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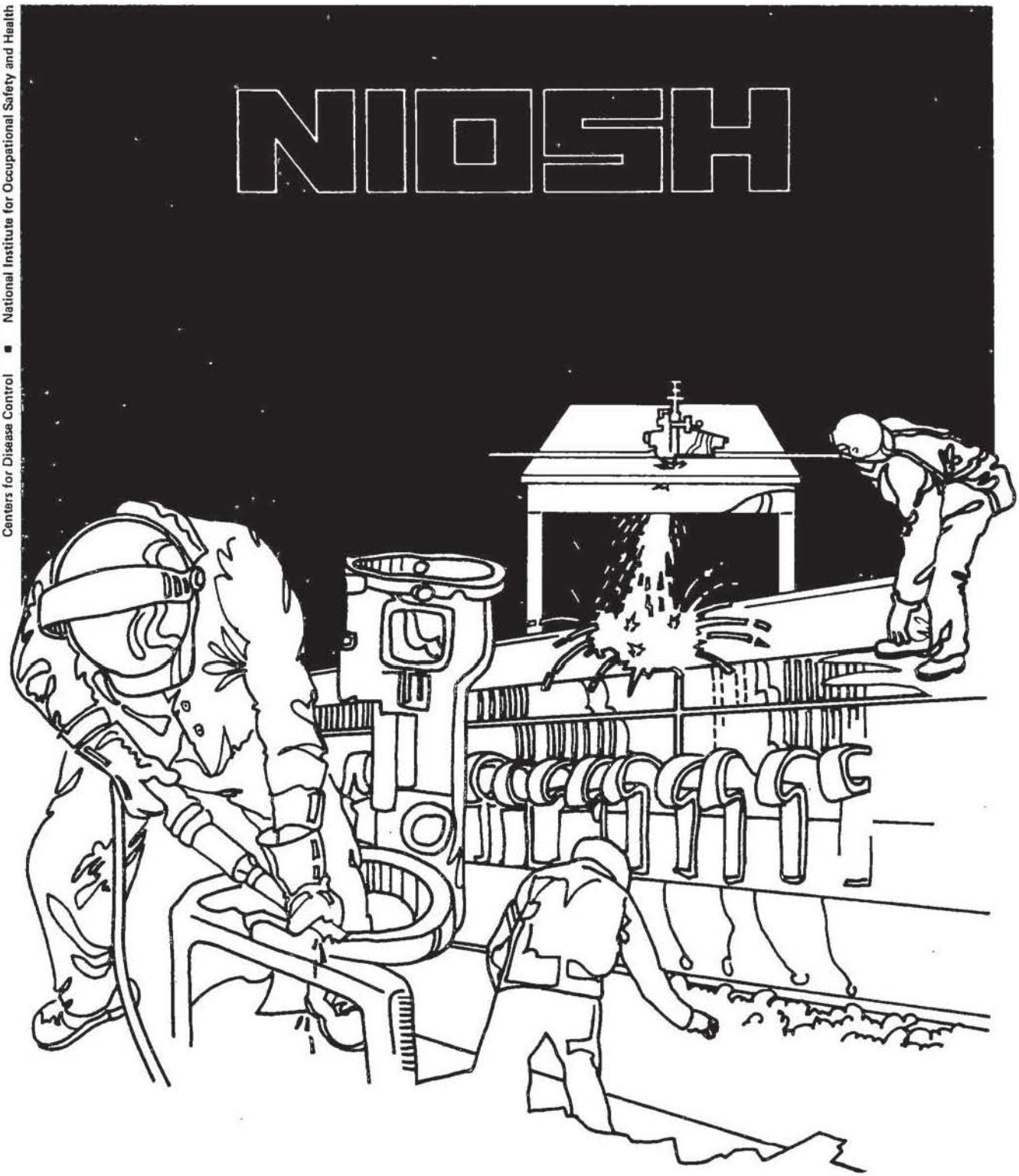

Health Hazard Evaluation Report

HETA 81-064-1035
UNITED STATES STEEL SOUTHWORKS
CHICAGO, ILLINOIS

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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I. SUMMARY

In November 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Steel Workers of America, Local 65, to conduct a health hazard evaluation at United States Steel Southworks, Chicago, Illinois. The requestor was concerned with potential exposure of electrical repairmen to polychlorinated biphenyls (PCBs) during maintenance activities on transformers. The request was prompted by an incident during which an employee became ill after working on a transformer containing PCBs.

In December 1980, NIOSH investigators conducted an initial survey visit. An environmental survey was conducted in May 1981. During this latter survey, work practices were observed and personal breathing zone air samples were collected to determine employee exposure to airborne PCBs.

Laboratory analysis detected no PCBs in the four personal samples collected. The limit of quantitation was 0.05 micrograms (ug) per sample for the specific PCBs (Aroclors 1016, 1242, 1248, 1254, and 1260). NIOSH recommends that occupational exposure to PCBs be controlled so that no worker is exposed at a concentration greater than 1.0 microgram per cubic meter of air (ug/M^3) total PCBs for a 10-hour time weighted average (TWA). The current OSHA standard for 8-hour TWA exposure to PCBs is 1.0 milligram per cubic meter of air (mg/M^3) for PCB mixtures containing 42% chlorine, and 0.5 mg/M^3 for mixtures containing 54% chlorine.

Observation of a transformer repair operation indicated that proper work practices were not being strictly adhered to by all employees, thereby presenting the possibility of a hazard through skin contact with the PCBs.

The employee who had been acutely intoxicated recovered fully and no definite relationship could be established between his illness and PCB exposure.

On the basis of data obtained during this investigation, NIOSH has determined that no hazard to electrical maintenance employees existed from exposure to airborne PCBs at the time of this survey. However, a potential for skin exposure to PCB's did exist as a result of employee work practices. To reduce the possibility of future exposures, recommendations on work practices and personal protection are incorporated in Section VIII of this report.

KEY WORDS: Polychlorinated Biphenyls (PCBs), transformer repair, askarel, Arochlor SIC 3312.

II. INTRODUCTION

On November 17, 1980, the United Steel Workers of America, Local 65, requested a NIOSH health hazard evaluation at the United States Steel Southworks, Chicago, Illinois. The requestor was concerned with the potential exposure of electrical repairmen to PCBs during maintenance activities on transformers located throughout the facility. Prior to the request, an employee had become ill subsequent to working at a transformer repair operation.

On December 5, 1980, NIOSH investigators responded to the request by conducting an initial survey. An opening conference was held followed by a walk-through evaluation of two areas where transformers containing PCBs were awaiting repairs. Due to the length of time required to obtain replacement parts necessary to complete the transformer repair operation, an environmental survey was not conducted until May 13, 1981. During this survey, work practices were observed and personal samples were collected to determine employee exposure to PCBs.

III. BACKGROUND

A. Background Information on PCBs and Their Use

Polychlorinated biphenyls (PCBs) are a class of chlorinated aromatic hydrocarbons. They were first available in the United States in 1929, and became widely distributed between 1957 and 1977 when large quantities were commercially produced by the Monsanto Industrial Chemicals Company, and marketed under the trade name "Aroclor". At least nine different Aroclors were manufactured, and designated by numbers such as 1221, 1242, 1254, and 1260, where the last two digits represent the percent by weight of chlorine in the mixtures. Another grade of Arochlor, 1016, was made primarily of tri, and tetrachlorbiphenyl compounds and contained 41% chlorine by weight.

Over the past decades, PCBs found a wide range of industrial uses. Properties such as thermal stability, non-flammability, and dielectric capability, led to the use of PCBs as a major component in most "askarels" marketed after 1932. Askarel is the generic term used to refer to a broad class of synthetic chlorinated hydrocarbon insulating liquids used in electrical capacitors and transformers. Transformer-grade askarels are usually mixtures of trichlorobenzene and more highly chlorinated PCBs.

Other properties of PCBs, such as their chemical stability, resistance to biodegradation, and lipid solubility, have led to their wide-spread accumulation in the environment. An increasing concern with the public health and ecological effects of this contaminination resulted in the promulgation of legislation by the Environmental Protection Agency (EPA) governing the use and disposal of PCBs, and subsequently led to the cessation of their manufacture in the United States. Occupational exposure to PCBs is now limited primarily to workers servicing equipment containing PCBs, or to persons who have inadvertent exposure through leakage or explosion of this equipment. In addition, exposure can occur at processes involving the recycling of sludges, oils, and other products containing PCBs.[1,2]

B. General Description of the Plant and its Use of PCBs

The United States Steel Southworks plant has been in operation since 1881, and produces steel plates, rods, and assorted structural materials. Electrical transformers, many of which contain PCBs, are located throughout the facility and supply electricity to the various processes of steel production. Electrical maintenance employees of the Power Division are responsible for servicing approximately 90% of the PCB containing transformers within the plant. At the time of the survey, there were 45 employees in this division. It was estimated that from 5 to 10 PCB containing transformers were serviced per year. Generally, a repair operation requires 2 to 4 employees per shift for the 1-2 shifts necessary to complete the repair. At the time of the initial survey, two PCB containing transformers were awaiting repair.

C. Plant Procedures for Working with PCBs

Following the 1977 EPA regulations on PCBs, the company identified transformers within the plant which contained PCBs. Procedures were adopted to deal with spills and maintenance activities on those transformers containing PCBs, including training sessions for supervisors of the electrical maintenance employees on proper work practices and personal protection. These procedures were in accordance with those contained in the NIOSH criteria for a recommended standard...Occupational Exposure to PCB's[1], except that:

1. They did not specify that only personnel trained in the emergency procedures and protected against the attendant hazards shall shut off sources of PCBs, clean up spills, control and repair leaks, and fight fires, in areas where PCBs are used.

2. Upon entering an area of unknown concentration during an emergency, the respirator selection procedures did not require the use of proper respiratory protection.

IV. MATERIALS AND METHODS

Arrangements were made with plant management to monitor a transformer repair operation in the Central Substation area of the plant. The operation consisted of the draining of the transformer askarel, disassembling of the transformer top, and removal of the defective part. Prior analysis of a bulk sample of the transformer askarel had revealed its composition to be a mixture of 43.5% chlorobenzenes, and 56.5% polychlorinated biphenyls. Manufacturers data indicated the PCB mixture to be 42% chlorine by weight.

During the repair operation, environmental samples were collected to assess the magnitude of employee exposures. Personal samples were collected near the breathing zone of four employees using battery powered pumps operating at 0.1 liters per minute (lpm) connected with tygon tubing to Florisil tubes which served as the collecting media. The duration of sampling ranged from 61 to 91 minutes. The samples were analyzed for Aroclors 1016, 1242, 1248, 1254, and 1260 using NIOSH P&CAM Method No. 244 with minor modifications.[3] A bulk sample of the transformer fluid was collected for use in the analysis. Due to it's low vapor pressure (1mm @ 38°C), and relatively high exposure criteria when compared to PCBs, no environmental samples were collected for 1,2,4-trichlorobenzene.

V. EVALUATION CRITERIA

A. PCBs

In human beings PCB's have been documented to produce a variety of toxic effects:

1. Chloracne, a chemicaly induced acne, consisting of blackheads, pimples, and pustules in exposed areas of the body. Additionally, red pruritic contact dermatitis, upper airway irritation, and persistant body odor have been reported following exposure.
2. Nausea and digestive disturbances have been noted following high dose exposure, and mild asymptomatic liver dysfunction has been recorded after low level exposure.
3. Dysfunction of sensory and motor nerves in the extremities has occurred, evidenced by numbness, pain, tingling, and weakness in the hands or feet.

In animals PCB's have been documented to produce:

1. Eye, nose, mouth and throat irritation, with facial swelling and a loss of hair.
2. Liver damage with stomach irritation and ulcers.
3. Bone marrow suppression producing anemia, and an impaired ability to combat infection by the immune system. Low blood protein levels have also been recorded.
4. Increased numbers of miscarriages, low birth weight offsprings, and newborn deaths, as well as fewer members per litter.
5. Increased numbers of liver cancers in animals, and mutations in bacteria.[4]

Based on the adverse reproductive and tumorigenic effects that PCBs have shown in experimental animals, NIOSH recommends that occupational exposure to PCBs be controlled so that no worker is exposed at an airborne concentration greater than 1.0 ug/M^3 total PCBs on a TWA basis for up to a 10-hour workday, 40-hour workweek.[1] In addition, NIOSH recommends that exposure to PCB's through skin contact be minimized through the use of safe work practices and proper personal protective equipment. The current OSHA standard for exposure to PCBs is 1.0 mg/M^3 for PCB mixtures containing 42% chlorine, and 0.5 mgM^3 for mixtures containing 54% chlorine on an 8-hour TWA basis.[5]

B. Trichlorobenzene

In humans, chlorinated benzenes have been noted to cause irritation to skin and mucous membranes and at high doses have shown narcotic effects. Chronic high level exposure in animal studies have produced liver, kidney, and lung damage.[6] Based on the irritative properties of this substance, the American Conference of Governmental Industrial Hygienists (ACGIH) has recommended that exposure to 1,2,4-trichlorobenzene should not exceed 5 parts of contaminant per million parts of air (ppm) or 40 mg/M^3 at any time.[7] There is currently no OSHA standard for exposure to 1,2,4-trichlorobenzene.

VI. RESULTS

No PCBs were detected in the four environmental samples. The limit of quantitation was 0.05 ug/sample for Aroclors 1016, 1242, 1248, 1254, and 1260 on the Florisil tubes.

No employee complaints of skin or mucous membrane irritation that would be expected to be associated with exposure to high concentrations of PCBs or trichlorobenzene were noted during the repair operation.

VII. DISCUSSION AND CONCLUSIONS

In view of the current research linking PCBs with carcinogenic and teratogenic effects in animals, human exposure to PCBs should be avoided or restricted to as low a level as possible. Although no PCBs were detected in environmental samples, this does not eliminate the possibility of exposure to PCBs through skin contact or ingestion. Since liquid PCBs can penetrate the skin to cause systemic effects, the role that proper work practices and personal protection play in reducing exposure should not be overlooked. Although the company has adopted procedures for dealing with these areas, observation of employee work practices indicated that many of these were overlooked, as noted by the following examples:

1) Protective clothing did not fully cover the skin and clothing of all employees. Portions of the forearms of some employees were left exposed, providing a potential area for skin contact. A recent NIOSH study has shown that many of the materials used in personal protective clothing (gloves, boots, and coveralls) may not provide adequate protection against PCB permeation. Protective equipment of Viton elastomer was recommended as affording the best protection against these substances.[8]

2) Protective boots were not worn by one employee. This could lead to possible contamination of the employees everyday work boots and possible spreading of the PCBs to other areas.

3) Employees used a chlorinated hydrocarbon solvent (DECHLOR) to clean their hands at the end of the operation. This could lead to defatting of the skin, stripping the hands of natural protective layers and increasing susceptability to absorption of PCBs, and/or possibly resulting in skin irritation or dermatitis. Thorough rinsing of the skin with soap and water is the recommended procedure for removing PCBs.

4) Upon completion of the operation, employees drank beverages and smoked in the area where the repair operation had occurred, increasing the possibility of ingestion and/or inhalation of PCB decomposition products.

The lack of detection of PCBs in the air samples should also be considered in light of the duration and the location of the transformer repair operation that was monitored. The operation, which lasted approximately 70 minutes, was located in a large room which was provided with good dilution ventilation through an open loading dock door. If a similar operation was conducted for a greater period of time, or in a confined space or an area lacking good ventilation, it is possible that quantifiable levels of PCBs would be present. One recent survey at a private utility company found 8-hour TWA PCB concentrations to range from 3.2 to 82.3 ug/M^3 in personal samples collected during the overhaul of transformers located in underground vaults.[9]

The degree to which a transformer fire or explosion could affect the hazard of repair or cleanup activities should also be emphasized. The pyrolysis of askarel can produce highly toxic and potentially carcinogenic thermal decomposition products such as dibenzofurans and dibenzo-p-dioxins. In addition, the increased temperature of the askarel would result in the volatilization of these substances, thereby increasing their airborne concentrations.

VIII. RECOMMENDATIONS

The following recommendations are made to further reduce and/or eliminate future employee exposures to PCBs. Although many of these recommendations are presently incorporated into the current company policy for working with PCBs, their reemphasis is appropriate in view of the potential health hazard presented by these substances.

A. Environmental

1. Respiratory Protection

The NIOSH Criteria Document states that there are three conditions under which compliance with the permissible exposure limit may be achieved by use of respirators, as opposed to engineering controls. These are (1) during the time necessary to install or test the required engineering controls, (2) non-routine maintenance or repair activities and (3) during emergencies when concentrations of airborne PCBs may exceed the permissible limit. Based on this information, it is assumed that the present evaluation covers the latter two conditions, and therefore the employer should establish and enforce a respiratory protection program meeting the requirements of 29 CFR 1910.134. The employer is also required to provide respirators as described in Table 1.

TABLE 1

RESPIRATOR SELECTION GUIDE

Concentration of PCBs	Respiratory Type Approved under Provisions of 30 CFR 11
Greater than 1.0 ug/cu m or Emergency (entry into area of unknown concentration)	(1) Self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode. (2) Combination Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure mode and an auxiliary self-contained breathing apparatus operated in pressure demand or other positive pressure mode.

However, due to the variety of conditions under which an exposure can occur, it is very possible that a self-contained breathing apparatus or air-supplied respirator could be a hinderance, and thus, a potential safety hazard to the worker. It should also be kept in mind that these workers are only occasionally exposed to PCBs and rarely, if ever, exposed to PCBs as defined in the criteria document, i.e., "up to a 10 hour workday, 40 hour work week, over a normal working lifetime". Therefore, Table 2 is the recommended respiratory program which should best favor the variety of situations which employees may be confronted with.

TABLE 2

Recommended Respiratory Protection Guide*

1. Inside Spill/Confined Space	-- Self-contained and/or airline respirators described in Table 1.
2. Explosion/Fire/Heat	-- Self-contained and/or airline respirator as described in Table 1.
3. Outside Leak	-- Full face respirator with acid gas/organic vapor cartridge with high efficiency pre-filter. Care should be taken to replace these cartridges as necessary.

NOTE: These recommendations are based on personal communications with NIOSH Regional Consultants (Regions VIII and X), NIOSH Morgantown representatives, and OSHA recommended PCB respiratory program / Region VIII, as previously cited NIOSH Health Hazard Evaluation Report NO. 80-85-745[10].

2. Environmental Monitoring

Personal breathing zone environmental monitoring should be performed on a sub-sample of the employees who normally respond to the various PCB problems. This data will be useful in determining which conditions require the respiratory protection as outlined above. Therefore, for each time weighted average concentration determination, a sufficient number of samples should be taken to characterize the various conditions and each employee's exposure during the various types of operations. Until environmental data is available that rules out the possibility of PCB exposure in excess of 1 ug/M^3, the above respiratory program should be complied with routinely. Also, if the environmental survey illustrates excursion above the standard, surveys should be repeated at least once every year. Records of these evaluations, including the basis for any conclusion that there may be no exposure to PCBs, should be retained until the following year when the next survey has been completed. Environmental monitoring data should be retained for at least 30 years after the employee's last exposure. (Refer to the Criteria Document for further details.)

B. Medical

The following medical surveillance should be made available to those workers who may come in contact with or routinely respond to PCB problems.

1. Examinations

a. Preplacement or initial medical examinations for workers should include:

(1) Comprehensive medical and work histories with special emphasis on hepatic function, skin condition, and reproductive history.

(2) Comprehensive physical examination with particular attention to the skin and to hepatic function including determinations of

serum glutamic-oxaloacetic transaminase (SGOT) and serum glutamic-pyruvic transaminase (SGPT) activities. The responsible physician may also wish to obtain measurements of serum triglyceride concentrations or of other indices of fat metabolism.

(3) A judgment of the employee's ability to use positive pressure respirators.

b. Periodic examinations should be made available at least annually and include: (1) interim medical and work histories, and (2) physical examinations as outlined in paragraphs 1.(a,b, & c) of this section.

c. Pertinent medical records should be maintained for all employees exposed to PCBs in the workplace. Such medical records should be maintained for the period of employment plus 30 years. These records should be made available to the designated medical representatives of the Secretary of Health and Human Services, of the Secretary of Labor, of the employer, and of the employee or former employee.

C. Sanitation Practices

1. Facilities for shower baths should be provided for employees exposed to PCBs. Therefore, after working with PCBs, workers should shower before changing into street clothes.

2. Employees exposed to PCBs should be advised to wash their hands and exposed skin before eating, drinking, smoking, or using toilet facilities during work with PCBs.

3. Food, drink, or smoking materials should not be permitted in areas where PCBs are handled.

D. PCB Training and Education

The training and education of employees regarding safe work practices is the key to reducing and/or eliminating exposures to PCBs. Therefore, in order to maximize the present employee training program regarding PCBs, the following information should be referred to and emphasized as necessary.

1. A continuing education program to ensure that all employees occupationally exposed to PCBs have current knowledge of job hazards, proper maintenance and cleanup methods, and proper use of protective clothing and equipment, including respirators. Emphasis should be placed on using this protective clothing and equipment any time an exposure to PCBs may exist. The instructions should include a general description of the medical surveillance program and of the advantages to the employee of participation. Special attention should be given to women in the workplace. They should be made aware of the potential adverse effects of PCBs on the unborn child, and of the known transport of PCBs to breast milk. Other elements of the program should emphasize:

Emergency procedures and drills;
Instruction in handling spills and leaks;
Decontamination procedures;
First-aid procedures, equipment location, and use;
Rescue procedures;
Confined space entry procedures;
Low warning (odor) properties of PCBs'

2. All new and present employees in any area in which PCBs are used should be informed of the hazards, relevant symptoms, and effects of overexposure to PCBs, and the precautions to be observed for safe use and handling of these materials.

3. Each employee involved with the use, transport, or storage of PCBs should be informed that PCBs have been found to induce tumors in experimental animals after repeated oral ingestion and that because of these findings it is concluded that PCBs are potential human carcinogens; employees shall also be informed that adverse reproductive effects may result from occupational exposure to PCBs.

4. Finally, all the information explaining the hazards of working with PCBs should be kept on file and be readily accessible to workers at all places of employment where PCBs are used, stored, or transported. Required information should be recorded on the "Material Safety Data Sheet[10].

IX. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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A. United Steel Workers Union, Local No. 7771

B. United States Steel Southworks

C. U.S. Department of Labor, OSHA - Region V

D. NIOSH Regional Offices/Divisions

For the purposes of informing the affected employees, copies of the report should be posted in a prominent place accessible to the employees, for a period of 30 calendar days.