on Aroclor 1016, 1242, 1248, 1254, and 1260.

One personal sample was collected for determination of exposure to tri- and tetrachlorobenzene (a vehicle for PCB's and a possible contaminant of transformer oil). The sample was collected on activated charcoal at a flow rate of 200 cc/min. from the breathing zone of a worker who spent the majority of the work-shift in very close proximity to an open transformer.

B. Medical

During the site visit, the NIOSH physician interviewed all 12 then-current Mowbray employees and conducted a limited physical examination of the skin and eyes. We used a questionnaire designed to elicit a history of eyelid swelling, eye discharge, mucous membrane and skin irritation, skin rashes and acne, as well as open-ended questions about any other symptoms, illnesses, and physician visits since coming to work at Mowbray. In addition, we collected information on job activities and duration.

After receiving the results of environmental monitoring for PCB's, we elected to obtain blood samples for PCB levels from consenting employees. The county health department agreed to collect samples for us, and on July 9, 1981, health department personnel obtained samples from 6 Mowbray employees. Because the samples were damaged in transport, none of the blood could be analyzed. In late August, a representative of the state health department collected a second sample from four of the six original consenting employees. Blood samples were centrifuged, and the serum frozen and mailed to the NIOSH laboratories. Analysis was performed using the NIOSH P&CAM method 329.[1] Analysis of spiked fish tissue obtained from the EPA and the inclusion of a standard obtained from pure Arochlor 1260 provided quality control for the serum analysis. Workers were notified of their serum PCB levels with an explanatory letter in February 1982.

IV. EVALUATION CRITERIA AND REVIEW OF THE LITERATURE

Polychlorinated biphenyls (PCB's) are a class of complex molecules composed of paired phenyl rings substituted with varying amounts of chlorine. The tradename for U.S. PCB's is Arochlor, of which Monsanto was the sole producer. In the Arochlor 1200 series, the last two digits refer to the percentage of chlorine in the molecule.[1,2]

PCB's have become ubiquitous in the environment because of their resistance to biochemical degradation and their widespread use, until the manufacturing ban, in transformers, capacitors, pesticides, plasticizers, and carbonless copying paper. They are widely dispersed in water, sediments, and in many foodstuffs, and they are known to accumulate in the tissues of fish. It has been estimated that the average daily intake of PCB's by a young man in the United States ranges between 10 and 20 micrograms daily.[3]

PCB's are measurable in the blood, organs, and fat of some percentage of the "normal" population. In a study of a population in South Carolina, PCB's were measured in rural and urban blacks and whites. The prevalence of detectable levels ranged from a low of 5% in rural blacks to a high of 62% in rural whites, and average levels in these groups ranged from about 4-10 ppb.[3] In Bloomington, Indiana, Baker et al., found mean PCB levels of 24.4 ppb in community members and 75.1 ppb in workers occupationally exposed to PCB's.[4] In another study of workers, Hasegawa et al., found that in workers exposed to air concentrations of PCB's between 26 and 965 micrograms/cubic meter (ug/M^3), serum levels averaged 370 ppb.[3] Smith et al., found a low but statistically significant correlation between serum PCB levels and both elevated liver enzymes (SGOT and GGTP) and elevated serum triglycerides in PCB-exposed workers[5]. The triglyceride elevation was observed in the Yusho incident (see below) and corroborated by Baker.

The long term consequences of PCB exposure to humans remain unknown. In occupationally exposed groups, an acneiform eruption known as chloracne has been the only medical finding consistently associated with PCB exposure. In the accidentally exposed community in Japan--the famous Yusho incident--more than 1000 members of the community ingested an estimated 1-15 milligrams of PCB's in contaminated rice oil daily for more than three months. Symptoms of the resulting illness included chloracne, eye discharge, flattened nailbeds, and hyperpigmentation. Babies born to women who ingested the oil were darkly pigmented, had eye discharge, and jaundice.[6] In animals, PCB's appear to be mutagenic, are associated with increased fetal loss, fatty degeneration of the liver and kidneys, and tumors of the liver and pituitary gland.[2,7] Although such effects have not been demonstrated in humans, animal studies serve to guide the standards of acceptable human exposure. For this reason, the NIOSH recommended standard for occupational environmental exposure to PCBs is 1.0 ug/M^3 of air (the lowest concentration that could be reliably measured at the time) as a time-weighted average (TWA) concentration, for up to a 10-hour workday, 40-hour workweek.

V. RESULTS

A. Environmental

At a detection limit of 0.05 micro-grams (ug) per sample, no PCB's were detected in any of the personal or area air samples. Sampled air volume adjusted, this generally corresponds to airborne levels of less than 0.9 ug/M^3.

Results of wipe samples indicate levels of surface contamination ranging from below the 0.05 ug limit of detection to 1.9 ug/100 cm^2. Because of the non-uniform nature of swipe sample aquisition, these results should be used only as indices of relative levels of contamination. Table 1 presents results of the wipe sample analysis.

Results of bulk oil analysis are presented Table 2. The highest PCB content was measured from the used oil holding tank (46 ppm Aroclor 1260 and 2 ppm Aroclor 1242).

Analytical results of the trichlorobenzene and tetrachlorobenzene sample indicate levels below the analytical limit of detection (30 ug/sample and 20 ug/sample, respectively). These correspond to air volume-adjusted levels of less than 0.3 mg/M^3 for trichlorobenzene and 0.2 mg/M^3 for tetrachlorobenzene.

B. Medical

Questionnaire and Medical Exam: Of the 12 persons interviewed, eight men worked only in the shop. Four of the eight worked only 20 hours per week. Of the remaining four employees, one was a full-time office employee, one was a truck driver who spent an average of 16 hours weekly working in the shop, and two were the father and son owner and manager who worked in the shop only intermittently. For the purposes of evaluating the medical exam and questionnaire data, the office employee was excluded.

All employees were white and male. Production employees ranged in age from 19-65. Six men had worked in the shop for less than 1.5 years, four men had worked there between 5.5 and 20 years, and the owner for 35 years.

Seven of the 11 workers (64%) who worked either daily or occasionally in the shop reported no symptoms. Of the other four employees, two described eye problems beginning before they came to Mowbray, one had developed a rash responsive to steroid cream, and one reported developing eye discharge during the preceding few years. One employee's acne disappeared after he came to work at Mowbray.

On physical examination, the NIOSH physician found the following: one of 11 had pigmented areas on the forearms; two had slightly thickened skin on the hands; three had mildly injected conjunctivae; four persons had eye discharge, and four had

"blackheads" on the face; five had pingueculae (wing-shaped accumulations of tissue at the border of the cornea). The individual with the faintly pigmented areas insisted that those were his normal skin color and that the paler areas were depigmented, but this was not clear from the examination. Conjunctival injection, eye discharge, and changes in the skin of the hands were associated with a longer duration of employment (16 years ± 12.4) in the five men so affected than in the six men without such findings (1.5 years ± 2.0). It must be noted that changes in the skin of the hands were also characteristic of the chronic changes associated with repeated drying and defatting, as occurs with frequent exposure to mineral spirits. The occurrence of blackheads and pingueculae appeared unrelated to duration of employment.

Serum PCB Levels: By August 1981, only 6 of the original 12 hourly employees still worked at the plant. Four persons, all shop workers, agreed to have blood drawn. Because the group was so small, and to protect the privacy of these employees, we will not characterize them in detail. The PCB levels obtained ranged from 6-52 ppb, with a mean of 22.5 and a median of 16 ppb.

VI. DISCUSSION

We cannot with certainty attribute physical findings to PCB exposure, and our group with blood PCB levels is too small to correlate levels with duration of exposure or physical findings. All serum values but one fall within the range that is usually seen in populations not occupationally exposed to PCB's, and the single elevated level (of 52 ppb) may indeed have been the result of occupational exposure. However, the absence of chloracne or significant acneiform eruptions in this group with such extensive skin exposure to transformer oil would suggest, as do the serum levels, that the chronic exposure to PCB's has not been to high levels, or that absorption has not been at levels usually seen in occupationally exposed persons. The elevated levels of PCB's in the swamp sediment would appear to attest both to the persistence of PCB's and to their occurrence in at least some of the transformer oils dumped into the swamp in past years.

VII. RECOMMENDATIONS

1. Despite the low levels of PCB's in the work environment at the time of our environmental sampling, we suggest that efforts be made to keep at a minimum skin contact with even "uncontaminated" transformer oil handled in the future, since such oil may contain up to 50 ppm PCB's. We suggest that frequent handwashing and frequent laundering of work clothes should be practiced, and that eating lunch in the shop is undesirable.

2. If Mowbray receives a transformer which appears to contain PCB's, that transformer should be closed without being worked on and turned over to a company licensed to dispose of contaminated oil. The EPA should be able to provide any assistance necessary.

3. Any transformer oil spills should be cleaned up promptly. If the transformer contains PCB's or is suspected of containing PCB's, the health department should be notified at once and NIOSH guidelines for protective equipment use followed in the clean up. Since Mowbray may not have such equipment available, the spill should be contained with absorbent material (kitty litter, soil) and clean up performed by a qualified contractor.

VIII. REFERENCES

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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1. Employees (7)
2. Alabama State Health Department (2)
3. Center for Environmental Health, CDC
4. Mowbray Engineering Co.
5. Butler Co. Health Department
6. NIOSH Region IV
7. 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 1

ANALYTICAL RESULTS OF WIPE SAMPLES BY LOCATION
MOWBRAY ENGINEERING
MARCH 18-19, 1981

Location	Amount of PCB (ug/sample)
Office desk top	ND*
Office floor	0.73
Assembly area floor	1.90
Assembly area work bench	0.08
Hammer handle	ND
Above drying oven	1.30
Palm and inner finger area of worker	0.12

* None detected; less than 0.05 ug.

TABLE 2

PCB ANALYSIS OF BULK OIL
MOWBRAY ENGINEERING
MARCH 18-19, 1981

Source	Concentration (ppm)	
	Aroclor 1242	Aroclor 1260
Used oil; bulk storage	2	46
Recycled oil	6	8
New transformer oil	ND*	8
1968 transformer oil	ND	4
1950 transformer oil	ND	3

* levels below the analytical limits of detection (1 ug/gram)

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