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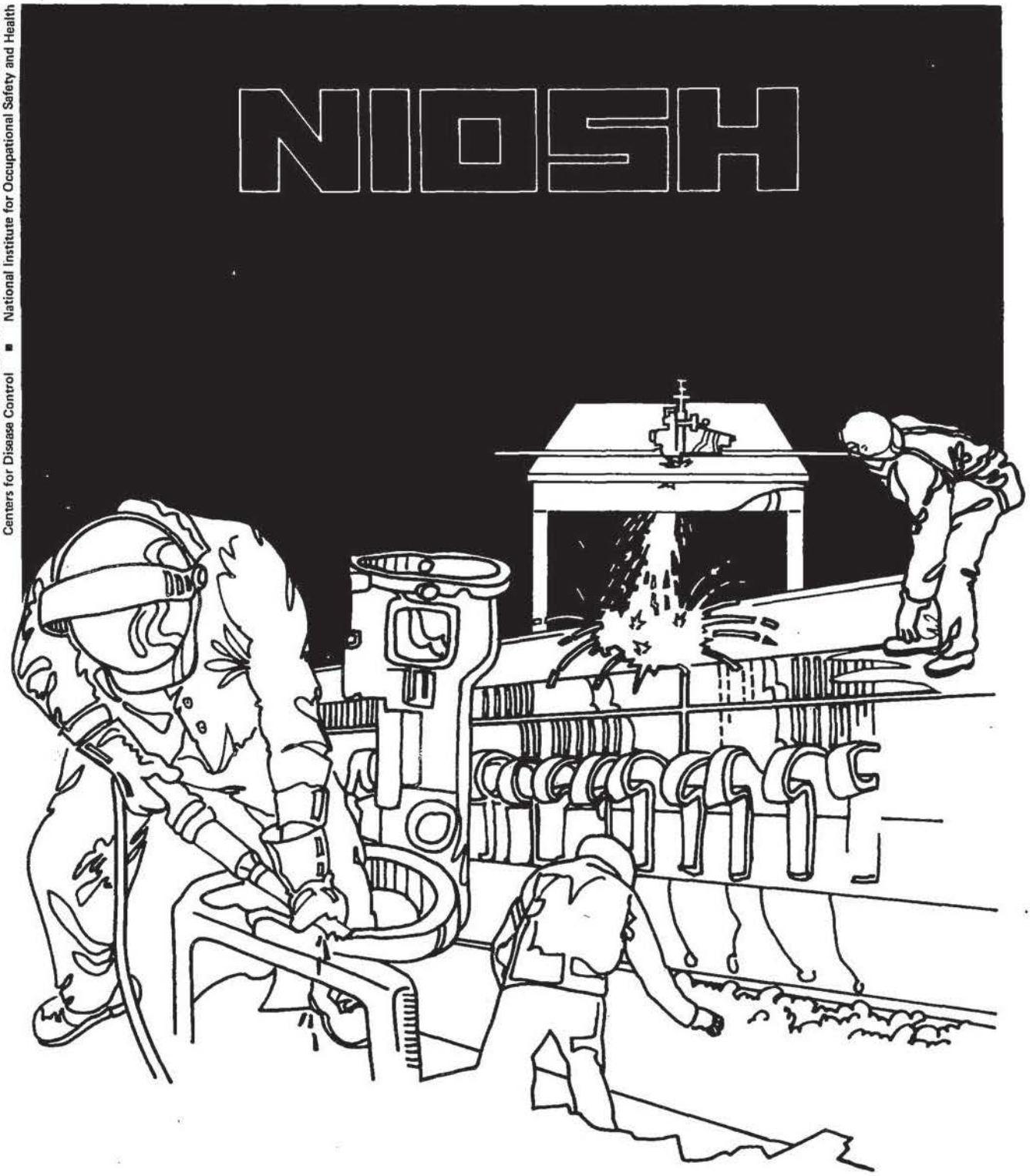

Health Hazard Evaluation Report

HETA 81-111-949
U.S. NAVAL SECURITY GROUP ACTIVITY
WINTER HARBOR, MAINE

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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HETA 81-111-949
September 1981
U.S. NAVAL SECURITY GROUP ACTIVITY
WINTER HARBOR, MAINE

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I. SUMMARY

On December 2, 1980 the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation at the United States Naval Security Group Activity, Winter Harbor, Maine. The request originated from civilian employees' concerns for potential health effects, both short and long term, from polychlorinated biphenyls (PCBs) exposure while servicing capacitors. The request specified that five antenna maintenance employees (Shop 10) were potentially exposed to PCBs during spills and clean-up of ruptured capacitors in the Uninterruptible Power Supply (UPS) system.

NIOSH conducted an industrial hygiene evaluation on February 4, 1981 of the occupations in question. During the February survey, NIOSH met with Navy and employee representatives who were responsible for procedures for handling PCBs, and information was exchanged regarding the Navy's past and present position on PCBs. Area air samples were collected in the three locations where the banks of capacitors are housed; one of which had undergone a recent PCB clean-up. Results of the PCB sampling showed the following levels. Building 103; 3.95 ug/M^3, Building 154; 4.48 ug/M^3, and Building 41; less than 0,05 ug/M^3. The NIOSH recommended standard is 1.0 µg/M^3.

This information as well as information collected from the Navy, and a review of the pertinent literature regarding PCBs, were used to determine the effectiveness of the Navy's PCB program.

Based on the data obtained in this evaluation, NIOSH has determined that the Navy did not have a formal PCB program at Winter Harbor prior to November 1980, and consequently, employee protection against PCB exposure was incomplete. Although personal exposure levels could not be documented due to the unpredictability of capacitor rupture, the results of area air samples indicate that a potential PCB hazard existed in Buildings 103 and 154. Recommendations are made in the body of this report concerning personal protective equipment, sanitation, respiratory protection, environmental and medical monitoring to assure employee protection against the harmful effects of potentially hazardous levels of PCB exposure.

Keywords: PCBs, Aroclor 1242, Capacitors

II. INTRODUCTION/BACKGROUND

On December 2, 1980 the employees in Shop 10, U.S. Naval Security Group Activity, Winter Harbor, Maine, submitted a request pursuant to Executive Order 12196 - Occupational Safety and Health Programs for Federal Employees. The request stated that employees of Shop 10 were potentially exposed to PCBs used in capacitors, during maintenance, repair, and spill clean-up operations.

The Winter Harbor facility employs the use of PCB containing capacitors in two Uninterruptible Power Supply (UPS) systems that assure power is maintained to the base computers in the event of power loss. The UPS systems contain capacitor banks consisting of approximately 200 nine (9) pound capacitors electrically interconnected by bus bars. Each 9 pound capacitor contains a maximum 3.2 pounds of PCB (Aroclor 1242).

Each PCB capacitor is identified according to the Environmental Protection Agency (EPA) marking system and, therefore each of these units can be easily recognized as containing PCB.

Since the capacitors are sealed units, PCBs can only be released as a result of rupture or other damage to the units. Employee exposure to PCBs may occur during clean-up and repair of the system (as a result of a rupture), or from improper storage and handling of leaking capacitors.

Five technicians who make up the Antenna Maintenance Group - Shop 10 - are responsible for maintenance and repair of the UPS systems. This also includes clean-up of spills and disposal of PCB contaminated equipment.

Prior to 1976, only one UPS system was in operation. The second system was aquired in 1972, but was not installed until 1976. Employees could only estimate that a minimum of 12 capacitor ruptures occurred prior to 1976. However, when it came time to install the new system, it was noticed that all the capacitors that had been in storage for 4 years showed signs of corrosion. Many of the approximately 200 capacitors had visible leakage. All were removed and replaced with new ones. The damaged capacitors were taken to a room in building 41, where they remain as of February 1981.

Since the installation of the second UPS system in 1976, records have been kept for each capacitor failure. These records indicate that 12 capacitor ruptures occurred in 1980.

The following is a compilation of the information gathered during this investigation. This includes: Navy personnel's past practices; and the Navy's present policy for safety and health while handling PCBs.

Past Practice

When the UPS system malfunctions, it is usually due to a capacitor failure. Whenever this happens, Shop 10 employees are called to rectify the problem. Their task involves, (1) locating the blown capacitor, (2) electrically isolating the capacitor bank, (3) removal of the "dead" capacitor(s), (4) clean-up of any spilled oil, and (5) installation of a new capacitor.

Until the Fall of 1980, no specific procedures were set up for the clean-up of spills. Employees would routinely wipe up the PCB containing oil with shop rags and paper towels. Clean-up materials were discarded with the general trash in the nearest dumpster.

Employee exposure to PCBs occurred primarily through skin contact, although on at least one occasion a blown capacitor had apparently undergone high voltage stress, releasing oil mist throughout the room. Two (2) Shop 10 employees recalled performing the maintenance in the misty atmosphere without respiratory protection. Also, employees indicated that they could taste the oil on their hands even after several soap and water washings following a spill clean-up.

Present Policy

The current Navy policy governing safety and health concerns for PCB handling and disposal is contained in a November 1980 Navy Environmental Support Office Publication (NESO 20.2-028) "PCB Compliance, Assessment, and Spill Control Guide". The provisions in this manual deal primarily with EPA regulations, as it states in the Introduction:

> "This guide was designed to provide updated information and assistance to Navy shore activities for complying with EPA's complex and intricate PCB regulations. It presents a concise summary of the regulations in understandable terms, provides practical guidance to all Navy commands for implementing these requirements, outlines a methodology for assessing activity compliance, and provides useful information for initiating a PCB awareness program at the activity level."

Also, the majority of the Guidelines deal with large PCB transformers and their implications; i.e., reference under heading, "Spill Emergency Procedures" to use of a crane, closing valves and petcocks, trenching, and removal of contaminated soil.

The U. S. Naval Security Group Activity in Winter Harbor is currently attempting to implement these guidelines to their operation. In this regard, the Navy has accomplished the following:

1. Labeling of all PCB equipment
2. Central storage of dead capacitors
3. Purchase of full face respirator and GMP cartridges
4. Purchase of 3/4 sleeve rubber gloves
5. Purchase of TYVEK^{R} type 14 protective suits
6. Purchase of metal drums (sealed) for disposal of PCB contaminated material.

In addition to the requirements of the current policy, the Winter Harbor employees have recently received blood tests for hepatic function and total PCB in serum.

III. EVALUATION DESIGN AND METHODS

Employee exposure to polychlorinated biphenyls, via skin absorption and suspected airborne concentrations were evaluated. Due to the nature of the potential exposure (intermittent and unpredictable situations when spills occur) environmental sampling of the workers was not feasible. That is, it would be impractical for NIOSH to evaluate conditions that would require a stand-by situation as well as immediate response, in order to adequately monitor these exposures. Therefore a thorough evaluation of the Navy's protocol for handling PCBs was conducted. Environmental area air samples were collected in the three buildings where PCB containing equipment is located. The samples were collected on Florisil^{R} media and analyzed for Aroclors 1016, 1242, 1248, 1254, and 1260 following NIOSH Method P&CAM No.244.

IV. EVALUATION CRITERIA

1. Environmental

There are several criteria used to evaluate the toxic air contaminants of an employee's work environment: (1) NIOSH Criteria Documents for a Recommended Occupational Health Standard, (2) Proposed and Recommended Threshold Limit Values (TLVs), as suggested by the American Conference of Governmental Industrial Hygienists (ACGIH), 1980, and (3) the Occupational Safety and Health Administration (OSHA) Standards. The values are based upon the current state of knowledge concerning toxicity of these substances. The values for each contaminant are designed to allow an occupational exposure an 8-10 hour work day, 40 hour work week over a normal lifetime, without the worker experiencing adverse health effects.

The following is the present criteria established by ACGIH, OSHA, and the justification for the present NIOSH recommended standard.

The ACGIH has two Threshold Limit Values (TLVs) for PCBs: 0.5 milligrams per cubic meter of air (mg/M^3) for chlorodiphenyl (54% Chlorine), and 1.0 mg/m^3 for chlorodiphenyl (42% Chlorine), and these were adopted by OSHA and are enforceable today. NIOSH recommends that worker exposure be limited to 1.0 microgram per cubic meter of air (ug/M^3) - a level lower than any OSHA standard by a factor of at least 500. This recommended criteria (published in 1977) is based on an exhaustive review of available literature, animal toxicity testing, epidemiological data, and industrial experience, which showed basically that there was no detectable level at which there was not some demonstration of liver dysfunction.

It should be understood that OSHA is always updating its' standards based on need; as expressed by the number of workers involved, technical feasibility, economic impact, etc. Thus, the standard for PCBs happens to be one that has not had its turn in review. Therefore, based on this information, the NIOSH recommended criteria of 1 ug/M^3 will be used as a guideline in this evaluation.

2. Medical

The medical criteria used to determine a toxic response to the substance under investigation consists of signs and symptoms which the agent produces when a toxic exposure occurs. These factors, as well as other investigative strategies as described above were used to determine the toxicological effects of PCBs and these are discussed in the following paragraphs.

The most famous incident of non-occupational exposure to PCBs was the Yusho, Japan incident. This domestic poisoning focused attention on PCBs and provided much of the human exposure/effect data, and this information is often used when comparing occupationally related exposures.

Briefly, in 1968 approximately 1057 cases of a similar poisoning occurred in Japan. Epidemiological investigations ultimately determined that these people had consumed rice bran oil contaminated with PCBs. During the manufacture of rice oil, a heat exchange unit had leaked PCBs into the product. The disease became known as Yusho, or rice oil disease.

The predominant symptoms associated with this exposure were acneiform eruptions, eye discharges, chloracne, and hyperpigmentation of the skin, nails, and mucuous membranes. Other clinical signs were alterations in liver function, fetal contamination (including placental crossing of PCBs), and passage of PCBs to the infant via mothers milk. In addition, large quantities of PCBs were found in adipose tissue samples, indicating storage and slow release. Follow-up of these patients indicated that symptoms persisted for several years after exposure. The period of ingestion was only a few months, but the average amount ingested was estimated to be about 2 grams of PCB.

NOTE: Although much was learned about the effects of PCBs on humans from Yusho, the application of this exposure/effect data to occupational exposures must be done cautiously. The route of entry (ingestion) will be different (except in the most bizarre circumstances) than normal occupational routes of entry, i.e., skin contact, inhalation, etc.

In 1974 the Division of Occupational Health and Radiation Control of the Health Commission of New South Wales, Australia, conducted a study of a condenser manufacturing firm that used PCBs. Breathing zone concentrations ranged from 0.32 - 2.22 mg/ M^3. Significant clinical findings included rashes, chloracne, and high blood PCB levels. Hepatic function tests were normal[9].

NIOSH conducted an industrial hygiene study of two capacitor manufacturing facilities in April, 1977. In plant #1, the personal breathing zone samples ranged from 24 ug/M^3 to 383 ug/M^3. In plant #2, the personal breathing zone levels ranged from 170 ug/M^3 to 1260 ug/M^3. A medical study (not in conjunction with the NIOSH

study) conducted previously on 326 volunteer workers in plant #1 revealed mostly dermatological problems and decreased lung capacity; there was little increase in abnormal liver findings although there were liver enzyme changes associated with PCB exposed versus the non-exposed workers. The NIOSH epidemiologist identified cancer of the rectum and cancer of the liver as the only two categories of cancer which were greater than expected (4 observed vs. 1.2 expected, and 3 observed vs. 0.9 expected respectively). Cancer of the liver is noteworthy in this study for its finding parallels those animal studies where PCBs were found to cause liver damage.

NIOSH (June 1977), in a discussion on local and systemic effects from PCBs, described the local effects as deriving from prolonged skin contact with PCB fumes. This can cause the formation of comedomes, sebaceous cysts, and pustules known as chloracne. Other local effects are irritation to the eyes, nose, and throat. The systemic concerns are derived from the toxic effects which are dependent upon the degree of chlorination; the higher the degree of substitution, the stronger the effects.

It is also stated that acute and chronic exposures can cause liver damage. Signs and symptoms include edema, jaundice, vomiting, anorexia, abdominal pains and fatigue.

Finally, in two recent investigations both NIOSH and OSHA determined that both linemen and maintenance personnel (performing repairs, clean-up, etc.) were exposed to PCBs levels as high as 40-60 times the NIOSH recommended standard. In the NIOSH survey investigators found PCB values ranging from non-detectable levels to 60 ug/M^3. A total of 19 samples were taken over a period of 1-6 hours. Among the various medical effects described in this investigation were skin rashes, headaches, sterility and loss of appetite.

Federal OSHA investigators, monitoring similar operations, found PCB levels ranging from 20-40 ug/M^3 for 1-2 hour sampling periods.

V. RESULTS AND DISCUSSION

1. Environmental

Area air samples collected in the 3 buildings which contain PCBs indicated that in the two buildings that house the UPS systems, PCB air concentrations exceeded the NIOSH criteria (Aroclor 1242 was the only PCB detected in any of the samples). The levels (3.95 ug/M^3 in building 103, and 4.48 ug/M^3 in building 154) indicate incomplete decontamination following a spill. Residual PCBs on the surfaces of the buildings are volatilized as a result of the heat generated by the UPS systems. Even though the systems are ventilated, the sampling results indicate a continuing source of PCBs.

In building 41, where the "dead" capacitors were stored, the level of airborne PCBs was below the limit of detection (0.05 ug/M^3). This can be accounted for by the fact that the sample was collected in this unheated room during the winter. The extremely cold temperature in this room (below 30 F) minimizes the possibility of volatilizing the liquid PCBs. However, the circumstances may be quite different during the summer.

It is difficult to adequately assess the extent of employee exposure to PCBs without personal sampling data. However, after reviewing employee work practices at the Winter Harbor facility, it was obvious that a specific protocol for employee protection was lacking.

Even the Navy's attempt at providing personal protective equipment was inadequate in the following respects: (1) TYVEK^{R} type 14 protective suits are not intended for use with PCBs. These suits are designed for dust hazards such as asbestos, but offer little or no protection against liquid PCBs; (2) The respiratory protection purchased for the use of employees "in areas of unknown concentration" do not meet the criteria for respirator selection recommended by NIOSH in the PCB Criteria Document. The selection of a chemical cartridge respirator for use in indoor locations is also not in accordance with the Navy's own PCB guidelines. Appendix B of the PCB Compliance, Assessment, and Spill Control Guide specifically recommends these respirators "be worn when cleaning up PCB spills in outdoor locations". NIOSH recommends the use of air supplied respirators in areas where the levels of PCBs are above the NIOSH criteria, or in areas of unknown concentration.

Other areas where the Navy's PCB program is substantially deficient are: (1) employee education and training; in that employees have had no formal instruction in the use of protective equipment and its limitations, (2) Sanitation; in that facilities for shower baths are not available, (3) Environmental monitoring; in that exposure levels of employees have not been determined. These environmental evaluations are especially necessary in light of the high levels of PCBs found in the UPS system buildings.

2. Medical

Biological monitoring of 3 employees was performed by the Navy in December 1980. The Navy reported that two employees had slightly elevated liver enzyme levels and the third was normal. Total PCBs in blood was reported normal in all three cases. No interpretation of these results is included in this report. Employees in Shop 10 did not have visible signs of skin disorders.

Clinical measurements of the effect of PCB exposure are not easily interpreted. Dose - Response relationships have not been confirmed with PCB exposures. Therefore, medical surveillance is not as reliable as environmental monitoring in assuring protection against the harmful effects of PCB exposure.

VI. CONCLUSIONS

Based on the data obtained in this evaluation, NIOSH has determined that a potential health hazard existed at the U.S. Naval Security Group Activity, Winter Harbor, Maine. This conclusion was arrived at after it was determined that PCB levels in the UPS system buildings exceeded the NIOSH criteria, and that employees often enter these buildings without personal protective equipment.

VII. Recommendations

In view of the findings of NIOSH's environmental and medical evaluations, the following recommendations are made to reduce and/or eliminate employee exposure to PCBs.

1. Environmental

A. Decontamination

Wipe samples should be collected from the surfaces of the buildings to identify the areas of contamination. Once identified, a rigorous program of decontamination should initiated, following the procedures in the PCB Compliance, Assessment and Spill Control Guide (pp. 35-36). After decontamination is completed, the concrete floors in the capacitor bank areas should be covered with an epoxy paint or coating to seal in any residual PCBs and to render the floors non porous. This will also aid in subsequent spill clean-ups, as the PCBs will not soak into the concrete.

B. Respiratory Protection

The NIOSH Criteria Document states that there are three conditions under which compliance with the permissible exposure limit may be achieved by the 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 activity, 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/M^3 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.

C. Environmental Monitoring

Personal breathing zone environmental monitoring should be performed during an actual PCB spill clean-up. This data will be useful in determining if employees require the respiratory protection as

outlined above. Until environmental data is available that rules out the possibility of PCB exposure in excess of 1.0 ug/M^3, the above respiratory program should be complied with routinely. Also, employees should not be allowed to enter a building following a spill clean-up until environmental monitoring indicates that the decontamination is complete. Records of these evaluations, including the basis for any conclusion that there may be no exposure to PCBs, should be retained until the next survey has been completed.

Finally, personal 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.

C. Personal Protective Equipment and Clothing

Due to the nature of PCB spills at this facility, an assessment should be made each time a spill occurs as to what protective equipment is necessary. Eye protection and gloves are necessary for each clean-up operation. Aprons, coveralls and boots would be necessary when it is likely that other parts of the body may contact the PCBs or PCB contaminated material.

Respiratory protection should conform to paragraph (A) above.

2. Medical

A. The following medical surveillance should be made available to those Antenna Maintenance Group members who may come in contact with or routinely respond to PCB problems.

(1) Preplacement or initial medical examinations for workers which includes:

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

(b) Comprehensive physical examination with particular attention to the skin and to hepatic function.

(c) A judgement of the employee's ability to use positive pressure respirators.

(2) All female workers should be advised of the potential adverse effects of PCB on the unborn child, especially those of childbearing age. Those who bear children while working with PCBs should be counseled concerning the advisability of nursing their babies.

(3) If evidence of adverse effects of exposure to PCBs is suspected or confirmed, appropriate medical care should be made available to the affected worker(s).

3. Sanitation Practices

(A) 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.

(B) 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.

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

4. 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, the following information should be referred to and emphasized as necessary:

(A) The Navy should institute an education program to ensure that all employees occupationally exposed to PCBs have current knowledge of job hazards, proper maintenance and clean-up methods, and proper use of protective clothing and equipment, including respirators. Emphasis should be placed on using this protective clothing and equipment any time 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.

(B) 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.

(C) 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 should also be informed that adverse reproductive effects may result from occupational exposure to PCBs.

(D) 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".

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IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

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4. Maine Health Department
5. OSHA, Region 1
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