U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 77-7A & 7B-486

UNION ELECTRIC COMPANY
ST. LOUIS, MISSOURI

MAY 1978

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health during the period of December 1976 through June 1977 at Union Electric Company in their facilities in and near St. Louis, Missouri.

A. Based on results of environmental monitoring, it has been determined that at the time of the survey, employees were exposed to levels of polychlorinated biphenyls (PCBs) in excess of the NIOSH recommended standard[1] of 0.1 micrograms per cubic meter of air ($\mu g/M^3$) for polychlorinated biphenyls but well below the Federal standard of 500.0 $\mu g/M^3$ for PCBs (29 CFR 1910.1000) during overhaul operations and yearly inspections of transformers containing PCBs. Significant amounts of smearable contamination of PCBs were found on various tools and equipment and on the hands and faces of employees. In view of the inadequacy of existing knowledge of the potential toxicity of low level exposures to PCBs, a judgement as to whether employees were being exposed to levels of PCBs which may be potentially hazardous cannot be made at this time. A report on the results of the medical study is not available at this time. Final interpretation of the medical data will be completed as a separate report when all laboratory specimens have been completed and reviewed.

B. Employees were not exposed to toxic concentrations of organic solvents (i.e., trichlorobenzene; stoddard solvent; 1,1,1-trichloroethane; and aliphatic solvent "140 Flash") during operations involving transformer oils containing PCBs at the time of the survey.

C. It was further determined that employees were not exposed to toxic concentrations of propylene glycol butyl ether esters of 2,4,5-trichlorophenoxyacetic acid and diesel fuel No. 2 during herbicide spraying operations at the time of the survey.

Available information concerning the study results and recommendations are contained in the body of this report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services; Information 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 the NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

a) Union Electric Company; St. Louis, Missouri
b) Authorized Representative of Employees, International Brotherhood of Electrical Workers, Local 1439
c) International Union Headquarters; Director of Health & Safety
d) U.S. Department of Labor - Region VII
e) NIOSH - Region VII

For the purpose of informing the approximately 200 "affected employees" involved in PCB operations and the 100 "affected employees" involved in herbicide spray operations, the employer shall promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) near where exposed employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an employer or authorized representative of employees, to determine whether any substance normally found in a place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative of Local No. 1439 - International Brotherhood of Electrical Workers (affiliated with AFL-CIO), St. Louis, Missouri, concerning complaints of employees regarding: (a) irritation of skin and eyes during operations involving oils containing PCBs; and (b) skin irritation, dizziness and feelings of nausea during herbicide spraying operations.

IV. HEALTH HAZARD EVALUATION

A. Process Description - Conditions of Use

The Union Electric Company is a private utility firm which furnishes electricity primarily in the State of Missouri. There are a total of 5400 employees of which 3400 are production and field personnel.

1. Operations Involving Polychlorinated Biphenyls (PCBs)

There are approximately 150 transformers in the power generating stations and 210 network or building transformers which use insulating fluids that contain polychlorinated biphenyls in their formulation. The generic term "Askarel" is applied to these synthetic chlorinated hydrocarbon insulating fluids used in transformers. Whatever the trademark brand, "Askarel" generally contains polychlorinated biphenyls (Aroclor 1260 or Aroclor 1254) either alone or in combination with tri-and/or tetrachlorobenzene. A diepoxide scavenger is generally present in concentrations much less than one percent.[2] Union Electric Company officials stated that Askarel tradenames that have been purchased by the company have included Inerteen, Pyranol, Chlorextol, Dykonol, and Eleinex. In general, all transformer Askarels are interchangeable in use.

Exposure to polychlorinated biphenyls among employees of the Union Electric Company occur infrequently during minor maintenance operations (i.e., draining and filling operations which last approximately 2 hours, etc.), and more frequently during yearly inspections of the transformers, which normally involve work in confined spaces in underground vaults. The yearly routine maintenance operation includes obtaining two pint samples of the oil, which is then tested for color and electrical properties. This routine normally requires approximately 40 minutes of potential exposure to PCBs. Transformer maintenance operations are conducted by linemen on an intermittent or infrequent basis, and this does not involve daily exposure to PCBs. Linemen may also have potential exposure to PCBs when replacing a capacitor that has leaked, but this would be on a very infrequent basis.

Limited overhaul of transformers is conducted at the Dorsett facility in an area approximately 100 feet x 25 feet. Approximately 9 transformers containing PCB insulating fluids were overhauled at this facility during the previous year with the time involved for overhaul varying from 3 to 6 weeks. Maximum potential exposure occurs during the first 2 or 3 days of operation (i.e., draining of PCBs, opening of the transformer, decontamination, etc.) and the last day of overhaul when the transformer is filled with insulating fluid containing PCBs. Equipment and parts are cleaned with typical organic solvents such as stoddard solvent.

2. Operations Involving Propylene Glycol Butyl Ether Esters of 2,4,5-T (E 2,4,5-T)

Most lineman crews work approximately 1½ months (intermittently throughout the year) in spraying operations utilizing E 2,4,5-T. Normal operations involve mixing six gallons of concentrated E 2,4,5-T with 194 gallons of diesel fuel No. 2 in a tank trailer rig. Spray operations are conducted for two to five hours per shift around the main facilities and the rightaway around the transmission lines. Other pesticides are also used.

There are approved management instructions covering operations utilizing PCBs and draft management instructions covering operations utilizing pesticides such as E 2,4,5-T. Protective clothing was available to employees involved in both operations. The company has full-time professional expertise available in the Safety and Health Department.

B. Evaluation Progress and Methods

1. Progress

An initial walk-through survey was conducted on November 30, and December 1 and 2, 1976, to identify potential exposures to the various environmental contaminants. Some employees were informally interviewed at that time to more fully evaluate their complaints. Based on information obtained from management and union representatives, the following operations were further evaluated to answer the question of toxicity as covered by the original request:

a. Operations during the first few days of overhauling a transformer containing PCBs at the Dorsett facility. The environmental survey was conducted on January 10-12, 1977.

b. Yearly inspection operations of transformers containing PCBs located in an underground vault. The environmental survey was conducted on March 9-10, 1977.

c. Operations involving the mixing and spraying of E 2,4,5-T. The survey was conducted on March 9-10, 1977. This also included private interviews with employees to determine if there were any symptoms which could be attributed to exposure to these operations.

The above environmental surveys were conducted during normal operating conditions. In addition, a medical survey was conducted during June 1-3, 1977, of employees in operations involving potential exposure to PCBs. This survey was conducted following a protocol developed for a cross-sectional medical survey of occupational exposure to polychlorinated biphenyls.

2. Environmental Evaluation Methods

Breathing zone samples (plus some general area samples) were obtained on workers who were considered to have the highest potential exposures to the contaminants involved at the time of the survey. The following is a summary of the sampling/analytical methods used during the survey:

a. "Florisil"® tube samples were obtained for analysis of polychlorinated biphenyls (PCBs). These samples were collected using Sipin pumps at a sampling rate of 0.1-0.2

liters of air per minute (lpm). Some "Florisil"® tube samples were preceded by an "AA" filter (3 piece cassette) for a cursory comparison of sampling methods for PCBs. These samples were collected using an MSA Model G pump at a sampling rate of 1 liter of air per minute (lpm). Smear samples were obtained using an "AA" filter or its backup pad and wiping about 100 square centimeters of surface area on tools and equipment and the face and/or hands of some employees. These samples were analyzed for PCBs to determine the amount of removable contamination on the surface.

b. Charcoal tube samples were obtained for organic vapors (e.g., trichlorobenzene; stoddard solvent; 1,1,1-trichloroethane; tetrachloroethylene; and aliphatic solvent "140 Flash"). These samples were collected using Sipin pumps at a sampling rate of 0.1-0.2 liters of air per minute (lpm).

c. AA filters (3 piece cassette) followed by charcoal tube samples were obtained and analyzed for diesel fuel No. 2. These samples were collected using an MSA Model G pump at a sampling rate of 1 lpm.

d. Glass fiber filters (3 piece cassette) followed by midget impingers containing ethylene glycol solution were obtained and analyzed for E 2,4,5-T. In addition, glass fiber filters followed by a charcoal tube were obtained and analyzed for esters of 2,4,5-T to compare results of sampling methods. These samples were collected using an MSA Model G pump at a sampling rate of 1 lpm.

All of the samples were analyzed in accordance with appropriate and/or minor modified procedures (e.g., gas chromatography, mass spectroscopy, etc.) contained in the NIOSH Manual of Analytical Methods, HEW Publication No. (NIOSH) 77-157, Cincinnati, Ohio 1977.

3. Medical Evaluation Methods

Questionnaire information including occupational history, past medical history, symptom history, and history of exogenous exposures (alcohol, smoking, drugs, etc.); limited physical examinations; and fasting blood and urine specimens were obtained from 25 individuals judged to be exposed to transformer oils containing PCBs and 24 nonexposed controls. The exposed and control groups were matched for age, race and sex. The clinical biochemical tests performed on blood specimens included complete blood counts, a battery of liver function tests (i.e., SGOT, SGPT, GGPT, and Alk. Phos.), a lipid profile (i.e., fasting plasma triglycerides, cholesterol, HVL-cholesterol and LDV-cholesterol), and plasma PCB analyses. Porphyrin measurements were obtained on the urine samples.

Questionnaire information including occupational history, past medical history and symptom history were also obtained from six employees involved in herbicide spraying operations.

C. Evaluation Criteria

1. Environmental Criteria

The three primary sources of environmental evaluation criteria considered in this report are: (a) NIOSH Criteria Documents with recommended standards for occupational exposure; (b) American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) with supporting documentation; and (c) Federal Occupational Health Standards as promulgated by the Occupational Safety and Health Administration, U.S. Department of Labor (29 CFR 1910.1000). For the substances evaluated during this study, the primary environmental criteria considered most appropriate are:

TABLE OF ENVIRONMENTAL CRITERIA

SUBSTANCE	STANDARD OR GUIDE mg/M^3*
Polychlorinated biphenyls (PCBs)	0.001 (a)**
PCBs (42% chlorine) - skin	1.0 (b,c)
PCBs (54% chlorine) - skin	0.5 (b,c)
1,2,4-trichlorobenzene (trichlorobenzene)	40.0 (b)
1,1,1-trichloroethane	1910.0 (b)
	1910.0 (a) (15 minute sampling period)
Stoddard solvent	350.0 (a)***
Aliphatic solvent "140 Flash"	150.0 (b)
Tetrachloroethylene (perchloroethylene)	339.0 (a)****
Kerosene (diesel fuel No.2)	100.0 (a)
2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	10.0 (b)

*Approximate milligrams (mg) of substance per cubic meter (M^3) of air sampled. (NOTE: 1.0 mg of weight equals 1,000 micrograms (µg) of weight or 0.001 mg equals 1.0 µg. 1.0 mg equals 0.0000022 pounds which equals 0.000035 ounces. Also, one M^3 equals 35.31 cubic feet of air or a volume of air which is 3.28 feet high, 3.28 feet wide, and 3.28 feet long).

**Reference letters in parentheses refer to the source(s) from the above discussion from which the standard or guide was obtained.

***In case of a mixture of air contaminants which produce similar biological effects, particularly with organic solvents, the overall effects are considered as additive. An employer shall compute the equivalent exposure as follows:

$$*Em = \frac{C_1}{L_1} + \frac{C_2}{L_2} \cdots \frac{C_n}{L_n}$$

Where:

Em is the equivalent exposure for the mixture.
C is the concentration of a particular contaminant.
L is the exposure limit for that contaminant, from Table Z-1, Z-2, or Z-3.

*The value of Em shall not exceed the value of 1.

****In July 1976 NIOSH recommended an exposure limit of 339 mg/M^3. Recent studies by the National Cancer Institute (NCI) indicate that tetrachloroethylene causes liver cancer in laboratory mice. Therefore, this level may not provide adequate protection from potential carcinogenic effects because the limit of 339 mg/M^3 was selected to prevent toxic effects other than cancer. Therefore, it is prudent to consider the potential carcinogenicity of tetrachloroethylene when handling it in the workplace.

Occupational health exposure limits for individual substances are generally established at levels intended to protect workers occupationally exposed during an 8 hour work day, 40 hour work week, over a normal working lifetime. The following items should be noted in reviewing the above environmental criteria:

a. The ACGIH recommendations for occupational exposure to PCBs, adopted as the Federal standard (29 CFR 1910.1000), are 8-hour time-weighted average (TWA) exposure concentrations of 1.0 mg/M^3 for mixtures that are 42% chlorinated and 0.5 mg/M^3 for mixtures that are 54% chlorinated. The National Institute for Occupational Safety and Health's "Criteria for a Recommended Standard...Occupational Exposures to Polychlorinated Biphenyls (PCBs)"[1] recommended a lowering of the occupational exposure standard to 0.001 mg/M^3 as a TWA concentration for up to a 10 hour work day, 40 hour work week. "Based on the findings of adverse reproductive effects, on its (NIOSH's) conclusion that PCBs are potential carcinogens in humans and on its (NIOSH's) conclusion that occupational and animal studies have not demonstrated a level of exposure that will not subject the worker to possible liver injury, NIOSH recommends that the TWA concentration of PCBs in the breathing zone of workers be maintained at or below the minimally detectable TWA concentration for up to a 10 hour work day,

40 hour work week. NIOSH considers the minimally detectable concentration of PCBs for the monitoring of occupational exposures to be 0.001 mg/M^3, based on its review of the literature and the methodology presented in Appendices I and II---

"It is recognized that employees handling PCBs may have skin contact with these substances, potentially resulting in dermatologic and systemic effects. Consequently, appropriate work practices, training programs, and other measures should be required, regardless of the concentrations of airborne PCBs. Therefore, occupational exposure to PCBs has been defined as working with PCBs or with equipment containing PCBs that can become airborne or that can spill or splash on the skin or into the eyes, or the handling of any solid product that may result in exposure to PCBs by skin contact or by inhalation." (Page 157)

b. There is no recommended health standard for all isomers of trichlorobenzene. Therefore, for purposes of this report only, the recommended level for 1,2,4-trichlorobenzene was used as the environmental criteria for trichlorobenzene.

c. There is no recommended health standard for diesel fuel No. 2. Therefore, for purposes of this report only, the recommended level for kerosene was used as the environmental criteria for diesel fuel No. 2.

d. There is no recommended health standard for propylene glycol butyl ether ester of 2,4,5-trichlorophenoxyacetic acid (E 2,4,5-T). Therefore, for purposes of this report only, the recommended level for 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) was used as the environmental criteria for E 2,4,5-T. However, it is noted that 2,4,5-T is known to cause birth and other defects in laboratory animals and is being studied by EPA to determine if it should be banned or restricted. Therefore, the environmental criteria for 2,4,5-T may well be lowered in the very near future.

Samples were also obtained and analyzed for vinylcyclohexane dioxide (VCHD). VCHD is present in certain Askarels at concentrations of less than 1 percent as a scavenger for free radicals. Due to the inconsistent results of NIOSH's laboratory analyses for VCHD, the sample results are not considered by the investigators to be valid. In view of the results of the breathing zone level samples for PCBs, it would appear that concentrations of VCHD that might be expected to be found would have been much less than the current ACGIH recommended criteria of 60 mg/M^3 for VCHD. Therefore, VCHD is not discussed further in this report. It should be noted, however, that toxicological data have demonstrated VCHD to be an

experimental carcinogen, based on the induction of skin cancer in mice,[3] and this should be considered when devising control methods for reducing exposures.

2. Medical Criteria - Review of the Literature

a. Toxic Substances

(1) Polychlorinated Biphenyls (PCBs)

Polychlorinated biphenyls comprise a class of synthetic, chlorinated aromatic hydrocarbons which because of their remarkable physical and chemical properties, including high stability, nonflammability, low solubility in water, and high solubility in hydrocarbon solvents, have enjoyed a wide variety of industrial uses. These same properties, however, are characteristics that contribute to their extreme stability and persistence in the environment and result in their accumulation and concentration in the food chain ("bioaccumulation"). Because of their widespread distribution in the environment and because of concern for their potential toxicity, these chemicals were banned under the provision of the Toxic Substances Control Act (PL 94-469), so that by April 11, 1979, "no person shall process or distribute in commerce any polychlorinated biphenyl" except as may be exempted by the Administrator of the U.S. Environmental Protection Agency (EPA).

Despite the voluminous scientific literature that has been published over the past decade, inadequate information is available by which to judge the potential health hazard to man for occupational exposure to polychlorinated biphenyls. The early occupational literature generally describes occupational acne (also termed chloracne), occasionally in association with systemic symptoms (i.e., nausea, vomiting, malaise, etc.) from exposure to various chlorinated hydrocarbon compounds. Chlorinated biphenyls were generally minor constituents of various chlorinated hydrocarbon compounds termed "Halowax"®, which were used as insulating materials in the manufacture of electrical cables, capacitors, and transformers. Major constituents of the "Halowaxes"® were chlorinated naphthalenes, which are known chloracnegens[4,5,6,7]. A number of deaths from liver disease were described among exposed workers in "isolated individuals who had been picked out of large groups (of workers) having the same (Halowax®) exposure" with no ill effects[4]. Other chemical exposures were variously described, including exposure to solvents such as carbon tetrachloride, ethylene dichloride, and toluene[4]. Clearly, no judgements can be made about current types of occupational exposure to polychlorinated biphenyls based on a review of this early literature.

In 1968 in Japan an outbreak of skin disease similar to chloracne was traced to widespread ingestion of a rice oil used for cooking that had been contaminated with a 48% chlorinated PCB heat exchange fluid (Kaneclor-400)[8]. Initial analyses of the offending rice oil were based on measurement of the total chlorine content and calculation of the PCB level from the knowledge that Kaneclor-400 was 48% chlorinated. Subsequent

analyses, using the more refined methods of gas-liquid chromatography and mass spectroscopy, have identified the presence of polychlorinated dibenzofurans and other unidentified chlorinated hydrocarbon compounds, presumably products of the original PCB heat exchange fluid subjected to heat stress[9]. Thus, extrapolation from this epidemic, due to prolonged ingestion of a cooking oil in which the possible offending agents were multiple and are only partially identified, to the occupational exposure situation may not be warranted.

Occupational studies following the Yusho epidemic have failed to demonstrate any adverse human health effects due to occupational exposure to PCBs, except for the possible association with chloracne. These studies include studies of Japanese[10], Swedish[11], and Australian[12] workers. The Australian report should be noted because it demonstrated scattered abnormalities of liver function tests among PCB exposed workers. However, it was not possible to judge whether these abnormalities were present in excess of the expected, and the mere finding of these abnormalities cannot necessarily be equated with liver toxicity.

Thus, excluding such observations as the fact that exposure to PCBs at concentrations of 5-10 mg/M^3 have been reported an "unbearably" irritating[13], PCBs have not clearly been demonstrated to result in adverse human health effects with the possible exception of the induction of chloracne. In this regard, Crow[14] has stated: "Relatively mild fume exposure in the capacitor industry caused occasional chloracne with pentachlordiphenyls although this was not to be compared with that from penta- and hexaxclornaphthalene. Since the change to trichlordiphenyl, however, even this has entirely disappeared, as I can confirm from my own recent inspection of some two-thirds of the British capacitor industry which was using this material extensively. Contact with the cold liquid chlordiphenyls, although undesirable because of skin absorption, appears to pose no acnegenic hazard".

The basis for the occupational exposure standards largely comes from animal toxicological data. A marked species variation in reaction to PCBs has been noted. The liver appears to be primarily involved in most animal species. Reproductive effects have been noted, particularly in mink and in primates. Carcinogenicity seems to be limited to the higher chlorinated biphenyls. Aroclor 1260 and 1254 have been shown to produce tumors in rats and are classified as experimental carcinogens. While PCBs have not been proven to pose a demonstrable hazard to human health from occupational exposure, it may be assumed, based on the available toxicological studies, that PCBs are not innocuous. Except for the possible association with chloracne, no conclusions are warranted, based on the available human data, save only that occupational exposure to PCBs may pose an as yet unidentified hazard to the exposed individual. Substances such as PCBs that cause cancer in experimental animals are normally considered to pose a potential cancer risk in humans. Therefore, it should be judged as prudent that exposure to these compounds be kept to the minimum detectable level, and that the absence of human data to demonstrate an adverse effect should not be interpreted as evidence for their safety.

(2) 1,2,4-Trichlorobenzene (Trichlorobenzene)-TCB)[13,15,16]

Health effects of 1,2,4-trichlorobenzene have been reported in the literature to include irritation to the eyes, mucous membranes and skin. A study of the acute and subacute inhalation toxicity of trichlorobenzene (1,2,3/1,2,4-TCB; 8%/92% weight/weight) indicated that the target organs from non-lethal exposures of cats, dogs, rats, rabbits, and guinea pigs included the liver, kidney, ganglion cells at all brain levels, and mucous membranes. Cutaneous exposure to 1,2,4-TCB can cause irritation, but does not cause chloracne or acne-like dermatitis.

(3) 1,1,1-Trichloroethane[13]

The most harmful effects of exposures to 1,1,1-trichloroethane seem to be manifested as central nervous disorders. These include impairment of perceptual speed, reaction time, manual dexterity and equilibrium. Symptoms of light-headedness and dizziness are common. No injury to man has been reported at or below the suggested criteria levels and 1,1,1-trichloroethane is one of the least hepatotoxic (liver damage) of the common chlorinated hydrocarbon solvents.

(4) Tetrachloroethylene (perchloroethylene)[13,17]

This solvent is primarily used for degreasing. Its vapor is narcotic with symptoms of headache, dizziness, nausea, incoordination and somnolence. The vapor also causes irritation of the eyes and upper respiratory tract. The liver is a principal target organ of tetrachloroethylene exposure in animals. Typical toxic effects are fatty liver, liver enlargement, and abnormal liver function tests. Tetrachloroethylene has also been shown to cause kidney damage in mice following intraperitoneal injection and in rats and rabbits following inhalation. Tests conducted by the National Cancer Institute have shown that tetrachloroethylene has carcinogenic potential. The long-term animal study reported by NCI demonstrates that tetrachloroethylene is carcinogenic in laboratory mice. Therefore, NIOSH recommends that it is prudent to handle tetrachloroethylene as if it were a human carcinogen[17].

(5) Refined Petroleum Products (Stoddard solvent, kerosene, or diesel fuel No.2, aliphatic solvent "140 Flash")[13,18]

The refined petroleum solvents considered in this evaluation have a total aromatic content of less than twenty percent. Analyses of the bulk samples showed that benzene was present in trace quantities only. Exposure to high concentrations may cause a narcotic effect resulting in light-headedness, drowsiness and irritation of the eyes, nose and throat. Direct contact may defat the skin, leading to drying or cracking of the skin, or may result in oil clogging the pores of the skin resulting in a rash. Vapor is also irritating to conjunctiva and mucous membranes of the upper respiratory tract.

(6) 2,4,5-Trichlorophenoxyacetic Acid (2,4,5-T)[13,19]

Exposure to 2,4,5-T has been reported to cause nausea, vomiting, abdominal pain, diarrhea, and blood in the stool. It may also cause irritation of the skin. Contaminants of commercial preparations of 2,4,5-T have been dioxins (i.e., 2,3,7,8- and/or 2,3,6,7-tetrachlorodibenzo-P-dioxin), which are potent animal teratogens and a potent acnegenic (chloracne) agent which is hepatotoxic (liver) in animals. The dioxins are present as unwanted side products of the synthesis of 2,4,5-T and its esters. 2,4,5-T is of low toxicity with the oral LD50 for dogs in the range of 100 mg/kg or higher. The Department of Agriculture stopped the use of 2,4,5-T around homes, parks, and recreational areas in 1970 to protect women of child-bearing age from the threat of birth defects (teratogenic effects). Esters of 2,4,5-T may act similarly to 2,4,5-T in animals and humans. EPA is currently studying whether to restrict or even ban the manufacture or use of 2,4,5-T due to the teratogenic and/or other effects. 2,4,5-T is also absorbed through the skin. Esters of 2,4,5-T also contain trace amounts of dioxin. The manufacturer of the product states that their quality control laboratory has limited the concentration to trace amounts of dioxin (less than 0.1 parts of dioxin per million parts of product - current EPA requirement) for the past several years. EPA does not think the current use of this chemical poses an imminent or emergency threat to people or the environment.

D. Evaluation Results and Discussions

1. Environmental Results & Discussions - PCBs - Organic Solvents

a. Operations Involving Potential Exposures During Overhaul of Transformer Containing PCBs at the Dorsett Facility.

Table IA shows the results of samples obtained for PCBs. The samples obtained using an "AA" filter followed by a "Florisil" tube were not obtained over the same period of time as the "Florisil" tubes. The eight-hour time-weighted average (TWA) concentrations of PCBs in the breathing zone of employees varied from 3.1 to 82.3 micrograms per cubic meter of air ($\mu g/M^3$) of PCBs. All personal air samples exceeded the NIOSH recommended criteria of 1.0 $\mu g/M^3$ for PCBs during the first two days of transformer overhaul, although they were well below the Federal OSHA standard of 500.0 $\mu g/M^3$ for PCBs. The two area sample results (maximum of 6660 $\mu g/M^3$ for PCBs) on January 11, 1977, are not exposure levels and were expected to be very high, as the samples were attached to a funnel which was inserted into a 55 gallon barrel of oil containing PCBs. The results of these two samples were high, and therefore, tend to confirm the sampling/analytical methodology used in the survey. There were minimal operations involving oil containing PCBs during the 3rd day of overhaul operations. Only three area samples were obtained for general information purposes. These results varied from 0.8 to 7.2 $\mu g/M^3$ for PCBs and are indicative of some potential exposure to PCBs.

Table IB shows the results of smear samples from various tools and pieces of equipment with results varying from non-detectable or less than 0.01 micrograms per 100 square centimeters ($\mu g/100\ cm^2$) to 9200 $\mu g/100\ cm^2$).

Table IC shows the results of smear samples from the face and hands of employees before and after washing which varied from less than 1 $\mu g/100\ cm^2$ to 38 $\mu g/100\ cm^2$ for PCBs. These samples were obtained during the afternoon of the second day after transformer and parts were decontaminated. The results are indicative of smearable contamination on parts and some smearable contamination of PCBs on the skin of employees which could possibly be absorbed through the skin.

Table ID shows the results of samples obtained for organic solvents. Results were all less than 5 percent of the environmental criteria of 40 mg/M^3 for trichlorobenzene, 350 mg/M^3 for stoddard solvent, and 1900 mg/M^3 for 1,1,1-trichloroethane. Even when considering the combined effects of these compounds as additive, employee exposure would be less than 10 percent of the environmental criteria of Em = 1 at the time of the survey.

b. Operations Involving Potential Exposures During Yearly Inspection of Two Transformers (with oil containing PCBs) in Underground Vaults

Table IIA shows the results of samples obtained for PCBs. The results of personal air samples varied from 1.6 $\mu g/M^3$ to 21.6 $\mu g/M^3$ for PCBs which results in an eight-hour TWA from 0.4 to 8.8 $\mu g/M^3$. The area air sample result of 253.7 $\mu g/M^3$ was located closer to the point of operation in the underground vault and there was a minor spill of oil containing PCBs at the time of the survey. The personal air sample results show 1 out of 2 employees were in excess of the NIOSH criteria of 1.0 $\mu g/M^3$, but were well below the current Federal standard of 500.0 $\mu g/M^3$.

Table IIB shows the results of smear samples from the hands and face of two employees varying from 5 $\mu g/100\ cm^2$ to 487 $\mu g/100\ cm^2$. There are normally no washing facilities available when working in underground vaults. Employees wiped hands with clean rags which may or may not be saturated with solvent. Rags, gloves and other materials which may contain oil containing PCBs were for the most part segregated for appropriate disposal. The smear of the table top containing test equipment and the floor of the test area showed about 800 $\mu g/100\ cm^2$ for PCBs, demonstrating localized or general smearable contamination. The results are indicative of smearable contamination on surface areas in the test area and some smearable contamination of PCBs on the skin of employees which may be absorbed through the skin.

Table IIC shows the results of samples obtained for organic solvents. Results were all less than 12 percent of the environmental criteria of 339 mg/M^3 for tetrachloroethylene and 150 mg/M^3 for aliphatic solvent - "140 Flash". No trichlorobenzene was detected in the samples. Even when considering the combined effects of these compounds as additive, employee exposure would be less than 20 percent of the ACGIH environmental criteria of Em = 1 at the time of the survey. However, it is noted that significant amounts of airborne tetrachloroethylene (maximum TWA of 40 mg/M^3) were found in the breathing zone of the two employees. Tetrachloroethylene was present in significant amounts in the cleaning fluid used at the time of the survey. The level of 339 mg/M^3 for tetrachloroethylene may not provide adequate protection from potential carcinogenic effects because this level was selected to prevent toxic effects other than cancer.

2. Medical Results and Discussions - PCBs - Organic Solvents

To date all participants in the medical evaluations have been informed of their individual laboratory results, except for plasma PCB analyses. Plasma PCB analyses have not been run at the time of this writing. Since these PCB analyses provide us with the primary independent variables by which to evaluate our clinical biochemical tests, an analysis of the medical survey cannot be given at this time. These results will be released once laboratory analyses of plasma PCB levels have been undertaken and the data obtained in the course of this medical survey have been analyzed. Therefore, the medical survey concerning employees' exposure to PCBs will not be considered further in this report. While no apparent symptomatology directly attributable to exposure to any of the substances found in the workplace have been identified by preliminary examination of the data to date, this observation may change when the data are assembled for final analysis.

3. Environmental Results and Discussions - Esters of 2,4,5-T

Table IIIA shows the results of samples obtained for esters of 2,4,5-T. All sample results were less than 1 percent of the environmental criteria of 10.0 mg/M^3 for 2,4,5-T. Results for the esters of 2,4,5-T varied from 0.01 to 0.06 mg/M^3 and are indicative of some exposure to the esters of 2,4,5-T. Four samples (each consisting of an "AA" filter followed by a charcoal tube) were analyzed for diesel fuel No. 2. Quantitative analysis of the filter samples show a maximum result of 2.8 mg/M^3 which is less than 3 percent of the environmental criteria of 100 mg/M^3 for kerosene (diesel fuel No. 2). Most of the diesel fuel would probably pass through the filter and be collected on the charcoal tube. A quantitative analysis was not made on the tubes, although a qualitative analysis was accomplished by the laboratory. In addition, two samples were lost due to mechanical failure in the refrigerator. The remaining two charcoal tubes showed: (a) the presence of aliphatic compounds at their major peaks; (b) no benzene or naphthalene; and (c) the presence of small amounts of aromatics in the form of alkylbenzenes (toluene, xylene, trimethylbenzene,

diethylbenzene, and methyl-butylbenzene). It was estimated that the total airborne aromatics is about 5 percent with 95 percent as aliphatic hydrocarbons.

The results show that employees were not exposed to excessive levels of esters of 2,4,5-T. No definitive statement can be made concerning employees' exposure to diesel fuel No. 2 (kerosene) as no quantitative analysis was made of the charcoal tube portion of the sample. However, employees were wearing NIOSH approved masks for organic vapors as well as chemical goggles and impervious outerwear. Therefore, inhalation of fumes or mists by the employees may not present a problem, although the NIOSH investigators believe that the levels may at times exceed the environmental criteria of 100 mg/M^3 for kerosene (diesel fuel No. 2).

4. Medical Results and Discussions - E 2,4,5-T and Diesel Fuel No. 2

Six employees were interviewed and complained of the following symptoms during spraying operations:

a. Four complained of headaches and/or dizziness;

b. Two complained of being somewhat sick to the stomach and/or nauseated; no vomiting, diarrhea or more serious problems were noted;

c. Four complained of burning sensation and/or skin rash on areas of unprotected skin;

d. Two complained of eye irritation; and

e. No employee complained of nose and throat irritation.

The majority of the complaints appear to be attributed to the diesel fuel No. 2, as the smell of the fuel or fuel on skin and clothes appeared to be the causative agent in discussions with employees. All of the above symptoms appeared regularly when the linemen were spraying and not wearing protective clothing and respirators plus goggles. However, no employee has had any of the above symptoms since the company has provided appropriate protective clothing and respirators a few years ago. The only employee complaint since the company furnished protective clothing is that while wearing rubberized rainwear or impervious outerwear they get hot and sweat a lot in the summertime.

E. Observations and Conclusions

1. Based on the above environmental information, it is determined that employees are being exposed to levels of PCBs exceeding the NIOSH recommended standard but well below the current Federal standard during overhaul operations and yearly inspections of transformers containing PCBs at the time of the survey. It is

noted that exposure of all potentially exposed employees is on a limited basis, particularly the linemen, and does not occur on a daily basis throughout the year. For instance, the maximum exposure period of employees for normal operations would be around 5 days per month for the electrical mechanics during overhaul operations at the Dorsett facility. It is hoped that the additional medical information from this and similar NIOSH studies when it is available will provide more insight as to the overall effect of exposure to PCBs on an intermittent exposure period and any cumulative effects over long periods.

2. The NIOSH investigators believe there were significant amounts of smearable contamination of PCBs found on tools and equipment and the hands and faces of employees at the time of the survey. Good control of contamination was not always apparent during the survey. For instance, on one occasion oil containing PCBs spurted out on an employee's hand and the employee wiped his hand with a cloth. A few employees had a few spots of oil on their personal clothing. These observations are important since the NIOSH recommended standard recognizes (page 157), "that employees handling PCBs may have skin contact with these substances", and therefore, defines occupational exposure to PCBs as "working with PCBs... that can spill or splash on the skin or into eyes...", in addition to exposure to airborne PCBs measured as a TWA concentration. It appears evident that mere air sampling will not by itself provide an adequate measure of occupational exposure to PCBs, although that method is the only readily quantifiable measure of PCB exposure.

3. Based on the above environmental and medical information, it is determined that employees were not exposed to concentrations of organic solvents (e.g., stoddard solvent, etc.) in excess of the environmental criteria during operations involving oils containing PCBs at the time of the survey. However, tetrachloroethylene was a major component in the cleaning solvent used in the underground vaults. The airborne levels of tetrachloroethylene are considered significant considering the potential carcinogenicity of tetrachloroethylene, although there were no apparent acute symptoms (e.g., headache, dizziness, etc.) at the time of the survey.

4. Based on the above environmental and medical evaluation and the fact that appropriate protective clothing and NIOSH approved respirators were utilized, it is determined that employees are not being exposed to toxic concentrations of E 2,4,5-T and diesel fuel No. 2 during spraying operations at the time of the survey. However, current studies by EPA, NIOSH or other agencies may lower the environmental criteria of 10 mg/M^3 for 2,4,5-T.

tight-fitting top on filter press, etc.) for storage of oils containing PCBs only. Local exhaust of electrical test operations should be provided for tests of samples containing PCBs. Also, drums or other containers used for storage of oil containing PCBs should always be closed with a tight-fitting lid when not in use.

F. Where engineering controls are not feasible to lower the airborne levels of PCBs and/or under conditions specified in the criteria document on PCBs, NIOSH approved respirators (self-contained breathing apparatus--, or combination type C supplied-air respirator--) should be used. For those operations where the use of such respiratory protection is not feasible or may present a safety risk to the employee, the authors believe that NIOSH approved respirators (full-face because better face fit and skin protection is afforded) with an ultra-particulate filter followed by an organic cartridge should provide adequate protection for short-term intermittent exposure of employees to airborne concentrations of 0.001 to 0.050 mg/M^3 of PCBs.

G. The company should evaluate and modify the respiratory protection program to assure that it reflects the current program and that it is in compliance with requirements described (outlined as eleven criteria for a "minimal acceptable program") in the Occupational Safety and Health Administration Standard, Title 29 of the Code of Federal Regulations, Part 1910, Section 134.

H. An improved education program should be instituted so that employees are made aware of the toxicity and hazards associated with the materials handled during operations covered by this evaluation. Good work practices and first aid procedures should also be included in this program.

I. Employees' direct contact (e.g., soiled clothing, spill, etc.) with substances covered by this evaluation should be avoided by wearing appropriate protective clothing, and areas of the skin which may be covered by hair (face, head, etc.) should also not be contaminated.

J. Pre-employment and yearly medical examinations should be provided for all workers exposed to PCBs and pesticides such as E-2,4,5-T. The examining physician responsible for assessment of employee placement should be aware that PCBs and E-2,4,5-T have been alleged to affect the liver, and therefore should carefully asses the risks associated with occupational exposure to PCBs and/or E-2,4,5-T for a person with known liver disease or damage.

K. Potentially exposed women in the work force who are of child-bearing age should be advised of the adverse effects of PCBs and/or E 2,4,5-T on the unborn child. Also, those who bear children while working with PCBs should be counselled on the adverse effects of nursing their child.

L. Workers should be very strongly encouraged to report all skin conditions to the plant physician and their family doctor.

M. The industrial hygiene resources available within the company should monitor various operations, particularly those involving PCBs during conditions (operational or environmental) which could result in similar (in case of PCBs) or higher concentrations (in case of E 2,4,5-T and diesel fuel No. 2) than found at the time of the survey.

N. The company should discontinue the use of mixtures which may contain significant amounts of tetrachloroethylene and substitute mixtures containing less toxic materials. The recommendations contained in the current NIOSH Intelligence Bulletin No. 20 on tetrachloroethylene should be followed if it is necessary to continue the use of products containing significant amounts of tetrachloroethylene.

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V. RECOMMENDATIONS

In view of the above information, the following recommendations are offered as suggestions to management and labor for their consideration to alleviate potential hazards and to provide for a more desirable working environment for all personnel working on operations covered by this evaluation (additional recommendations may be forthcoming when the PCB medical data are available and evaluated):

A. The recommendations contained in Chapter 1 of Criteria for a Recommended Standard...Occupational Exposure to Polychlorinated Biphenyls (PCBs); DHEW (NIOSH) Publication No. 77-225, 1977, should be implemented as appropriate.

B. The area at the Dorsett facility used for the overhaul of transformers containing the PCBs and the test area used by linemen for testing the oil should be segregated. Strict contamination control procedures for tools, equipment, facilities, and personnel should be implemented for all operations with PCBs at these facilities as well as during minor maintenance operations in underground vaults.

C. Personal hygiene of employees (e.g., washing hands, changing clothes, etc.), routine clean up of the work area, contamination control, and use of required protective clothing should be stressed for employees working with PCBs and pesticides such as E 2,4,5-T. Employee education about the importance of personal hygiene when eating and smoking should be stressed. Employees should be instructed not to eat, drink, or smoke at work stations during operations involving these materials due to potential contamination to mouth and gastrointestinal tract of employees.

D. The current written procedures concerning operations involving PCBs, respirators, and pesticides (including E 2,4,5-T) should be reevaluated and rewritten to modify and reflect operating procedures to be followed in order to provide for a more desirable working environment for employees involved in these operations. Observations during the survey indicate that the procedures should place particular emphasis on contamination control of employees, equipment, areas, decontamination of personnel and/or equipment, emergency actions, and similar salient aspects which need special consideration in procedures covering these operations. These procedures should be readily available to employees, and employees should be knowledgeable with and follow the procedures.

E. Since there is little information available regarding the long-term effects of low level exposure over a working lifetime and since PCBs may be retained in the body for years, it is advisable to reduce air concentrations to the lowest detectable levels by means of engineering controls. For instance, at the Dorsett facility the air exhaust system from the transformer should be filtered and set up separate improved draining, filling and storage facilities (particularly

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UNION ELECTRIC COMPANY
JANUARY 10-12, 1977

TABLE IA

CONCENTRATIONS OF POLYCHLORINATED BIPHENYLS (PCBs) FOUND DURING OVERHAUL OPERATIONS INVOLVING A TRANSFORMER CONTAINING PCBs AT THE DORSETT FACILITY

Job and/or Area Classification	Date	Sample Number	Time of Sample	PCBs $\mu g/M^3$*	PCBs TWA-$\mu g/M^3$**
Electrical Mechanic #1	1/10	AA Filter 7	10:35--1:54	8.7	
		Florisil Filter 7	10:35--1:54	36.8 > series	
Electrical Mechanic #1	1/10	AA Filter 1	8:00-10:35	ND	19.0
		Florisil Filter 1	8:00-10:35	0.3 > series	
Electrical Mechanic #1	1/10	F-1	8:00--3:53	83.5	82.3
Electrical Mechanic #2	1/10	AA Filter 2	8:06-10:39	ND	
		Florisil Filter 2	8:06-10:39	16.0 > series	
Electrical Mechanic #2	1/10	AA Filter 6	10:40--1:54	ND	8.1
		Florisil Filter 6	10:40--1:54	7.5 > series	
Electrical Mechanic #2	1/10	F-2	8:06--3:52	13.9	13.5
Electrical Mechanic #3	1/10	AA Filter 3	8:10-10:51	ND	
		Florisil Filter 3	8:10-10:51	ND > series	----
Electrical Mechanic #3	1/10	F-3	8:10--3:34	5.3	4.9
Electrical Mechanic #4	1/10	AA Filter 4	8:15-10:50	3.0	
		Florisil Filter 4	8:15-10:50	3.0 > series	----
Electrical Mechanic #4	1/10	F-4	8:15--3:19	19.7	17.4
Filter Press Area	1/10	A-F-9	8:50--3:35	ND	----
Electrical Mechanic #1	1/11	F-10	1:55-11:32 & 12:11--3:40	15.4	13.7
Electrical Mechanic #2	1/11	F-11	8:00-11:37 & 12:16--3:41	5.9	5.2
Electrical Mechanic #3	1/11	F-12	8:02-11:35 & 12:10--3:39	3.5	3.1
In funnel on top of drum-area	1/11	AA Filter E-4	8:42--1:35	ND	
		Florisil Filter F-22	8:42--1:35	3750.0 > series	----
In funnel on top of drum-area	1/11	F-20	8:42--2:44	6660.0	----
Work bench-area	1/12	F-01	7:37--3:00	7.8	----
Top storage tank by vent-area	1/12	F-02	7:39--2:03	1.0	----
Area by 2nd line of transformers	1/12	F-03	7:43--3:00	1.4	----

Environmental Criteria for PCBs is 1 $\mu g/M^3$.

*$\mu g/M^3$ - approximate micrograms of substance per cubic meter of air.
**TWA --- the time-weighted average concentration for a normal eight-hour workday.
NOTE: Minimum detection limit for PCBs is 0.01 μg per sample.

UNION ELECTRIC COMPANY
JANUARY 11, 1977

TABLE IB

RESULTS OF SMEAR SAMPLES FOR POLYCHLORINATED BIPHENYLS (CPBs) ON EQUIPMENT DURING OVERHAUL OPERATIONS INVOLVING A TRANSFORMER CONTAINING PCBs AT THE DORSETT FACILITY

Description of Smear Site	Sample Number	Results μg PCBs/100 cm^2*
Switch box - bottom outside	S-1	ND
Switch box - back and top outside	S-2	1.0
Transformer - temperature gauge outside	S-3	1.0
Floor - in front of primary switch - walking area	S-4	ND
Transformer platform - front	S-5	4.0
Switch box in oven	S-10	222.0
Sample hole on transformer box in oven	S-13	10,000.0
Platform and floor area in oven	S-14	12,000.0 (smear was 120,000 ug/1,000 cm^2)
Transformer - inspection part	S-15	774.0
Primary switch - bushing	S-16	9,200.0
Primary switch - bushing	S-17	1,300.0
Primary switch	S-18	2,800.0
Dry floor	S-19	1,500.0
Dry floor	S-20	364.0
Top of filter press	S-21	9,200.0
Top of filter press	S-22	711.0
Work bench - protector	S-29	257.0
Objects on work bench (protector)	S-30	289.0
Work bench (primary station)	S-31	128.0
Arm wrench	S-32	410.0
Primary switch - bushing	S-33	3,200.0

*μg PCBs/100 cm^2 - micrograms of PCBs per approximately 100 square centimeters of surface area.

Minimum detection limit is 0.01 micrograms per sample.

UNION ELECTRIC COMPANY
JANUARY 11, 1977

TABLE IC

RESULTS OF SMEAR SAMPLES FOR POLYCHLORINATED BIPHENYLS (PCBs) ON PERSONNEL DURING OVERHAUL OPERATIONS INVOLVING A TRANSFORMER CONTAINING PCBs AT THE DORSETT FACILITY

Description of Smear Site	Sample Number	Results µg PCBs/100 cm^2*
Operator #1 face before washing	S-6	1
Operator #1 face after washing	S-38	34
Operator #1 hands before washing	S-7	318
Operator #1 hand after washing	S-39	13
Operator #1 hand after washing	S-40	57
Operator #2 face before washing	S-11	4
Operator #2 forehead, face; after washing	S-34	24
Operator #2 face after washing	S-35	2
Operator #2 hands before washing	S-12	381
Operator #2 right hand after washing	S-36	3
Operator #2 left hand after washing	S-37	ND
Operator #3 face before washing	S-8	9
Operator #3 hands before washing	S-9	318

*µg PCBs/100 cm^2 - micrograms of PCBs per approximately 100 square centimeters of surface area.

Minimum detection limit is 0.01 micrograms per sample.

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JANUARY 10 1977

TABLE ID

CONCENTRATIONS OF TRICHLOROBENZENE, STODDARD SOLVENT, AND 1,1,1-TRICHLOROETHANE FOUND DURING OVERHAUL OPERATIONS INVOLVING A TRANSFORMER CONTAINING PCBs AT THE DORSETT FACILITY

Job and/or Area Classification	Date	Sample Number	Time of Sample	Trichlorobenzene mg/M^3*-TWA**	Stoddard Solvent mg/M^3*-TWA**	1,1,1-Trichloroethane mg/M^3*-TWA**
Electrical Mechanic #1	1/10	C-1	8:00--3:53	1.8	4.7	50.6
Electrical Mechanic #2	1/10	C-2	8:06--3:52	1.7	3.6	22.3
Electrical Mechanic #3	1/10	C-3	8:10--3:34	ND	2.4	10.6
Electrical Mechanic #4	1/10	C-4	8:15--3:19	ND	2.1	11.6
Filter press & transformer - area	1/10	A-C-9	8:50--3:35	0.8	3.3	15.5
Electrical Mechanic #1	1/11	C-13	8:46-11:32 & 12:11--3:40	0.4	4.9	5.5
Electrical Mechanic #2	1/11	C-15	8:00-11:37 & 2:16--3:41	0.7	1.6	5.3
Electrical Mechanic #3	1/11	C-14	8:02-11:35 & 1:33--3:39	0.9	3.0	9.9
On drum - area	1/11	C-21	8:42--2:44	9.9	1.8	6.5
Desk storage tank - area	1/12	C-04	7:37--3:00	0.3	1.4	6.1
Top of storage tank - area	1/12	C-05	7:39--2:03	0.2	1.0	5.5
2nd line on transformer area	1/12	C-06	7:43--3:00	0.2	1.2	7.1
Environmental Criteria for these substances are----------				40.0	350.0	1900.0

*mg/M^3 - approximate milligrams of substance per cubic meter of air.
**TWA --- the time-weighted average concentration for a normal eight-hour workday.

NOTE: Minimum detection limit for trichlorobenzene, stoddard solvent and 1,1,1-trichloroethane is 0.01 milligrams per sample.

UNION ELECT COMPANY
MARCH 9-. , 1977

TABLE IIA

CONCENTRATIONS OF POLYCHLORINATED BIPHENYLS (PCBs) FOUND DURING YEARLY INSPECTION OPERATIONS INVOLVING TWO TRANSFORMERS CONTAINING PCBs AT TWO DIFFERENT UNDERGROUND VAULT LOCATIONS

Job and/or Area Classification	Date	Sample Number	Type of Sample	Time of Sample	PCBs $\mu g/M^3$*	PCBs TWA-$\mu g/M^3$**
Lineman A	3/9	P-16	AA filter	10:24--1:39	14.8 > series	8.8
Lineman A	3/9	F-16	Florisil	10:24--1:39	6.8	
Underground vault - area	3/9	P-2	AA filter	10:20-11:24	11.4 > series	33.8
Underground vault - area	3/9	F-2	Florisil	10:20-11:24	242.3	
Lineman B	3/10	P-8	AA filter	8:48-10:45	2.2 > series	0.7
Lineman B	3/10	F-8	Florisil	8:48-10:45	0.8	
Lineman B	3/10	F-Z	Florisil	8:48-10:45	1.6	0.4
Oil test area	3/10	F-A	Florisil	8:37-11:15	2.4	0.8
Oil test area	3/10	F-B	Florisil	8:37-11:15	1.3	0.4

Environmental Criteria for PCBs is 1 $\mu g/M^3$.

*$\mu g/M^3$ - approximate micrograms of substance per cubic meter of air.
**TWA --- the time-weighted average concentration for a normal eight-hour workday.

NOTE: Minimum detection limit for PCBs is 0.01 μg per sample.

UNION ELECTRIC COMPANY
MARCH 9-10, 1977

TABLE IIB

RESULTS OF SMEAR SAMPLES FOR POLYCHLORINATED BIPHENYLS (PCBs) ON EQUIPMENT AND PERSONNEL FOUND DURING YEARLY INSPECTION OPERATIONS INVOLVING TWO TRANSFORMERS CONTAINING PCBs AT TWO DIFFERENT UNDERGROUND VAULT LOCATIONS

Job and/or Area Classification	Sample Number	Results µg PCBs/100 cm^2*
Lineman A - face after wash	S-1	30
Lineman A - hands after wash	S-2	213
Lineman B - after test, hands before wash	S-10	487
Lineman B - after test,-hands after wash	S-11	7
Lineman B - hands after sample in vault, no wash	S-12	354
Lineman B - face after sample in vault, no wash	S-13	5
Oil test area - smear table and floor in oil test area	S-14	796

*µg PCBs/100 cm^2 - micrograms of PCBs per approximately 100 square centimeters of surface area.

Minimum detection limit is 0.01 micrograms per sample.

UNION ELECTRIC COMPANY
MARCH 9-10, 1977

TABLE IIC

CONCENTRATIONS OF TRICHLOROBENZENE*, TETRACHLOROETHYLENE, AND ALIPHATIC SOLVENT-"140 FLASH" FOUND DURING YEARLY INSPECTION OPERATIONS INVOLVING TWO TRANSFORMERS CONTAINING PCBs AT TWO DIFFERENT UNDERGROUND VAULT LOCATIONS

Job and/or Area Classification	Date	Sample Number	Time of Sample	Tetrachloroethylene mg/M^3**- TWA***	Aliphatic Solvent "140 Flash" mg/M^3**-TWA***
Lineman A	3/9	C-1	10:24--1:39	40	11
Underground Vault - area	3/9	C-2	10:20-11:24	30	7
Lineman B	3/10	C-Z	8:48-10:44	2	1
Oil test area	3/10	C-A	8:37-11:15	ND	ND
Environmental Criteria for these substances are ----------				339	150

The Environmental Criteria for trichlorobenzene is 40 mg/M^3.

*no trichlorobenzene was detected on the above samples.
**mg/M^3 - approximate milligrams of substance per cubic meter of air.
***TWA --- the time-weighted average concentration for a normal eight-hour workday.

NOTE: Minimum detection limit for trichlorobenzene, aliphatic solvent-"140 Flash", and tetrachloroethylene was reported as 0.01 mg/M^3 per sample.

UNION ELECTRIC COMPANY
MARCH 9-10, 1977

TABLE IIIA

CONCENTRATIONS OF PROPYLENE GLYCOL BUTYL ETHER ESTERS OF 2,4,5-TRICHLOROPHENOXYACETIC ACID (ESTERS OF 2,4,5-T) DURING MIXING AND HERBICIDE SPRAYING OPERATIONS ALONG POWER LINE RIGHT-OF-WAY

Job and/or Area Classification	Date	Sample Number	Time of Sample	Esters of 2,4,5-T mg/M^3*	Total per Sample Esters of 2,4,5-T mg/M^3*
Herbicide Sprayer #1	3/9	GF-12**	1:00--3:35	0.03	
Herbicide Sprayer #1	3/9	Imp-1**	1:00--3:35	0.03 > series	0.06
Herbicide Sprayer #1	3/9	GF-7	1:00--3:35	0.01	
Herbicide Sprayer #1	3/9	CT-2 **	1:00--3:35	ND > series	0.01
Herbicide Sprayer #2	3/9	GF-8 &-GF-13***	12:55--3:35	0.01	
Herbicide Sprayer #2	3/9	Imp-2	12:55--3:35	0.01 > series	0.02
Herbicide Sprayer #2	3/9	GF-4	12:55--3:35	0.01	
Herbicide Sprayer #2	3/9	CT-4	12:55--3:35	ND > series	0.01
Herbicide Sprayer #1	3/10	GF-2	10:35-12:35	ND	
Herbicide Sprayer #1	3/10	Imp-3	10:35-12:35	0.01 > series	0.01
Herbicide Sprayer #1	3/10	GF-1	10:35-12:35	0.01	
Herbicide Sprayer #1	3/10	CT-5	10:35-12:35	ND > series	0.01
Herbicide Sprayer #2	3/10	GF-3	10:35-12:35	ND	
Herbicide Sprayer #2	3/10	Imp-4	10:35-12:35	0.01 > series	0.01
Herbicide Sprayer #2	3/10	GF-6	10:35-12:35	ND	
Herbicide Sprayer #2	3/10	CT-7	10:35-12:35	ND > series	ND

Environmental Criteria for esters of 2,4,5-T is 10 mg/M^3.

*mg/M^3 - approximate milligrams of substance per cubic meter of air.

**"GF"-glass fiber filter followed by "Imp" impinger sample or a "CT" charcoal tube sample.

***GF-8 fell off and cracked cassette, replaced with GF-13 at 2:50 p.m.

Minimum detection limit for esters of 2,4,5-T is 0.01 micrograms per sample.