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LTV STEEL COMPANY
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SUMMARY

On October 30, 1990, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation from employees at LTV Steel Company, East Chicago, Indiana. NIOSH was asked to investigate an incident involving the exposure of workers to polychlorinated biphenyls (PCBs).

On January 4, 1991, NIOSH investigators met with concerned parties from LTV Steel, and inspected the worksite where the exposure had taken place. Because the PCB exposure had ceased in September 1990, NIOSH investigators relied upon discussions with LTV personnel and a review of the company records to evaluate the exposure. These records included environmental results from bulk and surface wipe samples collected at the worksite, and results from blood tests performed on samples collected from exposed and non-exposed workers.

Although the environmental results establish that the worksite was contaminated with PCBs at concentrations which warrant concern, blood test results indicate at the employees' actual exposures were probably small, as none of the workers had serum PCB concentrations considered to be above background levels.

KEYWORDS: SIC 3312 (Steel Works, Blast Furnaces (Including Coke Ovens), and Rolling Mills), SIC 3316 (Cold-Rolled Steel Sheet, Strip, and Bars), PCBs, polychlorinated biphenyls, Steel, confined spaces, electrical manholes, electrical vaults.

INTRODUCTION

On October 30, 1990, the National Institute for Occupational Safety and Health (NIOSH) received a request to perform a health hazard evaluation at LTV Steel's Indiana Harbor Works, located in East Chicago, Indiana. This is a steelmaking and finishing facility that produces flat rolled sheet products. The plant occupies over 1200 acres of land and employs approximately 4700 people.

The request was made by employees at the plant, after receiving information that they had been exposed to polychlorinated biphenyls (PCBs); telephone conversations with Health and Safety personnel from LTV confirmed that exposure to PCBs did occur. On January 4, 1991, NIOSH investigators accompanied by a representative from the Indiana State Board of Health made a site visit to the plant. During this time, opening and closing meetings were held and a walk-through survey was conducted in the area of concern, referred to as the 54" Hot Strip Motor Room Basement. Representatives of labor and management were present at both meetings and at the walk-through. Also present was a representative from the Indiana Department of Labor (IOSHA).

BACKGROUND

The 54" Hot Strip Mill basement is located in an abandoned building complex, referred to as Tin Mill Complex #1. Electrical Maintenance workers from the "line shop" were detailed to this area to supply electrical power for a recently built pumphouse. Work was performed in this area from 8/6/90 to 9/10/90 with the exception of a two week period between 8/10/90 and 8/28/90. The amount of time spent by any one worker in the area ranged from one to eight days.

At the time that the line shop personnel began work in the area, there was approximately one foot of standing water on the basement floor. This water, referred to as "ground water," drains into electrical manholes which serve as junction points for supplying electrical power. The water is pumped out of these manholes into a collection pool housed in a different building. The area where the PCB exposure occurred included one of these manholes, referred to as electrical manhole number four (EM-4). The dimensions of EM-4 are approximately 8'x 8'x 6', but the workspace is reduced substantially by electrical cables and equipment located along the periphery.

The level of water in EM-4 upon initial inspection by line-shop personnel was reported to be about five feet; according to these workers, it is not uncommon for water to rise to this level in the manholes. Before initiating work in EM-4, workers removed the standing water, but reported that residual sludge present on floor and wall surfaces was not removed.

The following represents the sequence of events leading to the employee request for a NIOSH Health Hazard Evaluation.

1) On August 6, 1990, two electrical maintenance workers from the line shop went to the basement motor room of the 54" Hot Strip Mill (abandoned since the late 1960s) to determine a route for a 7000 volt electrical cable to supply electricity to the pumphouse. During their inspection, several (7 or 8) barrels were noted. One of these workers reported that one barrel was leaking at the time and another was labelled as "transformer oil." The workers perceived this as a problem and notified the electrical testing foreman.

2) On August 10, 1990 the electrical testing foreman collected two samples from intact drums and one ground water sample. He determined that chlorine was present, and sent samples for analysis to a contract lab. The next day, the lab reported "no detectable" levels of PCBs. Nevertheless the electrical testing foreman requested that samples be collected from the rest of the drums in the area. Nineteen drum samples were collected on August 22, 1990. Work was halted in the area on August 10 to await the results from these samples, but was resumed on August 28, before the results were attained.

3) On September 4, 1990, the lab reported positive PCB results for two of the drums. On September 7, the electrical testing foreman notified line shop personnel present at the worksite of these sample results. Records received from LTV indicate that there were only two employees assigned to this area on September 7. This suggests that the majority of employees who had worked in the area may not have been notified.

4) On September 7, 1990, the contaminated drums were drained and were later (September 12, 1990) removed from the area. More samples were collected on September 7, including several ground water samples.

5) The line shop personnel continued to work in the area until September 10, 1990, when their job was completed.

6) "Ground water" contamination was confirmed on September 17 (samples collected on September 7). This information later appeared in the local press. Several line shop employees mentioned that this press release was the first mention they had heard of PCB exposures. At this time the employees became very concerned about the health effects possibly resulting from this exposure.

7) The workers requested LTV Steel to supply medical evaluations and decontamination of personal equipment (e.g., work boots). Serum samples were collected and Cook County Hospital was later consulted to interpret the results. The workers' boots were replaced and potentially contaminated equipment (e.g., wooden ladders) were removed for disposal or decontamination. LTV later hired a private contractor to clean up the contaminated area.

8) A NIOSH health hazard evaluation was requested by employees from the line shop on October 17, 1990.

METHODS

The following information was requested from LTV for the purposes of 1) determining the extent of the PCB exposure, 2) identifying the factors which led to the exposure, 3) recommending steps to prevent exposure from recurring.

1) Results from environmental sampling performed at LTV for PCBs in the 54" hot strip mill basement. This includes the above mentioned samples collected by LTV, and samples collected by the contractor during clean-up.

2) Copies of medical examinations and blood PCB test results for all workers evaluated.

3) Company policy on confined space entry, hazard communication, and the use of personal protective equipment.

4) Details regarding the origin of the contaminated drums that were stored in the basement of the 54" Hot Strip Mill.

5) The location of other drums stored throughout LTV Steel that might contain hazardous waste, as well as the location of PCB containing electric transformers and capacitors.

6) A description of the available provisions for personal hygiene.

7) Future plans by LTV Steel to clean-up the contaminated area and prevent future incidents of this type, including plans for inspection and environmental sampling in other abandoned buildings on the premises.

8) OSHA 200 logs for the electrical maintenance department for the past 5 years.

The exposure data was reviewed to estimate the concentration of PCBs to which the workers were potentially exposed and to determine if clean-up procedures were effective. This data included bulk samples of water, oil, and sludge, as well as surface wipe samples collected from the floor and lower wall surfaces of the basement.

The medical evaluation was limited to reviewing the blood results of LTV workers and the OSHA 200 logs for the electrical maintenance workers.

The blood chemistry results were grouped into the following categories: PCB serum values, liver function tests (various liver enzymes and bilirubin levels), and serum lipids (triglycerides and blood cholesterol). The blood chemistry results were compared with normal values. It was also determined if an association existed between having had an opportunity for PCB exposure during the event and the various blood chemistry values. Opportunity for exposure was determined by having entered the contaminated area for any time during the exposure period. For PCB serum data and those variables which were associated with exposure, we determined if the association persisted after accounting for the length of time spent in the contaminated site. Time spent in the contaminated area was reported by the company as the number of days assigned to work in the area. Workers who performed tasks in the area which required less than one day's time were considered by us to have been assigned for 0.5 day. Statistical comparisons were made by grouping the workers by their exposure opportunity and examining the means of the various blood chemistry results. Statistical comparisons were made using SAS version 6.03[1]. Students' T-tests were used to test whether exposure was statistically associated with PCB blood level. Analysis of Variance (ANOVA) was used to test whether the length of time spent at the site was statistically associated with PCB blood level.

The OSHA 200 logs were reviewed for the reporting of burns. Background rates for these outcomes are not available and these reports are only used for descriptive purposes.

EVALUATION CRITERIA - PCBs

General

PCBs are chlorinated aromatic hydrocarbons that were manufactured in the United States from 1929 to 1977 and marketed under the trade name Aroclor.[2] PCBs found wide use because they are heat stable; resistant to chemical oxidation, acids, bases and other chemical agents; and stable to oxidation and hydrolysis in industrial use. Additionally they possess favorable dielectric properties, are of low solubility in water, of low flammability, of low vapor pressure at ambient temperatures and display viscosity-temperature relationships which are suitable for a wide range of industrial applications. PCBs have been used commercially for insulating fluids in electrical equipment, hydraulic fluids, heat transfer fluids, lubricants, plasticizers, and components of surface coatings and inks.[3]

The PCB mixtures marketed under different trade names are often characterized by a four-digit code number. The first two digits denote the type of compound, ("12" indicating biphenyl), and the latter two digits give the weight percentage of chlorine, with the exception of Aroclor 1016. In other commercial preparations the number code may indicate the approximate mean number of chlorine atoms per PCB molecule (Phenoclor, Clophen, Kanechlor) or the weight percentage of chlorine (Fenclor).

Dietary PCB ingestion, the major source of population exposure, occurs especially through eating fish, thus PCB residues are detectable in various tissues of persons without known occupational exposure to PCB. In past years, reported mean whole blood PCB levels have ranged from 1.1 to 8.3 parts per billion (ppb), and mean serum PCB levels ranged from 2.1 to 24.2 ppb, for persons without known occupational exposure.[4] Mean serum PCB levels among workers in one capacitor manufacturing plant studied by NIOSH ranged from 111 to 546 ppb, or approximately 5 to 22 times the background level in the community. Mean serum PCB levels among workers in transformer maintenance and repair typically range from 12 to 51 ppb, considerably lower than among workers at capacitor manufacturing plants.[5]

Health Effects

PCB toxicity is complicated by the presence of highly toxic impurities, especially the polychlorinated dibenzofurans (PCDF),[6] which vary in amount depending on the manufacturer[7] and percent chlorination,[8] and which are found in increased concentration after incomplete pyrolysis of the PCB.[9,10] Furthermore, different animal species, including humans, vary in their pattern of biologic response to PCB exposure.[11]

Two human epidemics of chloracne, "Yusho" and "Yu-cheng," from ingestion of cooking oil accidentally contaminated by a PCB heat-exchange fluid used in the oil's pasteurization, have been described in detail.[12,13] Although PCB was initially regarded as the etiologic agent in the Yusho study, analyses of the offending cooking oil demonstrated high levels of PCDF and polychlorinated quaterphenyls, as well as other unidentified chlorinated hydrocarbons, in addition to PCB.[14]

The results of individual studies of PCB-exposed workers are remarkably consistent. Among the cross-sectional studies of the occupationally exposed, a lack of clinically apparent illness in situations with high PCB exposures seems to be the rule. Chloracne was observed in recent studies of workers in Italy,[15] but not among workers in Australia,[16] Finland,[17] or the United States.[5,18-20] Weak positive correlations between serum PCB level, and serum aspartate aminotransferase (SGOT) level, [15, 17-19] serum gamma-glutamyltranspeptidase (GGTP) level,[5,15,19,20] and plasma triglycerides[5,21,22] have been reported. Correlations between plasma triglycerides[23] and GGTP[24] have also been found

among community residents with low-level PCB exposures. Causality has not been imputed to PCBs in these cross-sectional studies.

The International Agency for Research on Cancer (IARC) has concluded that the evidence for PCBs carcinogenicity to animals and to humans is limited. IARC has reported that "Certain polychlorinated biphenyls are carcinogenic to mice and rats after their oral administration, producing benign and malignant liver neoplasms. Oral administration of polychlorinated biphenyls increased the incidence of liver neoplasms in rats previously exposed to N-nitrosodiethylamine".[25]

In a mortality study among workers at two capacitor manufacturing plants in the United States,[26] a greater than expected number of observed deaths from cancer of the liver and cancer of the rectum were noted. Neither increase was statistically significant for both study sites combined. However, in a recent update of this study,[27] with follow-up through 1982, the excess in liver/biliary tract cancer was statistically significant (5 observed versus 1.9 expected deaths); the rectum cancer was still elevated but not statistically significant. In this mortality study, the personal time-weighted average airborne exposures in 1976 ranged from 24 to 393 micrograms per cubic meter (ug/m^3) at one plant, and from 170 to 1260 ug/m^3 at the other. During the time period (1940-1976) when most of the workers were exposed, the levels were probably substantially higher. At one of the plants, the geometric mean serum levels in 1976 were 1470 ppb for 42% chlorinated biphenyls and 84 ppb for 54% chlorinated biphenyls.

In a mortality study among workers at a capacitor manufacturing plant in Italy,[28] males had a statistically significant increased number of deaths from all neoplasms. When analyzed separately by organ system, death from neoplasms of the digestive organs and peritoneum (3 observed versus 0.88 expected) and from lymphatic and hematopoietic tissues (2 observed versus 0.46 expected) were elevated. This study was recently expanded to include vital status follow-up through 1982 for all workers with one week or more of employment.[29] In the updated results, there was a statistically significant excess in cancer among both females (12 observed versus 5.3 expected) and males (14 observed versus 7.6 expected). In both groups there were statistically non-significant excesses in lymphatic/hematopoietic cancer and a statistically significant excess in digestive tract cancer among males (6 observed versus 2.2 expected).

A retrospective cohort mortality study conducted by NIOSH[30] at an electrical equipment manufacturing plant using PCBs demonstrated a standardized mortality ratio for all malignant neoplasms below that expected when compared to the United States standard. A statistically significant increase in deaths from malignant melanoma, a skin cancer, was observed (eight deaths observed compared with less than two deaths expected). In addition, there was an increase in the number of observed deaths from malignancies of the brain and central nervous system (five deaths observed compared with two deaths expected), though this increase is not statistically significant.

Environmental Evaluation 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 the following: 1) NIOSH Criteria Documents and Recommended Exposure Limits (RELs), 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor (OSHA) Permissible Exposure Limits (PELs). The OSHA PELs may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended exposure limits, 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 those levels specified by an OSHA PEL.

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.

Airborne exposure

In February 1986, NIOSH reiterated its previous recommendation that exposure to PCB in the workplace not exceed 1 ug/m^3 (based upon the recommended sampling and analytical method in use at the time), determined as a TWA for up to a 10-hour workday, 40-hour workweek.[31] This recommended exposure limit was based on the findings of adverse reproductive effects in experimental animals, on the conclusion that PCBs are carcinogens in rats and mice and, therefore, potential human carcinogens in the workplace, and on the conclusion that human and animal studies have not demonstrated a level of exposure to PCBs that will not subject the worker to possible liver injury.[32]

In 1971, based on the 1968 ACGIH TLVs, OSHA promulgated its permissible exposure limits of 1 mg/m^3 for airborne chlorodiphenyl products (PCB) containing 42% chlorine and 0.5 mg/m^3 for chlorodiphenyl products containing 54% chlorine, determined as 8-hr TWA concentrations (29 CFR 1910.1000). The TLVs, which have remained unchanged at 1.0 and 0.5 mg/m^3 through 1991, are based on the prevention of (non-carcinogenic) systemic toxicity.[33] The OSHA PEL and the ACGIH TLV values include a "skin" notation, which refers to the potential contribution to overall exposure by the cutaneous route, including the mucous membranes and eyes, by either airborne or direct skin contact with PCB.

Surface exposure

NIOSH recommends that occupational exposures to carcinogens be reduced to the lowest feasible level. Results of several investigations of PCB surface contamination in office buildings indicate that there is a "background" level of surface contamination in the range of 50 to 100 micrograms per square meter (ug/m^2).[34-37] Therefore, for surfaces in the occupational environment that may be routinely contacted by the unprotected skin, NIOSH investigators have recommended that PCB contamination not exceed 100 ug/m^2 (the lowest feasible level considering background contamination).

The risk posed by this level of contamination was assessed by the Environmental Protection Agency (EPA) in its PCB spill cleanup policy.[38] In the "Development" section of the policy (Risks Posed by Leaks and Spills of PCBs), the EPA states that the estimated level of oncogenic risk associated with dermal exposures to 50 ug/m^2 of PCBs on hard, indoor, high-contact surfaces is between 1×10^{-5} and 1×10^{-6} (between 1 in 100,000 and 1 in 1,000,000 excess deaths, usually stated in terms of workers with a 30-year work history). Although the EPA document did not provide a risk estimate for the cleanup criterion it established for high-contact indoor surfaces (1000 ug/m^2), it did state, "EPA also believes that the surface standards of 1000 ug/m^2 for indoor low-contact surfaces (and vaults) and high-contact surfaces in a restricted access industrial facility would not present significant risks to workers or the general population." However, since there is a considerable degree of uncertainty associated with such a risk assessment calculation, EPA also stated that, "...the results of these [EPA] studies indicate that high-contact surfaces such as manually operated machinery may require surface standards more stringent than the 1000 to 10,000 ug/m^2 standards."

RESULTS

Environmental Sampling Results

Table I presents PCB results supplied by LTV, from bulk and surface wipe samples collected under their direction. These results are from initial samples collected from EM-4 and nearby areas. The location of each of these samples is shown in Figure 1. Concentrations of the bulk samples are given as parts per million (ppm). The concentrations of surface samples are given as micrograms per square meter (ug/m^2). Total PCB results were reported as Aroclor 1260.

The highest PCB concentration reported for a bulk sample taken from EM-4 was 1172 ppm, this being an oil sample. NIOSH does not have recommended exposure limits for PCBs in bulk materials. There were not any results for surface-wipe samples collected from EM-4. The highest PCB concentration for a surface-wipe sample collected from a nearby area was 13.97 g/m^2. This value far exceeds the EPA cleanup criterion of 0.001 g/m^2, for indoor low-contact surfaces. For surfaces which workers' unprotected skin routinely comes in contact with, NIOSH investigators recommend a lower standard of 0.0001 $g/m.^2$

Results of successive samples collected from locations where clean-up operations have taken place, indicate that these procedures are effectively reducing the level of PCB contamination in the 54" Hot Strip Mill Basement. Results received from LTV, are limited to those from samples collected between October and January. During this period, clean-up operations focused on locations to the left of the area represented by Figure 1.

Blood Test Results

Blood was collected in mid-October from 35 workers at LTV Steel who had entered the contaminated area for any period of time (1 hour to 48 hours). Blood was also collected in mid-December from 23 additional workers who had not entered the contaminated area but had asked to have a similar evaluation performed. The results were reviewed by a contract physician and shared with the workers.

The amount of time each worker was assigned to the contaminated area varied from less than one day to eight days. The duration of their assignment is presented here:

# of workers	duration in days
13	<1
14	1
1	3
1	4
4	5
1	6
1	8

All PCB serum values were within the normal range (none detected to 17.9 ppb, normal range below 20 ppb). The mean serum PCB concentrations did not differ between the exposed and unexposed groups (Table II). There was no trend between serum PCB concentration and the number of days spent in the contaminated area.

The means for serum albumin, direct bilirubin and indirect bilirubin, three liver function tests, differed between the exposed and unexposed groups (Table II). Of these three variables, the exposed group had the higher value for only direct bilirubin. Evaluation of associations with liver function enzymes is complicated by inconsistent and inconclusive data from this and other studies, and lack correction for confounding variables such as alcohol consumption. No trends were noted between the days spent in the contaminated areas and any of these variables. No other associations were noted between potential PCB exposure and the various blood tests. The serum results suggest that workers did not suffer acute adverse health effects from this exposure.

OSHA 200 Logs

The OSHA 200 log reports of illness and injuries were reviewed for reports of electrical burns. A total of 11 burns were reported on the OSHA 200 logs during 1987-1990, accounting for 112 lost work days. Three burns were related to electrical work and two of these accounted for 74 lost work days.

DISCUSSION

Even though the exposure data from the surface samples indicate that the electrical maintenance workers in the 54" Hot Strip Mill basement had potential exposure to high concentrations of PCBs, their actual exposure was probably small as none of the workers had serum PCB concentrations considered to be higher than background levels. The reason for this is not totally clear, yet there are a number of possible explanations. First, airborne concentrations of PCBs during the majority of work done were probably very low because of their low vapor pressure at room temperature (approximately 10^{-6} millimeters of mercury for Aroclor 1254 at 20^{o}C).[3] For this reason, inhalation was not likely a significant route of exposure. Second, although PCBs can be absorbed through the skin, contact between workers' skin and highly contaminated surfaces may have been minimal. Work gloves were worn by some of the employees, but these were made of a cotton blend fabric, therefore their effectiveness at reducing exposure is most likely to be minimal. Third, most of the workers worked in the contaminated area for a short period of time (a maximum of eight days).

These conclusions, however, should not be taken to suggest that a problem did not exist in the contaminated area. Barrels containing hazardous waste were present in the basement for many years. The barrels were not properly labelled and were located in an area subjected to periodic flooding. The source of these barrels is not certain, but information received from LTV states that "all materials in the basement were from the 54" Hot Strip Mill complex. Materials were for use in this area; it was not used as a general storage area." This implies that the barrels may have been stored in this area since production ceased in the late 1960s.

Another possible source of the PCB contamination is the dielectric fluid from capacitors located between the first floor and the basement. At least one of these capacitors had reportedly cracked, resulting in dielectric fluid leaking onto the basement floor. In addition to the barrels and capacitors, a third source of PCBs may be dielectric fluid from damaged transformers which had been removed from the basement sometime during the last two decades.

Workers reported that they were sent into this area without any knowledge of the potential hazard. Because work was halted for two weeks to await sample results, it is apparent that LTV was concerned about PCB contamination. Therefore, it is unclear why work was resumed on August 28, 1990, six days before LTV obtained the sample results. Even after these results identified two of the barrels as containing PCBs, workers continued to be sent into the area. Furthermore, it is our understanding that the Health and Safety Office at LTV Steel was not notified of the PCB concern until groundwater contamination was confirmed on September 17, 1990, seven days after workers had completed the job.

The ground water sample collected on August 10, 1990, was used to give clearance for continuing work in the basement. PCBs are much more soluble in organic solvents than in water;[2] therefore, they are likely to be found in greater concentrations in the oil fraction when both water and oil are present.

The positive PCB test results from the barrel samples were not shared with all of the workers who could have been affected. The verbal communication of these results to some of the line shop employees was not effective. Although LTV does have a written hazard communication program, there is no indication that there are established lines of communication for notifying employees of a health hazard.

Several of the workers reported that they were not offered any personal protective equipment during the time which they worked in the area. In response to the recent PCB exposure, the Health and Safety Office has established a program for using personal protective equipment (PPE) in areas which are potentially contaminated with PCBs. This program differentiates PPE needs based on the PCB concentration being below or above the EPA disposal standard of 50 ppm. This standard was set by EPA as an economically feasible level of clean-up and therefore should not be used for purposes of preventing personal exposure. This program also recommends that vinyl gloves be used to protect the hands from PCB exposure. This type of glove material has been shown to be more permeable to PCBs than gloves made of other materials such as neoprene,[39] thereby offering less protection.

Shower facilities and locker rooms are provided for the electrical maintenance workers. Each worker has a locker for work clothes and a separate locker for clothing worn to and from work. The two lockers assigned to each worker are located side by side in one room. A preferable arrangement is locating the two lockers in two different rooms, with shower

facilities accessible by both rooms. This allows the worker to shower and change clothes while preventing the contamination of himself or the clothes worn to and from work.

The manholes are currently recognized as confined spaces by LTV. The LTV policy on confined space entry refers to NIOSH designations of class A, B, and C confined space, but it is unclear which designation LTV has given to the electrical manholes. The designation corresponds to recommended protective measures; therefore, it is important to provide the proper designation to each confined space. Regardless of the designation, NIOSH recommends that permits be required before entering a confined space. A supervisor or other qualified person trained in recognizing health hazards should sign this permit. This is used to certify that all existing hazards have been evaluated and that the necessary protective measures have been taken to insure the safety and health of the workers. If performed properly, this procedure should be effective in preventing exposures to hazards in the future. Specific NIOSH recommendations for working in confined spaces, including the issuing of permits, can be found in the NIOSH document "Criteria for a Recommended Standard... Working in Confined Spaces."

During the connection of electrical cables, a heat-shrinking process is used to seal the insulation at the point of connection. Several employees have complained of experiencing headaches as a result of this process. The material safety data sheet (MSDS) for the heat wrap lists thermal degradation and combustion byproducts which are considered hazardous. These byproducts include carbon monoxide, aldehydes and acid gases. According to the manufacturer, the required temperatures for the heat-shrinking process range from 120 to 140 ^{o}C, whereas decomposition temperatures range between 450 ^{o}C and 550 C. This suggests that decomposition should only occur if the wrap is not being heated properly.

Over the past four years, three workers have received electrical burns, two of these were serious enough to require 28 and 46 days of lost work. Because of the high potential for serious injury, electrical safety is extremely important for the electrical maintenance workers at LTV Steel. This is especially true, given the confined spaces and wet environments in which they must work. The presence of water is likely to accelerate deterioration of the cables in the manholes. This further warrants the inspection of the cables for signs of wear before any work is performed in the manholes.

An additional concern is the pipe along the North fenceline outside of the 54" Hot Strip Mill building. The pipe insulation may contain friable asbestos. If the insulation does contain asbestos, it represents an exposure hazard which should be abated.

RECOMMENDATIONS

PCB Exposure

It is clear that the potential for harmful exposures to PCBs existed in the 54" Hot Strip Mill basement. Because of the widespread presence of PCB containing equipment at the facility, it is likely that other areas of the plant also present a potential for PCB exposures. The following recommendations are made to prevent such exposures from occurring.

1) If any area is suspect of possible exposure, either due to knowledge of PCB containing systems, past spills, or lack of knowledge regarding historical use, they should be treated as contaminated areas until sampling proves otherwise. An inspection of the premises for the purposes of identifying health and safety concerns should be done by

someone trained in recognizing health hazards before work is begun. A permit system similar to that recommended by NIOSH for confined spaces is one method to assure that this takes place.

2) For any area that is suspected to be contaminated, bulk samples of water, oil, and sludge present in the area should be collected and analyzed before workers are allowed to enter. In the case of electrical manholes which often contain standing water, the water should be tested during its removal, and then any remaining sludge or oil should be tested. In addition, surface-wipe samples should be used for evaluating surfaces which workers could come into contact with.

3) If sampling results indicate that a job location is contaminated with PCBs, the area should be properly cleaned before work is performed. Removal of all bulk contaminants (oil, water, and sludge) followed by a thorough cleaning of work surfaces is recommended. This should include removal and proper disposal of PCB- containing equipment, such as capacitors and transformers which are damaged or are no longer being used. Surface-wipe samples should be collected to measure remaining PCB contamination. Because of the carcinogenic potential of PCBs, surface contamination should be reduced to background concentrations.

4) Protective clothing should be used in situations which require employees to work in an area suspected of PCB contamination, prior to sample collection or proper clean-up procedures. Both gloves and boots should be made of neoprene, nitrile, Viton, or butyl rubber because of their demonstrated resistance to permeation by PCBs.[39] Information on the selection and use of protective clothing can be found in the NIOSH Criteria Document[32] and Current Intelligence Bulletin[31] for PCBs.

5) Because of the health concern presented by PCB exposure, it is important that personnel from the Health and Safety Office be aware of the location and physical condition of all equipment containing PCBs. The Health and Safety office should be notified of any sampling done for PCBs, and the evaluation of the results should be carried out by this office.

6) A means of directing information through lines of communications should be established. This should facilitate the notification of workers to health concerns and provide a channel for workers to voice their concerns to management.

Other Recommendations

Workers using the heat-shrink wrap should be trained in its proper use to minimize exposures to hazardous byproducts. Workers' exposure to these byproducts should be measured to determine if local exhaust ventilation and/or respiratory protection are required.

The electrical burns received by electrical maintenance workers should be investigated by the Health and Safety Office to determine appropriate measures for preventing their future occurrence. An inspection of all electrical cables present in the work area should take place before any work is performed.

A sample of the insulation along the fenceline should be collected and analyzed for asbestos. If the insulation does contain asbestos, a hazard exists which needs to be abated.

An inspection of the entire facility for friable asbestos should be undertaken if this has not already occurred.

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1) Requester
2) LTV Steel Company
3) International Steel Workers local 1011
4) Indiana State Board of Health
5) Indiana State Department of Labor
6) OSHA Region Five

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

Table I
Results from Sample Analysis for PCBs

LTV Steel Company
East Chicago, Indiana
HETA 91-027

Sample designation in Fig. 1	Sample # supplied by LTV	Date Collected **	Sample Type	ppm PCB	ug/m^2 PCB ***
1	332	9/17/90	sludge	68,430 *	
2	328	9/17/90	oil	65	
3	334	9/21/90	oil	210	
4	9790-0425	11/3/90	surface		328,000
5	9790-0416	11/5/90	surface		790,000
6	9790-0520	11/7/90	surface		362,000
7	9790-0657	11/15/90	surface		13,970,600 *
8	WB21-05	12/18/90	surface		476,650
9	WB20-02	12/18/90	surface		282,000
10	WB19-15	1/8/91	surface		210,000
11	WB18-10	1/8/91	surface		250,000

* Samples taken from area where oil from a cracked capacitor is suspected to have leaked.

** Clean-up of the basement was initiated on 10/4/91.

*** The exposure level recommended by NIOSH investigators for surfaces which routinely contact the worker's unprotected skin is 100 ug/m^2. The EPA standard for indoor low-contact surfaces is 1000 ug/m^2.

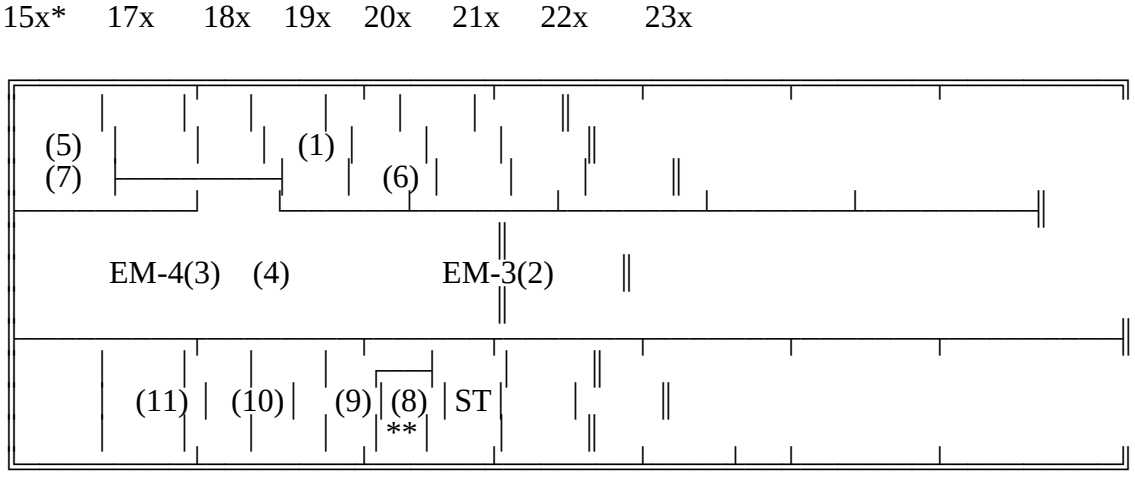
TABLE II
BLOOD TESTING RESULTS *

LTV Steel Company
East Chicago, Indiana
HETA 91-027

Test	units	normal	EXPOSED means yes	no	t-test p-value	EXPDAYS ANOVA p-value
Serum PCB	ppb	20.0	4.9	4.1	0.39	0.81
Serum Lipids						
albumin	gm/dl	3.2-5.5	4.1	4.4	0.01**	0.80
total cholesterol	mg/dl	100-220	214.3	211.7	0.90	
tryglycerides	mg/dl	10-160	202.1	168.3	0.21	
Liver Function						
bilrubin-D	mg/dl	< 0.4	0.3	0.1	0.01*	0.12
bilrubin-T	mg/dl	0.3-1.4	0.9	0.9	0.47	
bilrubin-I	mg/dl	< 0.6	0.6	0.8	0.01*	0.62
PROTT	gm/dl	6.0-8.0	7.0	7.1	0.61	
LDH	IU/L	100-225	141.6	154.6	0.07	
GGTP	IU/L	12-56	30.9	23.9	0.21	
AST	IU/L	10-40	25.3	25.8	0.71	

* Results of blood tests from 58 individuals, 35 of whom had entered the contaminated area at some time.

** p less than 0.05



* Numbers with "x" designation represent location of structural supports.

** Represents the location of the stairs leading from first floor down to the basement.

The location of the numbers in parenthesis represent the room or area where the sample was taken, the exact location is not known.

Figure 1: Sample locations in the
54" Hot-Strip Mill Basement

LTV Steel Company
East Chicago, Indiana
HETA 91-027