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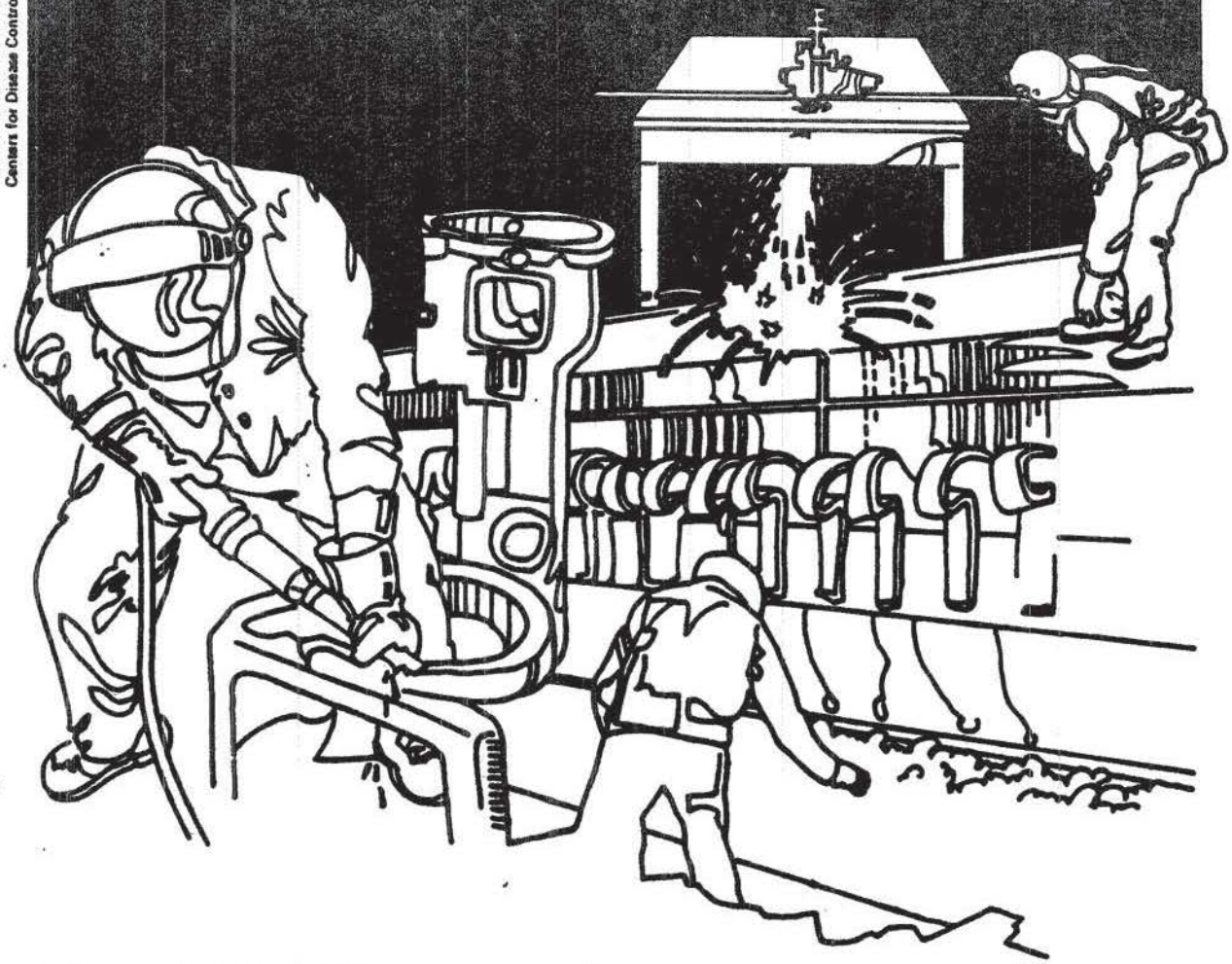

Health Hazard Evaluation Report

HETA 84-533-1565
LONG ISLAND RAIL ROAD
JAMAICA, NEW YORK

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 84-533-1565
Long Island Rail Road
Jamaica, New York
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I. SUMMARY

In September 1984, the Safety Department of the Long Island Rail Road and the International Brotherhood of Electrical Workers, Local Union 589 asked the National Institute for Occupational Safety and Health (NIOSH) for aid in determining potential exposure to polychlorinated biphenyls (PCBs) at an electrical repair shop in Jamaica, New York. PCB exposure may occur when electric energy is applied to capacitors in inverter-converters. When energized, defective capacitors may release a puff of smoke or may shatter. Because some of the capacitors contained PCBs, there was concern that material released in the smoke or by the shattered capacitors may have resulted in exposure to PCBs.

The release of material during the energizing process occurred about 2 or 3 times per week and the venting of smoke lasted only a few minutes. It was decided to collect wipe samples to determine if PCBs had been released and had been deposited on surfaces in the electrical repair shop. A sample of dust from the vacuum cleaner used to clean the inverter-converters also was collected. NIOSH has found that an upper limit for background surface contamination of PCBs should be no more than 0.5 microgram per 100 sq. cm. of surface area. Analysis of the samples determined that small amounts of PCBs (Aroclor 1016) were present in the vacuum cleaner dust (87 micrograms per gram of material) and in wipe samples collected from the surfaces of the inverter-converters and from the electric generator (12 to 35 micrograms per 100 sq. cm. of area).

The presence of PCB contamination on surfaces in the electrical repair shop indicated that a potential hazard existed from skin contact with PCBs and possible inhalation of PCB vapors. NIOSH informed the union and the safety department of the railroad of the results of the analysis and recommended several changes in procedures, the use of protective equipment, blood tests for exposed personnel and the installation of exhaust ventilation equipment. On January 15, 1985, after implementation of most of the recommendations, a re-inspection of the operation was performed. Based on that inspection, the following recommendations are made:

1) Replacement of the currently used vacuum cleaner with one which uses HEPA filters. 2) Continuation of the use of protective equipment. 3) Installation of an exhaust ventilated cover for the inverter-converters.

KEYWORDS: SIC Classification 7629--Electrical Repair Shops.
Polychlorinated Biphenyls (PCBs)

II. INTRODUCTION

In September 1984, the Region II office of the National Institute for Occupational Safety and Health (NIOSH) was contacted by the Safety Department of the Long Island Rail Road and by the International Brotherhood of Electrical Workers, Local Union 589. Both groups requested aid in determining if there was exposure to polychlorinated biphenyls (PCBs) at an electrical repair shop (the Morris Park Shops) in Jamaica, N.Y. The worksite was visited. Bulk and wipe samples were collected and analyzed. Management and the union were contacted by telephone on November 26, 1984 and were advised that small concentrations of PCBs were found in four of the samples, indicating contamination of the area. Recommendations to reduce the potential for exposure were discussed.

On January 15, 1985, a re-inspection of the operation was made following the institution of recommended protective measures and other modifications of the operation. The changes made are detailed in the RESULTS section of this report.

III. BACKGROUND

Inverter-converters are used to change direct current to useable current for lighting, etc. in passenger cars. They are about 4' x 3' x 1' and are housed in 1" steel boxes located beneath each car. Each inverter-converter contains 22 capacitors of various sizes. Most of the capacitors contain PCBs. When an inverter-converter malfunctions, it is taken for repair to the electrical repair shop at Morris Park (Jamaica). Prior to 1983, the unit was repaired out of doors. The current electrical repair shop occupies an area at the west end of the main repair shop. The area is approximately 20' x 30' with a 12 feet ceiling. Two sides of the area are windowed, a third side is painted cinder block and the fourth side is open to the general shop area.

About 50 inverter-converters are tested and repaired per month. Part of the testing consists of applying about 600 volts of direct current to the inverter-converter assembly. Upon application of the current, defective capacitors may vent a puff of acrid white smoke or (rarely) may explode. As the capacitors are tightly secured with metal bands, an explosion does not result in flying fragments, but does produce extensive cracking of the capacitor and release of vapor. The workers estimate that release of material from venting or cracking occurs about twice a week. A large window exhaust about 10 feet from the work position removes the generated smoke within a few minutes. Although the operation has been performed indoors only for the last 1 1/2 years, the four electricians have been doing the testing and repair for over 10 years each. The workers noticed that some of the new capacitors are labeled as containing no PCBs, and began to wonder if they had been exposed to PCBs while working with the capacitors.

IV. EVALUATION DESIGN AND METHODS

The venting of possible PCB emissions upon energizing of the capacitors is unpredictable and of short duration. Also, venting may occur from capacitors which do not contain PCBs. The collection of samples to determine concentrations of airborne PCBs would be a lenghthy procedure and might produce inconclusive results. It was decided to sample for PCBs by collecting wipe samples from surfaces in the electrical repair shop. PCBs have low vapor pressures, which means that, once deposited on a surface, they tend to remain on the surface for a long period of time. The surfaces in the shop had not been cleaned since the operation was moved indoors and therefore PCBs which had vented from the energized capacitors and had condensed on the surfaces would probably be present. Although this limited sampling procedure could not produce quantitative results, the presence of PCBs on any surface would indicate that exposure to airborne PCBs had occurred. The presence of PCBs on surfaces also would determine that exposure to PCBs through skin contact is ongoing and would indicate the need for using protective gloves.

Wipe sampling was performed by wiping a 100 square centimeter area with gauze which had been saturated with cyclohexane. Cyclohexane is a solvent for organic compounds, and this procedure is akin to cleaning a surface. Wipe samples were collected on the west windows, about 10 feet from the work area, from the south windows, about 15 feet from the work area, from a cabinet about 10 feet from the work area and from the generator which is adjacent to the work area. Wipe samples also were collected from the interior surface of an inverter-converter in which one of the capacitors had exploded and from the interior surface of an inverter-converter which had not yet been energized. A sample of dust was collected from the vacuum cleaner which is used to clean the interior of the inverter-converters.

V. EVALUATION CRITERIA

PCBs are chlorinated aromatic hydrocarbons that were manufactured in the United States from 1929 to 1977. Since the manufacturer and use of PCBs in the United States was banned by the Toxic Substances Control Act, occupational exposure has been limited almost exclusively to the servicing and repair of transformers and other equipment that contain PCBs and to activities related to the disposal of PCB contaminated equipment and waste material.

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. Mean serum PCB levels among workers in one capacitor

manufacturing plant studied by NIOSH ranged from 111 to 546 ppb, about 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.

PCB toxicology is complicated by the presence of highly toxic impurities, especially the polychlorinated dibenzofurans, which vary from different manufacturers. These impurities are found in increased concentration when PCBs undergo incomplete pyrolysis. In addition, different animal species, including man, vary in their pattern of biologic response to PCB exposure.

Two human epidemics of chloracne from ingestion of cooking oil accidently contaminated by PCBs have been studied in detail. Although PCBs were initially regarded as the etiologic agent, analyses of the cooking oil demonstrated high levels of polychlorinated dibenzofurans and polychlorinated quarterphenyls, as well as other unidentified chlorinated hydrocarbons, in addition to PCBs.(1)

Among cross-sectional studies of PCB exposed workers, there is a lack of clinically apparent illness in situations with high PCB exposure. Chloracne was observed in recent studies of workers in Italy, but not in workers in Australia, Finland or the United States.

The International Agency of Research on Cancer has concluded that the evidence of PCBs' carcinogenicity to animals and to 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 biphenlys increased the incidence of liver neoplasms in rats previously exposed to N-nitrosodiethylamine."(2)

Two mortality studies among workers at capacitor manufacturing plants in the United states and in Italy are both equivocal in regard to showing an association between PCB exposure and malignant neoplasms. An excess of liver cancer at two plants in the United States was not statistically significant and occurred within 20 years of first PCB exposure; and a rectal cancer excess, although statistically significant, was observed only among females at one of the two plants.(3) The increased risk for neoplasms at an Italian plant, although elevated in males and females, were not statistically significantly elevated. The risk for neoplasia was not analyzed by latency of exposures.

The Occupational Safety and Health Administration (OSHA) standard for exposure to PCBs is 1 milligram per cubic meter of air (mg/M^3) for 42 percent chlorinated biphenyl, and 0.5 mg/M^3 for 54 percent chlorinated biphenyl, as 8-hour time-weighted averages.(4) In 1977, NIOSH

recommended that occupational exposure to PCBs be limited to 0.0001 mg/M3 as a time-weighted average for up to a 10-hour workday, 40 hour workweek.(5) PCBs may be absorbed through skin contact, and NIOSH has found that an upper limit for background surface contamination should be no more than 0.5 microgram per 100 square centimeters of surface area (ug/100 sq cm).

VI. RESULTS

The results of analysis of the wipe samples and of the vacuum cleaner dust are listed in Table I. Several samples exceeded the background limit for surface contamination of 0.5 ug/100 sq cm: The wipe sample of the generator contained 3.5 ug/100 sq cm, the wipe sample collected on the inverter-converter with the exploded capacitor was 2.3 ug/100 sq cm and the wipe sample collected on the untested inverter-converter was 1.2 ug/100 sq cm. The vacuum cleaner dust contained 87 micrograms of PCBs per gram of dust, or 87 parts per million, based on weight. PCBs were not found in the other samples. The limit of detection for the wipe samples was 0.3 microgram per sample. The limit of detection for the dust sample was 0.05 microgram per gram. It is assumed that the PCBs found on the generator were the result of condensation of airborne PCBs vapors and/or PCB bearing smoke particles vented from energized capacitors. The only type of PCBs found in the samples was Aroclor* 1016, which contains 46% chlorine.

After the results of the investigation and recommendations were conveyed to the safety department of the rail road, the following measures were taken: 1) The Long Island Rail Road had the capacitors analyzed and identified the two (of seven) types of capacitors in the inverter-converters which contained PCBs. The electricians were instructed to replace these capacitors with non-PCB capacitors before energizing the inverter-converters. 2) The operation was moved to a secluded area in the locomotive shop and a warning light was installed to restrict entry into the area. 3) The contaminated generator was cleaned. 4) The voltage to the electric generator was regulated to insure that no more than 600 volts could be applied to the inverter-converters. This has reduced the number of capacitors which vented during testing (from 2 or three per week to two or three per month). The capacitors which have vented since this modification did not contain PCBs, and no capacitors have exploded since the use of reduced voltage has been instituted.

Presently, the steel covers of the inverter-converters are used when the units are energized to limit venting. The safety department has plans to construct an exhausted plexi-glass shield to be placed over the units when they are energized. The use of the vented shield should eliminate any possibility of exposure to PCB vapors.

* Aroclor is a registered trademark of Monsanto Company, St, Louis MO.

The employees have been issued organic vapor cartridge respirators, nitrile rubber gloves and Tyvek* coveralls for use when handling capacitors which have been damaged.

The vacuum cleaner used to remove debris from the inverter-converters is a "Shop-Vac 800". NIOSH contacted the manufacturer of the vacuum cleaner, who stated that these units do not contain HEPA filters. The safety department is under the impression that the vacuum cleaners do contain HEPA filters. The vacuum cleaners should be replaced with ones which contain HEPA filters.

A question arose about the proper disposal of the two small capacitors which contain PCBs. According to EPA, small capacitors of less than 100 cubic inches containing less than 3 pounds of dielectric fluids are not regulated, although disposal at approved chemical landfills is encouraged. Serum PCB levels were determined for the four employees who work in the electrical repair shop. All four employees had serum PCB levels of less than 10 parts per billion (ppb). Such serum PCB levels have been determined in persons without known occupational exposure to PCBs. None of the employees exhibited signs of chloracne or had medical complaints.

VII. CONCLUSIONS

NIOSH concludes that there was a potential hazard at the electrical repair shop from skin contact with PCBs. Although the amounts of PCBs determined to be present on surfaces and in the vacuum cleaner dust are small, PCBs are suspect carcinogens and exposures should be kept to a minimum. The measures that have been taken do reduce the possibility of exposure to PCBs in the electrical repair shop.

The type of PCBs identified in the capacitors (Aroclor 1232) differs from the type identified in the wipe samples (Aroclor 1016), which differs from the type of PCBs identified in the blood samples (Aroclor 1260). The body generally excretes PCBs preferentially, with the more highly chlorinated PCBs remaining in the body for longer periods. The multiplicity of types of PCBs indicates that the employees may have been exposed to PCBs from capacitors other than those tested. An inverter-converter may contain capacitors several years old, which may contain different types of PCBs.

* Registered Trademark

VIII. RECOMMENDATIONS

1. Exhaust ventilation should be provided to the workbench where the inverter-converters are processed. The practice of removing capacitors which are known to contain PCBs has greatly reduced the possibility of exposure to PCBs, However, the identification of different types of PCBs in the various samples indicates that all of the PCB-containing capacitors have not been identified, and the use of an exhaust hood or shield will provide additional protection.

2. Employees should wear protective equipment when replacing any damaged capacitors.

3. The vacuum cleaner used to clean the inverter-converters should be replaced with one which has high efficiency filters.

IX. REFERENCES

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X. ACKNOWLEDGEMENT AND AUTHORSHIP

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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, OH 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. Information concerning its availability can be obtained from the NIOSH Publications Office at the Cincinnati address.

Copies of this report have been sent to

1. The Long Island Rail Road
2. IBEW, Local 589
3. OSHA, Region II
4. NIOSH, Region II
5. The New York State Department of Health

TABLE I

HETA 84-533

LONG ISLAND RAIL ROAD
Electrical Repair Shop
Jamaica, New York

Concentrations of PCBs

Location	PCBs (microgram per 100 sq cm of surface area) - Aroclor 1016
West windows	N.D. N.D.
South Windows	N.D. N.D.
North Wall	N.D. N.D.
Cabinet (east)	N.D.
Electric Generator	3.5
Inverter-converter with exploded capacitor	2.3
Inverter-converter prior to testing	1.2
Vacuum cleaner dust	87 microgram per gram of dust

N.D. = none detected. Limit of detection = 0.3 microgram per 100 square centimeters of area.

NIOSH has found that the upper limit of background surface contamination of PCBs should not exceed 0.5 microgram per 100 square centimenters of area.

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