U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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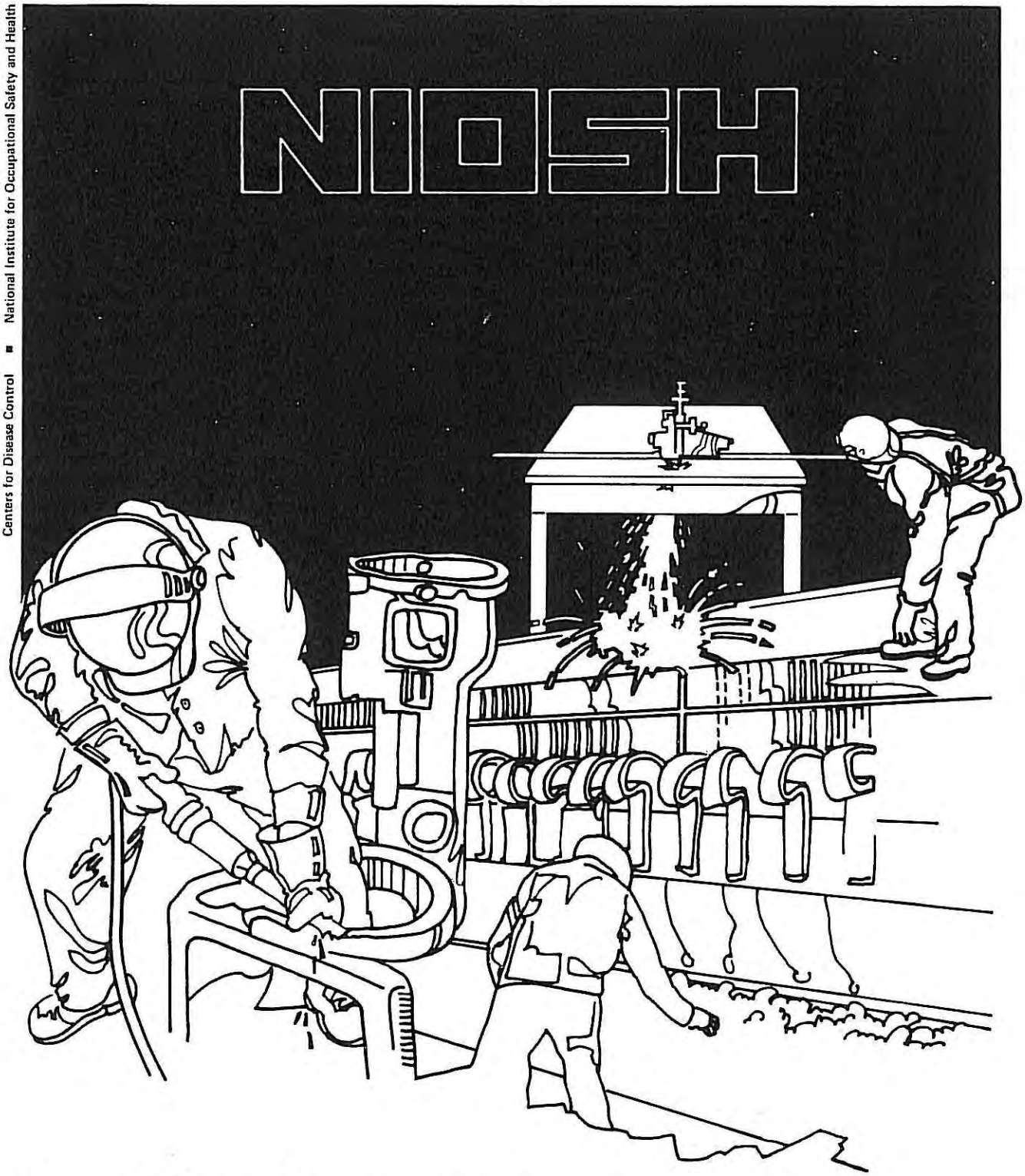
NIOSH



Health Hazard Evaluation Report

HETA 80-212-1474
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

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 80-212-1474
JUNE 1984
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

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I. SUMMARY

In August 1980 the National Institute for Occupational Safety and Health (NIOSH) received a request from Pacific Gas and Electric (PG&E), San Francisco, California, to evaluate the exposure to employees from polychlorinated biphenyls (PCBs) during repair and overhaul of electrical devices and in receiving yards or depot where these electrical devices containing PCBs are stored. Because of the number of employees involved in these types of activities within the PG&E network (4000-5000), NIOSH, in conjunction with PG&E's management and union representatives, selected a sample population from each of the groups/categories considered to be representative of the concerns mentioned in the request. NIOSH also evaluated employees who work in one of PG&E's receiving yards (depot) where electrical devices and various materials containing PCB's are handled, stored, and eventually shipped to a contract disposal site. Finally, NIOSH attempted to evaluate the potential exposures to PG&E employees who were involved in PCB fires, explosions, spills and clean-ups.

NIOSH conducted environmental and medical evaluations from September 1980 through February 1982. Personal and area environmental samples were obtained, and personal protective procedures used during the various exposure conditions was evaluated. Personal skin and surface wipe samples were obtained at each of the sites surveyed. The medical evaluation consisted of medical questionnaires; medical screening for chloracne, liver enlargement, and neurologic impairment. Blood was also collected for serum PCB levels.

NIOSH determined that the personal airborne samples taken for PCBs at each of the various operations evaluated were less than the NIOSH criteria of 1 ug/M^3 (range from non-detectable to 0.005 ug/M^3). Wipe samples taken of surface areas which a worker would be in contact with and wipe samples of the worker's face and hands did indicate the potential for exposures to a portion of the employees evaluated. The wipe sample results ranged from 1.5-2.63 ug/sample for hands and face and 0.24-5.0 ug/sample for surface wipe contamination.

The medical evaluation showed no acute symptoms among fifteen (15) workers evaluated. The serum PCB levels for these employees ranged from 21-70 parts per billion (ppb) with a mean serum PCB level of 44.7 ppb. The usual upper limit of normal range in unexposed populations for PCBs is 30 ppb and NIOSH found 73% of the employees blood serum levels exceeding this value. The years of exposure ranged from 1-26 years with over 60 percent of the workers having been exposed within the last seven years.

Based on the environmental air samples obtained at each of the survey sites, NIOSH determined that a health hazard did not exist at the various operations investigated. It was determined, however, that a potential health hazard did exist to PG&E's Decoto depot yard employees. This is based on: (1) Wipe samples taken which indicated PCBs on the worker's skin, work surfaces, as well as PCB contamination found in various areas in the Decoto yard; and (2) Elevated serum PCB values (which may indicate exposures to PCBs in the past). Recommendations are included in Section VIII of this report to assist PG&E in reducing those PCB exposures found at the receiving depot. Current information regarding PCDDs and PCDFs are also referenced in this report.

KEYWORDS: SIC 4911 (Establishments engaged in the generation, transmission and/or distribution of electric energy for sale), polychlorinated biphenyls (PCBs), polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) transformers, capacitors, switches, repair, overhaul, removal, receiving depot, linemen, equipment operator, cable splicer, electrician, current limiting fuses, and emergency spills and clean-ups.

II. INTRODUCTION

On August 4, 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request for assistance from Pacific Gas and Electric Company (PG&E), San Francisco, California. The request was to determine if there were any health concerns which would be associated with exposure to polychlorinated biphenyls (PCBs) in a number of the field operations where PCBs are found.

Until 1980 the normal exposures to PCBs would be to PG&E employees who repaired and overhauled electrical devices (e.g., capacitors, transformers, regulators, switches, etc.). Other potential sources and/or exposures to PCBs would be to those employees who work in receiving depots or yards where the above devices are stored (new or damaged) or to employees potentially exposed during PCB fires, explosions, spills or clean-ups. In 1980 however, PG&E announced a program to phase out and replace all capacitors containing PCBs in its network. Because of this effort it was thought that the potential for an increase in exposure to PCBs would put the employees involved in this handling program at higher risk. Therefore, NIOSH in conjunction with PG&E's management and union representatives selected a sample population from each of these groups to evaluate both environmental and medical concerns.

NIOSH also re-evaluated PG&Es personal protective program and materials handling for those employees exposed to PCB's. The original evaluation was performed in 1980 (HHE 80-85) and since that time PG&E has incorporated many of the NIOSH's recommendations into the current PCB health and safety program.

NIOSH conducted environmental and medical surveys from September 1980 through February 1982. The results and recommendations presented in this report were given to the company and union representatives as they became available.

Due to recently published information regarding PCBs and their relationship to polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) reference concerning these contaminants are also discussed in this report. NIOSH did not evaluate these chemicals during the study period due to a lack of technical information available at that time (i.e., inadequate sampling and analytical methods).

III. BACKGROUND

Pacific Gas and Electric is a utility company which has its headquarters in San Francisco, California. The company provides and services primarily natural gas and electric power to areas throughout California. At present PG&E has thirteen main divisions and numerous districts throughout its network. There are approximately 5,000 service personnel within the entire PG&E network and many of these workers have been or are presently directly involved in operations where electrical devices containing PCBs are found.

Since the banning of PCBs in 1976, the normal activities where service personnel encounter PCB exposures in the PG&E network are during inspection and maintenance of electrical devices such as transformers,

regulators, and switches. Each of these devices can be tested or evaluated at any time, but this would not normally put the operator in direct contact with the liquid material. These devices can, however, require emergency attention, as well as more involved maintenance which could place the operator in direct contact with either liquid and/or dust laden PCB materials.

Two other situations which can potentially place an employee in contact with PCB's are from emergencies (i.e., fires, explosions, spills and clean-ups) or during a recently announced program by PG&E which is to remove all of its capacitors filled with PCB's from its entire network.

The following are examples which briefly discuss normal exposure situations; PG&E's voluntary removal program, fire/explosion/spills and clean-up procedures, and PG&E's hygiene and safety concerns while working with PCB's. A discussion regarding PCB's involved with high temperatures, fires and explosions and the current concerns associated with PCDDs and PCDFs is also discussed.

A. Normal Exposures

Some examples of maintenance operations on electrical devices where PCBs are encountered are during inspections and maintenance of Tap-changer Transformers (selector compartments) and periodic overhauls on regulators (e.g. 4KV type regulators).

1. Tap-changer Transformer Inspections

Tap-changer transformer inspections and maintenance operations are routine and can be performed on any day in the PG&E network. This operation normally takes 2-3 operators and begins by first making the equipment safe to work on (i.e., disconnecting terminals, grounding the transformer, etc.). Once completed the tap-changer's oil is pumped out and access to the internal portion of the transformer is then performed. At this point the operator wipes all the oil off the doors and tap-changer mechanisms. Once completed the unit is inspected, repaired, and adjusted as required. After this the unit is closed, the oil is filtered back into the tap-changer, and the oil is tested for its dielectric strength. The last phase of this process requires the operators to remove the bag-filter hoses, fittings from the unit, and clean up the area around the outside of the unit.

2. Regulator Overhauling

The second routine operation, overhauling of regulators at substations or other facilities where regulators are housed, can take 4-5 workers from 3-5 hours to complete one regulator. On the average 2-3 regulators can be completed in one day assuming there are no problems with an individual unit. Normally the overhaul process begins the same as the example described earlier. That is, taking the individual circuit that is being worked on off-line (e.g., disconnecting terminals, grounding, etc.). This type of overhaul requires each of the units to be

physically moved by a crane to an open area for overhauling. Once the individual unit is in an open area the regulator mechanism and electrical windings are removed from the tank one phase at a time with the overhead crane. After this breakdown is complete the dielectric oil is removed and filtered, and the tank is then cleaned out. At this point the regulator mechanisms are cleaned, inspected, replaced and/or repaired as necessary.

Finally, the oil is filtered back into the regulator tank; the mechanisms are placed in the tank, and the oil is tested for its dielectric strength. Once this is completed the unit is put back into the bank and the next unit begins the same cycle just described.

There are other examples of operations where PG&E employees encounter PCBs on a routine basis; however, the above were examples that NIOSH choose to evaluate that illustrate a fairly routine prolonged exposure. The personal protective equipment and safe work procedures used by the operators during these types of activities are described later in this section.

B. Voluntary PCB Removal Program

A major portion of the interest in this study was the new policy adopted by PG&E in August 1980 concerning PCBs in its network. The following is a description of this policy:

In August 1980 PG&E announced a voluntary program to replace all capacitors filled with polychlorinated biphenyls (PCBs). This program was to consist of an orderly phaseout of PCB equipment from the PG&E network. The first step of the program was replacement of pole-top capacitors in the most sensitive locations, namely those near waterways, neighborhoods, and commercial areas.

PG&E also announced that it would install current-limiting fuses on some capacitor banks pending delivery of non-PCB capacitors. These fuses have proven to be effective in reducing the chances of rupture when capacitors fail, and therefore reducing the possibility of PCB exposure. The installation of fuses was to be completed by the end of 1980.

The next phase of PG&E's program was re-engineering the locations of capacitors on its transmission and distribution system so that replacements would be installed where they will be most effective. Locations near schools, food processing facilities, and high density residential areas would be given priority. Manufacturers of these units began delivery of replacement capacitors during the NIOSH study and these were being assembled into banks for pole-top installation.

This program required a concentrated effort on each of the 13 districts to remove the equipment and store it temporarily (less than 72 hours). There are approximately 150 locations throughout the systems that are allowed to receive equipment as in the program

described above. This is also the case for PCB laden materials which may have been involved in a fire, explosion, spill or clean-up. At the present time, however there is only one facility (the Decoto Yard in PG&Es East Bay Division) that is permitted to store PCBs and PCB contaminated materials for disposal in excess of 72 hours. The most frequently used of the former locations is PG&Es Emeryville Shop which is also located in the East Bay Division and is the site of a transformer repair facility.

C. Fire/Explosion/Spills and Clean-ups

1. Policy and Procedures

Situations where PG&E employees become involved with a fire, explosion, spill or clean-up occur occasionally each year. These types of situations when they occur, are still cleaned up principally by PG&E crews. There is no fixed policy regarding the hiring of hazardous waste specialty contractors. Any decision to retain a contractor is still made on the basis of individual case circumstances. These would include available manpower, weather conditions, size and location of the spill and a number of other considerations.

As stated in a previous NIOSH-PG&E study (HHE 80-85), it was thought to be impractical for NIOSH to attempt to perform environmental monitoring for conditions that would require a standby situation, as well as an immediate response in order to adequately characterize these types of exposures. However, during the developmental stages of the current study NIOSH did include these concerns in their environmental protocol. Basically, arrangements were made to notify all parties concerned (i.e., PG&Es management and union officials and NIOSH personnel) in order to evaluate these situations if they should occur during the study period.

During August 1981 an explosion situation did occur in Embarcadero Center, San Francisco, California, in which PCBs were a suspected contaminant and NIOSH Region IX personnel did perform environmental sampling during the episode. The following is a description of the events that took place during that time:

On Tuesday afternoon, August 25, 1981, a construction company working in the San Francisco business district (Embarcadero Center) inadvertently ruptured a 16 inch gas line. The gas eruption forced the evacuation of 15-20 buildings and a four-square block area was cordoned off. The San Francisco Fire Department officials noted an oily residue at the site and contacted the California Occupational Safety and Health Administration (Cal-OSHA) for technical assistance. The oil was analyzed by PG&E and Cal-OSHA and was found to contain traces of PCB (less than 25 ppm) which was below the Environmental Protection Agency standard (50 ppm) NIOSH conducted air and wipe monitoring during the clean-up operation in order to determine if there was any potential exposures to the clean-up personnel.

D. PG&Es Hygiene and Safety Program

The following subsections (1-3) are excerpts from PG&E's current Transmission and Distribution Bulletin No. 2-50 Revision #4 and #5-Effective September 1, 1980 and June 15, 1983 respectively. These excerpts specifically relate to PG&E's Hygiene and Safety Program (i.e., Materials Handling, Protection of Personal and Maintenance In Enclosed Spaces).

Note: NIOSH recommendations to further improve this information are discussed later in this report.

During normal operations where PCBs are involved PG&E employees are equipped, if required, with coveralls, gloves, boots, and NIOSH/MSHA approved respirators. All waste materials are disposed of in heavy bags (e.g., rags, soil, clothing, etc.) and eventually sent to a contract disposal site. If, on the otherhand, a situation should arise which requires more careful handling (.e.g., fire, explosion, spill or clean-up) then the following concerns would be instituted:

1. Materials Handling

During the control and clean-up of PCB leaks, spills, fires, and explosions PG&E employees are required to follow the specific safe work practices and environmental safeguards set forth in their Transmission and Distribution Bulletin No. 2-50, Revision #4 and 5-Effective September 1, 1980 and June 15, 1983. The following description is an example of the present program PG&E has for handling PCB fires, explosions, spills and clean-ups:

Upon receipt of notice of a potential PCB fire, explosion and/or spill a PG&E troubleman is dispatched to the scene to determine whether a full maintenance crew is immediately required. Notice is typically received in either the form of a telephone call from a customer to report a leak or a more serious situation involving a capacitor, or in the form of an automatic circuit relay alarm which is observed by the district operator. The normal response time for these types of situations are from 15-20 minutes.

The troubleman will electrically isolate a damaged capacitor bank using a 35 foot "extendo" stick and, if needed, he will place traffic cones around the contaminated area. The troubleman's call for a full maintenance crew is handled by the Electric Transmission and Distribution Department at the Oakland Service Center. If the capacitor unit is observed by the troubleman to be intact and not damaged, on instructions from the district operator the troubleman will re-fuse the bank and test.

Should the troubleman observe a capacitor unit to be swollen but not ruptured, again on instructions from the district operator, he will electrically isolate the damaged unit and the

replacement will be scheduled as a routine matter for the maintenance crew. The re-fusing procedure discussed above is not employed during night work. The reason for this is to minimize the potential of a PCB incident during the hours of darkness, which could hamper clean-up procedures.

2. Protection of Personnel

Based on the recommendations presented to PG&E in NIOSH's prior study (HHE 80-85) a number of these were incorporated into PG&Es revised September 1980 Bulletin and other recent PG&E correspondence. A portion of the recommendations concerned medical and environmental monitoring; respiratory protection, confined spaces, sanitation, and training and educational concerns. The following are excerpts from PG&Es Transmission and Distribution September 1980 Bulletin:

In general, the probability of a toxic reaction to PCBs depends on the concentration of and length of exposure. Occasional short-term exposure to PCBs, such as cleaning of a capacitor spill or handling a leaking transformer, has not been shown to have any significant toxic effects to utility operators. However, continuous unprotected exposure to high concentrations of PCBs have indicated that serious physical disorders, such as chloracne, jaundice or swelling of the kidneys and heart could develop. Laboratory experiments on animals suggest that several types of PCBs may cause tumors in animals. Many scientists feel that additional research is needed before any firm conclusions on human carcinogenicity can be reached.

The primary form of PCB exposure is presently considered to be through skin contact, since ingestion is unlikely and PCBs do not emit vapors at room temperature. Hot PCB fluids, however, do emit vapors which should be avoided. In this case one is referred to the "Precautions in Enclosed Spaces" section which states the following:

Do not enter vaults or enclosures where a PCB transformer's relief device is known to have operated, or where a transformer switch or capacitor has failed, until the area has been thoroughly ventilated.

Potentially harmful vapors may be generated when PCBs are subjected to severe internal arcing. The primary vapor produced is hydrogen chloride. The pungent, and somewhat suffocation effect from fumes of this gas are easily detected and should alert personnel intending to enter a vault or enclosure. If it is necessary to enter an enclosure where PCB fluid has vaporized before proper ventilation has been provided, a selfcontained breathing apparatus must be worn.

In case of accidental contact, wash the skin thoroughly with waterless hand cleaner and wipe off with rags or paper towels. These materials must be disposed of in an approved container. Soap and water may then be used to further insure cleansing of the skin.

Eye contact with PCBs can result in painful, temporary irritation. If contact with the eye occurs, immediately irrigate the eye with copious amounts of water for 15 minutes and contact the company physician for examination of the eyes.

When contact with PCBs is anticipated, disposable protective equipment shall be worn. This equipment consists of coveralls, plastic overshoes, vinyl coated gloves, and face shields. Sleeves of coveralls should be taped to the outside of the vinyl coated gloves to eliminate possible exposures to hands and wrists. Small spills, such as pole mounted capacitor failures, do not normally require respiratory protection. However, those who may want to wear respirators should be identified and fitted with an appropriate respirator prior to any cleanup to avoid delays when a spill occurs. Any member of the cleanup crew that has not been previously fitted, but decides at the job site they want to wear a respirator, will be fitted at that time by a supervisor qualified to do so.

Beards will not be a reason to refuse cleanup duty. Those with beards should be queried ahead of time regarding respirators and should be fitted if they indicate they will want a respirator. Disposable work clothing, equipment, and full and half-mask respirators are coded items. They may be ordered on requisitions and shall be made available at all district and division operating headquarters where PCB cleanup or handling may be encountered. After completion of PCB handling or cleanup, the disposable protective clothing shall be removed immediately and placed in an approved container. Gloves shall be removed last.

Hands should then be thoroughly cleaned with waterless hand cleaner and wiped with rags or paper towels. All materials used in cleanup should then be placed in an approved container. Clean-up personnel are not to eat, drink, smoke, or use toilet facilities until they have removed all protective clothing, are out of the spill area, and have cleaned hands as described above.

3. Maintenance in Enclosed Spaces

Transformers and capacitors located in manholes, vaults, and other enclosed spaces will occasionally require routine maintenance, such as addition of insulating fluid, tap changes, or removal due to lead changes.

When it is necessary to perform routine servicing or maintenance on PCB insulating equipment in enclosed spaces, it will not be necessary to use any special breathing apparatus. The quantities of PCBs released to the atmosphere during these activities are negligible. Proper protective clothing must be worn if the servicing or maintenance may result in personal contact with PCBs.

Personal clothing or body belts that have become contaminated shall be removed as soon as possible, and the contaminated articles shall be placed in heavy (6 mil) plastic bags. The bagged clothing and/or body belt shall be returned to the crew headquarters and held for disposition.

E. Current Interests - PCDDs and PCDFs

NIOSH has recently conducted a number of HHE's concerning the extent of polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in PCB assessments. A major consideration in these investigations are the number of chlorine atoms in PCDFs and PCDDs compounds. These vary between one and eight, and because of various levels of chlorine substitutions, there are 135 possible positional isomers of PCDFs and 75 possible positional isomers of PCDDs. PCDDs and PCDFs have isomers ranging from the mono to the octachloro compounds. In addition, commercial PCB formulations have been shown to contain polychlorinated naphthalenes (PCNs) as contaminants.

NIOSH's Current Intelligence Bulletin (CIB) #40 on Dioxin was published January 23, 1984 and a similar document on PCBs and related concerns regarding contaminants such as dibenzofurans should be available in the near future. The following is a portion of the information collected to date from NIOSH's investigations and a portion of the information that is contained in the documents described above:

NIOSH's investigations have shown that PCDDs and PCDFs may either be present in commercial PCB as contaminants or evolve, as with PCDFs to a higher degree where PCBs are involved in a fire or explosion. Studies have demonstrated that commercial PCB mixtures and individual PCB isomers can be converted to PCDFs under pyrolytic conditions. Pyrolysis of commercial PCBs (Aroclor 1242 and 1260) in the presence of air at temperatures between 500 to 700 degrees C resulted in a yield of 3 to 24% PCDF calculated on the amount of PCB decomposed. No net PCDF formation was detected at 700 degrees C. Pyrolysis of eighteen individual PCB isomers in the presence of air at 600 degrees C resulted in a yield of 0.1 to 2.8% PCDFs.

Significant PCDF formation also has resulted during fires involving transformers and large capacitors. Analysis of soot from a transformer fire showed a total concentration of 5ug/g PCDF compared to 0.05 ug/g PCDF in the original askarel demonstrating that pyrolysis of the fluid resulted in a 100-fold increase on the PCDF concentration. Analysis of soot from a capacitor fire showed a total concentration of 75 ug/g PCDF compared to 1.1 ug/g PCDF in the original dielectric fluid demonstrating that pyrolysis of the fluid resulted in a 70-fold increase in the PCDF concentration.

Concerning dioxins an office building fire in Binghamton, New York showed both the presence of dibenzofurans and dibenzo-p-dioxins. Air samples found levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) at 3 pg/m^3; total TCDD at 5 pg/m^3 2,3,7,8-tetrachlorodibenzofurans (TCDF) at 26 pg/m^3, and total TCDF at 292 pg/m^3. Analysis of the soot revealed significant amounts of the various

congeners and isomers of PCDFs and polychlorinated biphenylenes (PCBs). The concentration of 2,3,7,8-TCDD in the soot ranged from 0.26 to 2.9 ppm.

Based on examples like those described above it is now being considered that the isomeric content of the PCB formulation is very important to the nature of the pyrolytic products that may be expelled in the event of fire or explosion. As described above it is now known that particular isomers of pentachlorobiphenyl more readily and most directly form the most toxic polychlorinated dibenzofuran (PCDF) and 2,3,7,8-tetrachlorodibenzofurans (TCDF) under these conditions.

PCBs manufactured in the United States have been found to contain up to 2 ppm PCDF as contaminants and temperatures around 300 degrees C can increase concentrations of PCDFs with 550 to 650 degrees C as the point of maximum conversion. Although the available literature indicates that PCDDs may not be present as contaminants in commercial PCB formulations, the lack of scientific knowledge on the minimum conditions (heat, pressure, arcing, catalytic action, etc.) leading to PCDD formation serves as a basis for considering the PCDDs in askarel characterizations.

Because of the above concerns it is felt by NIOSH that these chemicals should also be considered as a possible occupational health problem to the employees who may be involved in handling such emergency situations as described above. These chemicals were not evaluated in the current investigation due to the lack of information known about them at the time of the NIOSH survey (i.e., lack of good sampling and analytical techniques). Therefore, current information regarding PCDDs and PCDFs is presented in this report to inform and assist management and union officials of these current concerns.

IV. EVALUATION DESIGN AND METHODS

A. Protocol

NIOSH, in conjunction with PG&E's management and union officials, developed an environmental and medical protocol to address those groups of employees considered to be at greatest risk to PCB exposures. Any PG&E employee who works with the electrical systems in question is potentially at risk. NIOSHs immediate concerns, however, were those groups of employees who work more frequently with PCBs. This would include the following operations and employees which NIOSH felt were the highest risk population who currently work with PCBs.

1. Employees involved in the removal of capacitors and transformers, as well as PCB fluid from transformers under the Pacific Gas and Electric Company PCB removal program.

2. Employees working at the De Coto receiving facility during the period that the equipment containing PCBs is received under the removal program.

3. Employees involved in PCB fires, explosions, spills and/or incidences which require clean-up.

Design of this study was primarily restricted to those employees located in the East Bay Division who were involved in the removal of capacitors and transformers; removal/replacement of PCB fluid from the transformers and workers at the De Coto receiving facility. Due to the irregular nature and timing of exposures among workers in group 3 it was not certain that NIOSH would have an opportunity to evaluate such situations. NIOSH did, however, have an opportunity to evaluate one unusual spill where PCBs were suspected (this was described earlier).

B. Environmental

Each of the employees working at the operations described above were evaluated using personal and area air monitoring devices; bulk sample analysis, and wipe samples of employees skin and suspected contamination surfaces. The following is a description of the sampling techniques used:

1. Personal and area samples were monitored for PCB vapors using P&CAM Method No. 244 with Florsil tubes. Air was drawn through the filters at a flow rate of one liter per minute (lpm). The dust laden PCB sampling was performed using AA filters, and a flow rate of 1.5 lpm was used. The samples were analyzed by gas chromatography/electron capture.

2. Personal and surface wipe samples were also collected at each of the work operations evaluated. Employees skin contamination of PCBs was studied by obtaining wipe samples from the hands and forehead of the workers. Surface area contamination from various work surfaces and hand-held tools at the workplace was also evaluated. The surface area sample size was approximately 75-100 cm^2 for the palmar and forehead surface of each person seen. When appropriate 75-100 cm^2 was also used for each of the work surface areas evaluated. The wipe samples were collected on Whatman smear tabs which were moistened with distilled water.

3. Bulk samples were collected only at the De Coto pipe yard. These samples consisted of dust scraped from surfaces both in the enclosed structure and at various locations around the yard. These samples were also analyzed by gas chromatography/electron capture.

C. Medical

All PG&E employees in the Bay Area belonging to groups 1 and 2 were

invited to participate in the medical testing program. Workers were asked to complete a brief questionnaire regarding their work history, other potential occupational exposures, history of alcohol use, medical history, and symptoms potentially related to PCB exposure. A NIOSH medical officer examined the workers for evidence of chloracne, liver enlargement, and neurologic impairment. Seven (7) cc's of blood were collected from each worker for analysis of serum PCB levels.

Analysis of the blood samples for PCB levels were performed using P&CAM No. 329, using a capillary column for quantification instead of a packed gas chromatographic column.

V. EVALUATION CRITERIA

A. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures. The following is the present criteria established by ACGIH, OSHA, and the justification for the present NIOSH recommended criteria:

> The ACGIH has two Threshold Limit Values (TLVs) for PCBs--0.5 milligrams per cubic meter of air (mg/M^3) for chlor- odiphenyl (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 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.

B. Medical

The medical criteria used to determine a toxic response to PCBs consist of signs and symptoms produced in significant occupational exposures.

PCBs have low acute toxicity but are of broader concern because they persist in the environment, bioaccumulate in human and animal tissues, and have a high potential for chronic or delayed toxicity. PCBs were introduced into industry in the early 1930s, and have been used widely since then because they are chemically stable, of low volatility, nonflammable, and have high dielectric constants. The most significant remaining use of PCBs is as heat exchange and dielectric fluids in transformers and capacitors constructed before 1977. Utility workers, electricians, appliance service workers and fire-fighters are the occupational categories at highest risk for continued exposure to PCBs.

Commercial products containing PCBs are mixtures of various chlorinated biphenyls, and are described according to the percent of chlorine in the mixture. While the degree of chlorination and structure of the chemical affects the rate of metabolism and excretion of PCBs, the clinical importance of this is not known. Common trade names for PCB compounds are "Aroclor" and "Askarel". All commercial products are contaminated to some extent with the polychlorinated dibenzofurans (PCDFs). The toxicity of PCDFs is much greater than PCBs in comparative animal studies; they are structurally similar to the dibenzodioxins.

Because PCBs are resistant to metabolic transformation, they persist in the environment and bioaccumulate in fish, wildlife and man. Detectable concentrations of PCBs have been found in the majority of samples of serum, fat tissues and breast milk from all geographic areas of the United States. The levels in human serum are typically less than 20 parts per billion (ppb) but range up to 30 ppb. Levels reported from adipose tissue (fat) are somewhat greater(usually less than 1 but ranging up to 2) parts per million (ppm), and residues measured in human milk have ranged from 40-100 ppm.

1. Human Toxicology and Epidemiology

PCBs are absorbed well by all routes (skin, gastrointestinal, inhalation). Distribution is primarily into fat, and excretion is quite slow so that bioaccumulation occurs even at low exposure levels.

2. Acute Toxicity

PCBs have very low potential for producing acute toxic effects, consistent with a very high acute oral LD_{50} in animals (1-10 grams/kg for rodents). Eye and skin irritation have been reported after occupational exposures at 0.1-10 mg/m^3.

3. Dermatologic Effects

Exposure to PCBs, dibenzofurans and dibenzodioxins have been associated with a specific skin rash known as chloracne. This superficially resembles adolescent acne. The distinctive lesion is the indurated cyst, (1-10 mm), and unlike adolescent acne, chloracne may occur at any age and may involve the trunk, arms and legs as well as face, neck and back. Chloracne may result from external contact or from systemic absorption of PCBs; onset is within days to weeks after a single large exposure, and at varying lengths of time after the beginning of chronic low-level exposures. Threshold blood levels for the development of chloracne have not been established.

4. Liver Damage

Abnormal liver function tests have been correlated with PCB exposure or serum levels in several studies and clinical hepatitis has been observed after accidental ingestion. Liver damage is the most consistent histological finding associated with PCB exposure among the many laboratory animal species tested, and is usually the most sensitive indicator of PCB exposure among the many laboratory animal species tested, and is usually the most sensitive indicator of PCB exposure in humans, elevated triglycerides have also been correlated with serum PCB levels.

5. Reproductive Effects

A wide range of reproductive and transplacental effects in humans have been associated with the ingestion of PCBs. Adverse reproductive effects found in many mammalian and avian

species include lowered fertility, birth weight or postnatal survival, but no direct teratogenic effects. Reproductive effects in males have not been adequately studied.

6. Carcinogenicity

Several PCB mixtures produce liver tumors (hepatocellular carcinomas) in rodent bioassays, and cell transformation assays are also positive. NIOSH, the International Agency for Research of Cancer (IARC) and the EPA have concluded that PCBs should be considered potential human carcinogens. No threshold has been determined for PCBs or any other carcinogens.

7. Other

The principal biochemical effect of PCBs is the stimulation and induction of certain enzyme systems, observed in both man and animals, primarily in the liver but also in the kidney, adrenals, lung, gut, skin, and testes. This has potential for altering the incidence of disease secondary to increased metabolism of endogenous or exogenous substances, and for interference with medical therapy due to increased metabolism of administered drugs. PCBs have also been reported as immunosuppressants and to have endocrine effects in animals. This is presently being studied in occupationally exposed populations.

8. Blood Serum - Evaluation Criteria

PCBs are resistant to metabolic transformation. Therefore, they persist in the environment and bioaccumulate in fish, wildlife, and man. Trace amounts of PCBs have been found in human blood, fat and milk in over 50% of people sampled in all geographic areas of the United States. These "background" levels in human serum are typically less than 20 parts per billion (ppb). Levels reported from adipose tissue are somewhat greater (1-2 parts per million [ppm]), and residues measured in human milk have ranged from 40-100 ppm.

Although there are no widely accepted normal values for serum PCB concentrations, levels can be compared to published values both for occupationally exposed groups and community groups without any known unusual exposure . Previously published studies have demonstrated that PCBs can be found in the serum of most non-occupationally exposed persons. Such studies have reported serum PCB values ranging from 0 to 42 parts per billion (ppb), with mean concentrations ranging from 2.1 to 24.4 ppb. In the largest study involving 616 individuals, the range of serum PCB was 0 to 29 ppb (refer to HHE 82-246).

Based on these findings in a group without unusual exposure to PCBs, a reasonable acceptable upper limit value for serum PCB would appear to be around 30 ppb.

Normal serum PCB levels for non-occupationally exposed persons are levels equal to or less than 30 ppb. Chloracne is not expected in a non-exposed population. Therefore, at present NIOSH feels that 30 ppb is a reasonable lower limit value for serum PCB levels in occupationally exposed populations.

Higher PCB serum levels have been found among occupationally exposed groups. A study measuring PCB serum levels in populations with and without occupational exposure in Bloomington, Indiana, found the following levels:

	Mean Serum PCB (ppb)
Sludge workers	17.4
Workers with occupational exposure	75.1
Workers' families	33.6
Community controls	24.4

No chloracne or systemic symptoms were discovered.

More recently, Maroni, et.al., reported results of PCB measurements done on whole blood of 80 electrical workers exposed for many years to PCB mixtures in a plant in Italy. They reported that mean PCB recovery from serum is approximately 60% of the recovery from whole blood. Their results were as follows:

	ppb (Mean $\pm$ SD)	Range
60 currently exposed workers	377+258	88-1319
17 past exposed workers	292$\pm$161	94-631
3 workers with occupation exposure	110$\pm$31	88-146

C. PCDD and PCDFS-TOXICOLOGY

Exposures to polychlorinated biphenyls, dibenzofurans, biphenylenes, or dioxins result in similar adverse health effects. However, the relative acute toxicity of these classes of compounds varies considerably. Dibenzofurans are approximately 1,000 times less acutely toxic than dioxins and biphenylenes show a similar acute toxicity to the diben- zofurans. The toxicity of the individual isomers within each class of compounds also varies considerably (refer to NIOSHs CIB #40 and HHE 82-246).

In general, PCDFs and PCDDs are tricyclic aromatic compounds which exhibit similar physical, chemical, and biologic properties. The most toxic of these compounds are believed to be 2,3,7,8-tetra-CDD and 2,3,7,8-tetra-CDF, which have LD50 values (lethal dose in

micrograms per kilogram of body weight for 50% of the animals tested) of only 0.6 ug/kg and 5.0 ug/kg respectively when administered orally to guinea pigs. The LD50 dose for rabbits exposed through skin absorption to 2,3,7,8-tetra-CDD is reported to be only 275 ug/kg. Recent research has demonstrated that the positionalisomers of PCDDs and PCDFs vary widely in their acute toxicity and biological activity. For example 2,3,7,8-tetra-CDD is 1000 to 10,000 times more toxic than 1,2,3,8-tetra-CDD. Human exposure to 2,3,7,8- -tetra-CDD has induced chloracne, polyneuropathy, liver dysfunction, and enzyme elevations. Animal studies have shown the compound to be teratogenic, embryotoxic, carcinogenic, and cocar- cinogenic. 2,3,7,8-tetra-CDD has also been identified by the National Toxicology Program as a carcinogen, based on positive results from their carcinogenesis bioassay testing with laboratory mice.

It should be recognized that at present the overall toxicity of these compounds is not well understood in humans, particularly their chronic effects. Most information comes from animal studies, and even most of that information is from studies of exposures to PCBs or dioxins. There is relatively little information on even the animal toxicity of the dibenzofurans and biphenylenes. The toxicity of these compounds is even more confusing due to differential organspecific toxicities in different animal species.

VI. RESULTS

Employee exposures to suspected PCB contamination was evaluated under various work conditions. The following are the results of these evaluations.

A. Environmental

1. Normal Exposure Conditions

All of the personal, area, and wipe sample results for the capacitor removal operations, the transformer, and regulator overhauling operations were all non-detectable, i.e., below the 0.05 ug/sample level of detection that was established for each of these sample groups.

2. Explosion/Spill Clean-Up Condition

All of the personal, area, and wipe samples taken during the clean-up operation at the Embarcadero Center explosion did not indicate levels which exceeded the 0.05 ug/sample used in this analysis.

3. De Coto Depot/Union City

Numerous bulk, wipe, personal, and area samples did indicate PCB contamination. Bulk and wipe samples were collected on two separate occasions and the results are listed in Tables 1 and

2. As noted in these tables, both PCB 1016, 1254, and 1250 were detected at the De Coto facility. Aroclor 1260 levels ranged from non-detectable (ND) to 200,000 ug/sample in bulk soil samples and ND to 21.0 ug/sample for wipe surface samples. Aroclor 1254 for similar areas of contamination ranged from ND to 26,500 ug/sample for bulk soil and ND to 4.0 ug/sample for wipe surface samples. Aroclor 1016 levels ranged from ND to 1500 ug/sample for bulk soil samples.

PCB wipe samples were evaluated during a second survey at the De Coto facility and Aroclor 1016 and 1260 were detected. The results ranged from ND to 0.16 ug/sample and these were found on a variety of surfaces, as well as on the employees' hands and face. Aroclor 1260 results ranged from ND to 7.6 ug/sample and these were also detected on various surfaces and on the workers' hands and face (refer to Table 4).

B. Medical

Eleven of the 15 workers (73 %) participating in the study had serum PCB levels greater than 30 ppb (range 30-70 ppb) consistent with past exposure to PCBs at levels greater than those in the general environment. No workers were found to have chloracne, enlarged or tender livers, or neurological abnormalities on physical examination. Serum PCB levels are given in Table 5.

VII. DISCUSSION AND CONCLUSIONS

Employee exposures to polychlorinated biphenyls, via skin absorption and suspected airborne concentrations (either as vapors or in dust laden form), were evaluated. It is felt by the environmental and medical officers that only a portion of the employees were exposed to PCBs during the NIOSH survey periods. However, the medical evaluation suggests that some of the employees may have higher exposures in the past. The following are the environmental and medical conclusions. Additional information pertaining to the current interest in PCDDs and PCDFs are also addressed in this section.

A. Environmental

The only employees found to have significant PCB exposures, either as vapors or in dust laden form, are those workers who are involved in the depot/receiving yard activities. That is, any employee who has in the past, present, or will in the future perform duties similar to those evaluated at the Union City depot. This would include any such receiving facility in the PG&E network.

NIOSH did not find PCB exposures from the one clean-up operation it evaluated at the Embarcadero Center. Although PCBs were suspected the NIOSH investigators feel that the material sprayed in this explosion was not contaminated with PCBs based on NIOSH's analytical results. Therefore, it is felt that this should not be considered as a example of PCB exposures which may expose a PG&E employee involved in explosions, spills, fires, etc.

Based on the environmental results from this study, it would appear that PG&E should concentrate future environmental evaluations on employees involved in receiving yard type facilities and those involved in emergency situations. They should also consider PCB dust laden exposures both inhalation and skin as a primary and/or secondary route of exposure.

B. Medical

Because PCBs accumulate in the body, measurements of serum PCB levels reflect all past exposure to PCBs. In the case of utility workers such as those examined in this evaluation, past exposure includes years during which the potential hazard of PCBs was not widely recognized and during which workers were relatively poorly protected against absorption of PCBs. The serum PCB levels measured in a portion of this population reflect past occupational exposure to PCBs, and do not indicate whether more recent exposures have been more adequately controlled.

It should be noted that the majority of those employees with serum PCB levels exceeding 30 ppb (mean = 45 ppb; range = 30-70 ppb) were working at the De Coto facility and these workers had fewer than five years experience. As explained in Section V-C above, serum PCB levels also do not provide any indication of future health risks, because the relationship between increases in PCB levels and subsequent disease has not been well established for low levels of serum PCBs.

C. PCDD and PCDFs Concerns

Based on NIOSHs recent studies on PCBs it is suggested that the formation of PCDF and PCDD isomers has occurred from the thermal decomposition of both chlorinated benzenes (a major component of askarels) and PCBs. Appendix I shows the PCDF (tri through octa chlorinated) concentrations in soot obtained from transformer fires in Miami, Boston, and Binghamton, New York. The 2,3,7,8-TCDF isomer was identified in soot samples from the Boston fire at a concentration of 3 ppm. The 2,3,7,8-TCDF isomer was identified in the Binghamton soot at concentrations of 273 ppm and 2,3,7,8-TCDD isomer was measured in concentrations of 3 ppm.

The toxic effects of the PCBs have generally been found to parallel the levels of PCDFs present as contaminants and the toxicity of the associated combustion materials (e.g., soot) varies according to the PCDF and PCDD isomers present. Recognizing that the PCDFs and PCDDs occur in various positional isomeric forms and various chlorine levels, substitution then becomes of paramount importance because these isomers are not equivalent toxicologically.

In addition to PCB assessments in utility operations as described in this report, PG&E should also be alerted and consider those employees to be at high risk who are involved in situations, such as electrical equipment failures, fires or explosions which can result in the release and potential exposure to the highly toxic PCDF and PCDD isomers. It is felt by NIOSH that these types of

situations could potentially be a health hazard to the PG&E employees under the following situations: 1) cleaning-up damaged equipment and/or areas suspected of contamination, 2) restoring damaged equipment and/or disposal, 3) handling all the materials involved in such a clean-up, and 4) persons involved in receiving damaged materials such as in a receiving yard or depot.

D. Population at Risk

Based on the information described in this report the employees considered to be at risk to the exposures evaluated in this study include only those employees who are or will be directly involved with depot receiving activities where materials contaminated with PCBs are handled and stored. Other employees potentially exposed include any workers involved in PCB fires, explosions, spills, and clean-ups. The remaining employees and operations evaluated in this study are considered at risk but not as likely to be directly exposed to PCBs as those described above.

VIII. RECOMMENDATIONS

In view of the findings of NIOSH's environmental and medical evaluation, as well as personal communications with individuals who perform the activities evaluated, the following recommendations are made to ameliorate potential health hazards and to provide a better work environment for the employees covered by this report. These recommendations are addressed for only those employees described at risk and especially for those considered to be at higher risk.

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.

NOTE: 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 a portion of these workersare 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 workweek, over a normal working lifetime". Therefore, Table 2 is the recommended respiratory program which should best favor the variety of situations which may be confronted in the future.

TABLE 2

Recommended Respiratory Guide

1. Inside Spill -- 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.

4. Leak on Pole -- Same as number 3.

5. Receiving Yards/Depots -- Same as number 3.

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 V.

2. Environmental Monitoring

Personal breathing zone environmental monitoring and personal wipe sampling should be performed periodically on those employees involved in receiving yard/depot operations throughout the PG&E network. An effort should also be made to perform similar sampling on those employees involved in explosions and spill clean-ups. This data will be useful in determining which of the exposed groups and/or conditions require the respiratory protection as outlined above. Therefore, a sufficient number of samples should be taken to characterize the various conditions and each employee's exposure during the various types of operations considered to be at high risk. 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.

Concentration of PCBs on surfaces where employees have contact should reduced to be the lowest feasible limit and these surfaces should be monitored with wipe sampling methods routinely. This can be achieved by continuous cleaning of those surfaces which the worker is frequently in contact with. Special concerns should be given to eating and bathroom/shower areas.

Based on current research data regarding the association between PCBs, PCDDs and PCDFs involved in explosions, fires, or excessive heating, it would be prudent of PG&E to evaluate their receiving yards/depots for these contaminants (refer to page for more discussion). This could initially be performed by analyzing bulk liquid or soil samples and then evaluating areas as discussed in this report.

Finally, 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 who are suspected of having significant PCB exposures.

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

   a. Comprehensive 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 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.

c. A judgment of the employee's ability to use positive pressure respirators.

2. During examinations, applicants or employees having medical conditions, as described in Section IV (Evaluation Criteria/Medical), that could be directly or indirectly aggravated by exposure to polychlorinated biphenyls or formulations containing polychlorinated biphenyls should be counseled on the increased risk of impairment of their health that might result from working with these substances.

3. All workers should be advised of the potential adverse effects of PCBs 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.

4. Initial medical examinations should be made available to all workers as soon as practical.

5. 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 (A)(1) and (A)(2) of this section.

6. 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).

7. 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.

8. A register of PCB exposed workers should be developed for PG&E's future concerns. This information could be used for retrospective analysis or to determine needed information on individuals for future concerns.

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 PG&E employee training program regarding PCBs, the following information should be referred to and emphasized as necessary:

1. PG&E should continue their 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 employee 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 through 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 where PCBs are used should be informed of the hazards, relevant symptoms, 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 should also be informed that adverse reproductive effects may result from occupational exposure to PCBs.

4. In order to simplify the training and education of employees regarding PCBs, each of the various Bulletins and Standard Practices NIOSH received from PG&E regarding their PCB program should be summarized into one document and up-dated as necessary.

5. 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."

E. PCDFs and PCDDs

Based on NIOSHs current interests regarding PCBs and potential contaminants (e.g., PCDD and PCDFs), it would be prudent that PG&E concentrate its environmental and medical evaluation and surveillance strategies on those high risk groups described in this report. Those involved in past exposures should not be involved in the surveillance program but should possibly be placed, along with current exposed employees in a recordkeeping system (register) for either future retrospective research or other interests which may be helpful to the company in the future.

The following recommendations are made to assist management and union personal to effectively understand and deal with future episodes where these contaminants may be encountered (fire, explosions, or spills) as well as existing sites (receiving depot or yards) that may currently be contaminated.

1. Environmental Monitoring

Environmental monitoring for PCDFs and PCDDs should be performed on all future sites where PCBs are involved in a fire, explosion or spill prior to attempting clean-up. The results of these assessments would then dictate the need for specific procedures to be taken during clean-up, e.g., worker personal protection, materials handling and disposal, future monitoring (environmental and medical, etc.).

PCDF and PCDD environmental monitoring should be performed in those areas where the containers and waste materials involved with PCB fires or explosions have been stored either temporarily or for extended periods.

2. Personal Protection

Employee personal protection against exposure to PCDF and PCDDs should be comparable to that described for the most hazardous circumstances involving PCBs (,i.e., self-contained and/or airline respirators, disposal clothing, etc.). These steps should only be taken after environmental monitoring data indicate PCDF or PCDD exposures, otherwise, normal PG&E handling procedures should be performed.

3. Medical

Medical monitoring should be performed on those employees considered to be at highest risk as defined in this report. Again, this should only be performed if environmental data dictates. It would also be prudent to include this information in a register as recommended for those employees exposed to PCBs in the past.

4. Sanitation Practices

If environmental results indicate potential PCDFs or PCDDs exposures to any of the employees then they should follow the recommendations described earlier under sanitation practices for PCBs.

5. Training and Education

Due to the previous NIOSH studies which indicate PCDF and PCDD exposures to utility operators it would be appropriate for PG&E to begin a formal training and educational program on these contaminants to those employees considered to be at highest risk as defined in this report.

6. Other Concerns

After reviewing PG&E's 1980 and 1983 Transmission and Distribution Bulletins as described in section III of this report, a number of concerns within this bulletin should be clarified and/or changed. This is especially true with the current concerns regarding PCB's, PCDF's and PCDD's and they are:

a. Regarding the term hot/temperatures at which PCB's become a problem. Current literature as described in this report, suggest that temperatures between 500 and 600 degrees centigrade can become a problem beyond those relating to PCB's. Therefore, whats is meant by "Hot PCB fluids" should be qualified or removed from the bulletin. This concern is also addressed to the statement made about "Potentially harmful vapors may be generated when PCBs are subjected to severe internal arcing" (refer to Section III-subpart D).

b. Reference to the most current material fabric to safe guard the employee should be referenced. That is, the garment should be made of a synthetic fabric such as spunbonded olefin TYVEK TM. The hand protection should include disposable gloves made of material such as nitrile rubber or neoprene and reusable cotton liners, etc.

c. In regards to respirator protection as described in the bulletin it should be mandatory, especially with the current concerns regarding PCDF's and PCDD's, that any employee who may become involved with an explosion, fire or spill should be fit tested prior to such a situation. As referenced in the bulletin statements such as "those who may want to wear respirators", or "Any member of the clean-up crew that has not been previously fitted, but decides at the job site they want to wear a respirator, will be fitted at that time", and "Beards will not be a reason to refuse cleanup" are inappropriate for a good respirator program and these types of statements and/or policies should be reevaluated by PG&E.

d. Finally, regarding PG&E's statements on Maintenance in Enclosed Spaces (refer to page 8, subsection d of this report). The last sentence states "bagged clothing and/or body belts shall be returned to the crew headquarters and held for disposition". If this refers to decontamination, the procedures should be described, otherwise, the term disposition should be defined.

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7. Personal Communications with:

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XI. DISTRIBUTION AND AVAILABILITY

Copies of this determination report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. International Brotherhood of Electrical Workers, Local 1245, Walnut Creek, California.
2. Pacific Gas and Electric.
3. U.S. Department of Labor/OSHA - Region IX.
4. NIOSH - Region IX.
5. California Department of Health Services.
6. State Designated Agency.

For the purpose of informing all employees, a copy of this report shall be posted in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE 1

PCB Sample Wipes and Bulks

Pacific Gas & Electric Company
De Coto Facility
August, 1980

Sample Number	Description	AROCLOR (ug/sample) 1260	1254
1	Small fork lift	ND	ND
2	Golf cart	ND	ND
3	Thought to be cable oil	ND	2.6
4	Box bonder tools	ND	ND
5	Thought to be cable oil	ND	49
6	Box containing leaking capacitor	ND	22,000
7	Dirt sample outside lunch room	ND	0.133
8	Big fork lift	ND	3.4
9	Barrel in storage area	ND	2.2
10	Dirt sample in drive way	3,700	ND
11	Barrel in storage area	200,000	ND
12	Barrel/dirt storage area	ND	ND
13	Table in lunch room	ND	2.2
14	Bench in lunch room	ND	1.3
15	Boot of worker	ND	4.0

ug/sample = micrograms per sample

ND = non-detectable

TABLE 2

PCB Bulk And Wipe Samples

Pacific Gas & Electric Company
De Coto Facility

July, 1981

Sample Number	Description*	AROCLOR (ug/sample) 1016	1260	Total
1	Southeast corner of yard/drum top	12	33	45
2	Southeast corner of yard/soil	1,500	25,000	26,500
3	Stacked pipe/soil	ND	0.10	0.10
4	Dirt pile/soil	20	1.0	21
5	Center of back lot/soil	0.06	0.13	0.19
6	Inside main building/center-dirt	1.7	14.0	15.7
7	PCB drum storage/back-dirt	0.48	1.2	1.68
8	PCB drum storage/front-dirt	11.0	4.9	15.9
9	Front of building/soil	.4	1.5	1.9
10	Sawdust pile/transformer	0.19	1.8	1.99
11	Finish box area/soil	24	17	41
12	Finish box area - Box top/dirt	2.0	1.1	3.1
13	Finish box area/soil	0.26	2.8	3.06
14	NIOSH investigator/shoes	3.8	21.0	24.8
15	NIOSH investigator/shoes	110	5.9	115.9
16	PG&E investigator/shoes	3.3	6.2	9.5

ug/sample = micrograms per sample
ND = non-detectable

Note: The surface area sample size was approximately 75-100 cm^2 when appropriate.

TABLE 3

PCB Wipe Samples

Pacific Gas & Electric Company
De Coto Facility

July, 1981

Sample Number	Description*	AROCLOR (ug/sample) 1016	1260	Total
1	Lunch table	ND	0.42	0.42
2	Lunch table	0.18	0.66	0.84
3	Lunch table-seat	0.06	0.28	0.34
4	Lunch table-seat	0.08	0.18	0.26
5	Washroom counter	0.16	0.18	0.34
6	Cross bar-north fence	ND	ND	----
7A	Cross bar-southeast fence	ND	ND	----
7B	Cross bar-northeast fence	ND	2.1	2.1
8	Golf cart	0.1	0.84	0.94
9	Big fork left cab	ND	0.24	0.24
10	Crain cab	ND	1.5	1.5
11	Yale fork left cab	ND	5.0	5.0
12	Tool handles (drawn/flushing)	ND	7.6	7.6
14A	Employee #1-Hands	ND	1.7	1.7
14B	Employee #1-Face	0.14	0.58	0.72
15A	Employee #2-Hands	0.12	1.1	1.22
15B	Employee #2-Face	ND	0.49	0.49
16A	Employee #3-Hands	0.13	2.5	2.63
16B	Employee #3-Face	ND	3.4	3.4
17A	Employee #4-Hands	0.11	1.4	1.51
17B	Employee #4-Face	0.07	0.40	0.47

ug/sample = micrograms per sample
ND = non-detectable

Note: The surface area sample size was approximately 75-100 cm^2 when appropriate.

TABLE 4

Breathing Zone and General Area Concentrations of PCBs

Pacific Gas & Electric Company
De Coto Facility

July, 1981

Sample Number	Job/Area Description	Sampling Time (Minutes)	PCBs (ug/m_3) Filter	Florsil
D1	Yard worker	360	0.004	0.004
D2	Yard worker	360	0.004	0.003
D3	Yard worker	360	0.004	0.002
D4	Yard worker	360	0.004	0.003
D5	Lunch room	360	ND	ND
D6	Office	360	ND	ND
D7	Receiving box-yard	360	ND	ND
EVALUATION CRITERIA		(NIOSH)	0.1 ug/m^3	
LABORATORY LIMIT OF DETECTION			0.05 ug/sample	

ug/M^3 = micrograms per cubic feet of air

ug/sample = micrograms per sample

ND = non-detectable

TABLE 5

SERUM PCB LEVELS

Pacific Gas & Electric Company
De Coto Facility

July, 1981

ID	Job Category	Years of Potential Exposure	Serum PCB Levels (ppb Aroclor 1254)
1	A	4	30
2	A	5	63
3	A	3	47
4	A	10	51
5	A	2	45
6	B	0	22
7	A	2	38
8	A	7	70
9	C	45	65
10	C	1	31
11	C	3	59
12	D	26	45
13	D	14	22
14	D	2	39
15	D	20	21

JOB CATEGORIES: A = De Coto Pipe Yard, Pipemen, Pipe Machine Operators, Maintenancemen
B = De Coto Pipe Yard, Clerical
C = Oakport Service Center, Electric Transmission and Distribution Department: Line subforman and Drivers
D = Richmond Service Center, Substation Maintenance Department: Electricians

APPENDIX I

Cholorinated Dibenzofuran Concentrations (ppm) in Soot

PCDF Isomers	Miami	Boston	Binghamton
Tri CDF	0.18	50	Non-detectable
Tetra CDF	0.53	60	16-320
Penta CDF	1.0	35	21-440
Hexa CDF	0.18	15	13-290
Hepta CDF	0.01*	2	1.2-100
Octa CDF	0.01	0.01	1.2-35
Total CDF	1.91	162.1	52.4-1185

Note: Limit of detection was 0.01 parts per million (ppm)