Abstract

Kevin Y. Chen. Strategy for Chemical Exposure Assessment in the Electric Utility Industry. (Under the Direction of Dr. Michael R. Flynn. Sc. D.)

There have been many approaches to determining historical exposures to chemicals in exposure assessment studies. This study used committees of industry experts to obtain qualitative exposure estimates for workers in two electric utility companies potentially exposed to five chemicals of interest (benzene, creosote, herbicides, polychlorinated biphneyls, and solvents) since the 1930s. The selection of these five chemical was based on evidence suggesting an association between them and leukemia and brain cancer. Study objectives, list of most common job titles within each occupational category, occupational job category descriptions, and five chemical survey forms were distributed to the each company for review and later used in the exposure assessment process.

The results obtained show discrepancies in exposures between the two companies to be possibly attributed to differences between company committee members, differences in tasks performed by persons holding the most common job titles in occupational categories, regulatory changes and their effects, technological changes, and unclear definitions of

exposure levels. These discrepancies raise concerns regarding the reliability of the estimates made by the company committees. However, the committees did consistently indicate occupational categories with potential exposure to the chemicals (creosote, herbicides, PCBs, and solvents). Thus, the exposure information can be used to determine if a relationship exists between exposure to the chemicals and the diseases of interest (leukemia and brain cancer).

DEDICATION

I would like to dedicate this paper to the people I hold most important in my life. To my family, whose love and support have always inspired me throughout my educational experiences. To my friends, old and new, who always gave me the encouragement that I needed during those times of frustration.

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Chapter I - Introduction

Several approaches have been used in exposure assessment technology. These are qualitative,[1-4] semiquantitative,[1,5-7] and quantitative[8-10] methods. All these methods require the classification of job titles into occupational categories which serve as the organizing framework for the assignment of exposures. These approaches have varying degrees of accuracy and feasibility depending on the limitations of the study. Most often the limitations are a result of the availability of information used to estimate exposure or lack there of. The types of information that are usually available include work histories, job titles and descriptions, standard operating procedures, process flow charts, purchasing records, plant layouts, and others.[1] Only recently has there been direct exposure information such as biological and air monitoring data, but the applicability of this information is limited depending on the study.

This study used committees of industry experts to make qualitative exposure estimates for workers in two electric utility companies potentially exposed to five chemicals (benzene, creosote, herbicides, polychlorinated biphneyls, and solvents) since the 1930s. An exposure assessment packet which includes an explanation of study objectives, a listing of the most common job titles within each occupational

category, occupational job category descriptions, and five chemical survey forms used by the committees in their assignment of exposures. The selection of the specific chemicals is based upon evidence suggesting an association between the chemicals and leukemia and brain cancer.

This study is directly related to the current interest in electric and magnetic field exposure.[11-17] The exposure of electric utility workers to chemical agents must be performed to properly assess the health effects related to electric and magnetic field exposure. The exposure information is to be combined with electric and magnetic field exposure information to establish if chemicals confound the effects of electric and magnetic field exposure.

Chapter II - Background

Occupational Epidemiology

Exposure assessment is used to determine a population's exposure pattern to a potential hazard. The use of exposure assessment in occupational epidemiology can provide the information for the epidemiologist to describe the pattern of disease occurrence among workers and to identify causative factors in the work environment.[18] Exposure assessment techniques must provide accurate accounts of exposure to identify toxic or carcinogenic agents in occupational epidemiologic studies.

While there are several types of epidemiologic studies, the occupational cohort study has played a primary role in investigating worker health concerns. Cohort studies are classified into two types depending upon the temporal relationship between the initiation of the study and the occurrence of the exposure and the disease of interest.[19-21] The study types are prospective and historical (retrospective). The common elements to each of these cohort studies are the identification of a study population (cohort) exposed to the agents of interest, the identification of a comparison population, follow-up of the cohort over time of study, and comparison of disease rates between the cohort and reference population.[20,21]

In a prospective cohort study, the population's exposure classification is made prior to the occurrence of disease. The study population is followed through time from the onset of exposure until the occurrence of disease. Cost and the amount of time required to conduct a prospective study of a disease with long latency (cancer) make them uncommon in occupational epidemiology.

In a historical cohort study, the population's exposure classification is made after exposure and disease have occurred. The mortality or morbidity information is compared between the exposed population and a reference population. Historical cohort studies are usually the preferred choice based upon cost and logistic considerations. The low cost makes them more common because all relevant events have already occurred at the time the study is initiated. More importantly, historical studies compared to prospective studies are particularly efficient for diseases with long latency periods requiring many years for the development of disease. The difficulty of historical cohort studies results from trying to evaluate exposures that have occurred many years previously. The exposure information is often inadequate and can result in exposure misclassification.

Role of the Industrial Hygienist

Historical exposure assessment studies for chronic diseases such as cancer are difficult because historical monitoring data are often not available or are limited to a

few job titles. This limitation makes the evaluation of past exposures a difficult task for the industrial hygienists. Industrial hygienists assume a vital role in exposure assessment studies because of their familiarity and understanding of plant processes, materials used, toxic properties of materials and reaction products, and engineering control measures.[18] Measurement of exposure has been more frequent, but still uncommon, especially for the time periods concerning chronic diseases such as cancer. In the absence of monitoring data, consultation with industrial hygienists is important. Several studies have obtained accurate exposure estimates upon collaboration with industrial hygienists.[2,3,5,6,8,10] In a study by Kromhout, industrial hygienists made the best qualitative exposure estimates when compared with the actual measurements of the same exposure.[2]

Retrospective Exposure Assessment

Retrospective exposure assessment studies are difficult because of the typical absence of current and/or historical data. The techniques that have been used are qualitative and semiquantitative techniques. Several types of these techniques have been used by researchers. A comparison between two earlier semiquantitative methods; the Job Exposure Matrix (JEM) and the Interview Based Evaluation (IBE); with three alternative methods; the Exposure Source Evaluation (ESE), the Job Function Evaluation (JFE), and the

Parallel Agent Evaluation (PAE); was made to determine which type was most effective.[7] Of all the methods, no one method is best for conducting exposure assessment studies. The selection of the appropriate method depends upon the study limitations, the availability of industrial hygiene information, and the preference of the investigator.[7]

Many retrospective exposure assessment studies have used similar approaches to reconstruct historical exposures including the classification of job titles either by occupation and industry,[22] by exposure zone,[23] by job task,[5,22] or by a combination of them.[8,24] The organization of job titles allows for greater manageability since the abstraction of job titles from company records can result in a large number of past and present job titles. Most often these job titles are classified into occupational categories/titles.[22,24] These occupational categories serve as the primary organizing structure for the assignment of exposures. The job titles classified within the occupational categories allow individual workers to be linked to exposure estimates by their occupational histories through a job exposure matrix.[24] As described by Hoar,[25] occupations are classified by industry and then task within the industry. Lists of suspect carcinogens are linked to the industries and tasks in which they have been used. The links make it possible to place all workers whose employment history suggests contact with the specific agents in the same

category. Epidemiologic analysis is then based on chemical and physical exposure instead of industry and task.

Selection of Chemicals

The chemicals of primary interest in the electric utility industry are those that are thought to possibly cause leukemia and brain cancer. The selection of the five specific chemicals; benzene, creosote, herbicides, polychlorinated biphenyls, and solvents; is based upon evidence suggesting an association between these chemicals and leukemia and brain cancer.

Benzene use in the past was primarily as a solvent, especially for rubber, as a diluent in lacquers, and paint removers.[26] Currently benzene use is minimal, and is present in the chemical industry as a raw material for various organic chemicals. It is also found in trace amounts in gasoline.[27,28]

Several studies on benzene have been conducted in the rubber industry because of its use as a solvent in tire manufacturing in the 1920s and 1930s. Toluene, hexane, naphthas, and other compounds have replaced benzene, however, there are still detectable air concentrations of benzene attributable to its presence as an impurity in other solvents.[29] The study of the tire manufacturers by Van Ert in 1980 reports a mean benzene concentration of 1.11 ppm for approximately 300 samples of solvent vapors.[9]

Several other studies of the rubber industry suggest a causal relationship between benzene exposure and leukemia. A case control study by Arp in 1983 reports a odds ratio of 4.5 for exposure to benzene.[29] Two other studies, one by McMichael in 1975 and the other by Wolf in 1981, report odds ratios of 3.3 and 3.2 respectively.[30,31]

Creosote is most extensively used in this country for the preservation of utility poles. Creosote is obtained from the distillation of tars of which the commercially important ones for wood preservative purposes are coal tars, oil tars, and wood tars.[32] The constituents of creosote are primarily polycyclic aromatic hydrocarbons which are known to be carcinogenic.[26] The main polycyclic aromatic hydrocarbons of interest are benzo(a)pyrene, pyrene, phenanthrene, and anthracene. Exposure to creosote involves contact with creosote treated poles and possibly railroad ties used in supporting transformers and capacitors in substations.

Herbicides, specifically phenoxyacetic acid, have been used for weed control in agriculture and forestry since the 1940s.[33] Phenoxy herbicides act similar to naturally occurring auxins, which in high concentrations lead to a disturbed and abnormal growth causing death to the plant.[33] The use of herbicides in the electric utility industry is for weed control in right of way construction and in areas around substations, utility poles and towers.

A case control study by Hoar of agricultural herbicide use reports a sixfold increased risk of lymphoma (odds ratio

of 6.0) in men exposed to them more than 20 days per year.[34] Another study in western Washington State by Woods, which looked at specific occupations and activities with potential exposure to phenoxy herbicides and chlorophenol, found significant increased risk of developing leukemia in some occupational activities where phenoxy herbicides were used with other chemicals particularly for prolonged periods of time.[35] One occupation of interest in the low exposure category, landscapers, is reported to have a nearly significant odds ratio of 1.7 for leukemia.[35] Two other studies on farming and workers manufacturing phenoxy herbicides show a significant elevated risk of leukemia with phenoxy herbicide exposure.[33,36]

Polychlorinated biphenyls (PCBs) have been used by electric utilities in capacitors, transformers, and other electrical equipment as a fire-resistant dielectric and cooling fluid. The systems are totally enclosed with exposure usually occurring during equipment maintenance and clean up of spills from damaged equipment. For example, routine maintenance of transformers include (1) sampling and testing transformer fluids for dielectric properties, (2) adding oil to transformers when the level of oil is low within the transformer itself, (3) cleanup of any spills or leaks in the transformer vaults using absorbent material and sometimes a solvent such as 1,1,1-trichloroethane, (4) repair of transformers, a process which might require drainage of transformer oil and the replacement of bushings within the

unit, and (5) filtering of the transformer oil to upgrade its dielectric properties.[37]

The performance of these tasks is accomplished by several workers: substation mechanics, substation electricians, transformer repairmen, and troublemen. Currently the sampling and testing of transformer fluids includes determining the concentration of PCB contamination. The limit for PCB contamination is 50 ppm. EPA in 1979 put a ban on the manufacture and use of PCBs in commerce.[38] This is a result of two major incidents of ingestion of PCB contaminated rice oil used for cooking in Japan and Taiwan.[39,40] The results of other studies on PCB exposure of workers involved with the manufacture and repair of capacitors and transformers show possible casual relationship between PCB exposure and leukemia.[41-44]

The studies suggesting a causal relationship between solvent exposure and leukemia also involved the rubber workers. Solvents like toluene, hexane, naphthas, and others have replaced benzene so these studies also examined exposure to these solvents. These studies reported a similar risk to that of benzene.[29-31] A study by Checkoway reported a strong association of leukemia with exposure to carbon disulfide and carbon tetrachloride, two solvents not normally associated with risk of leukemia.[45]

Chapter III - Materials and Methods

The chemical exposure assessment study was done in conjunction with the electric and magnetic fields exposure study being conducted by Dr. David Savitz of the Department of Epidemiology at the University of North Carolina at Chapel Hill. There were a total of five participating utility companies of which only two were involved in this study.

Company A served a population of 3.5 million covering a 30,000 square mile territory. The company operated a mix of fossil, nuclear and hydroelectric facilities with a total generating capacity of 9,654 megawatts.

Company B served a population of 3.9 million including 1.6 million which live in a metropolitan area. The total area served covers 2,475 square miles. Approximately 5 percent of the service area and 37 percent of sales were to the metropolitan area, and 95 percent of the electric service area and 63 percent of kilowatthour sales were in the suburbs.

The strategy created for the chemical exposure assessment study utilized a committee of experts from each of the two participating companies to assign potential exposure levels to job titles/occupational categories for the five chemicals of interest. The strategy included (1) consultation with researchers and industry professionals to

determine the feasibility of the approach, (2) preparation of a chemical assessment packet summarizing the chemicals and the job titles/occupational categories of interest, (3) selection of company expert for the committee, (4) review of chemical assessment packet by company experts, (5) assignment of potential exposure levels for each decade of the study for each occupational category by company experts, and (6) summarization of the results by company.

Development of Exposure Assessment Strategy

There were several limitations that needed to be addressed in the development of the exposure assessment strategy. The historical nature of the study and the scale of the study were of concern because the results may lack the desired sensitivity. Measurements of exposures were not available for the chemicals of interest. The study was also limited by constraints in time and funding. The companies were also unable to give full support to the study without compromising their participation in the electric and magnetic exposure study. However, the strategy still needed to be consistent and gather reliable exposure information.

With collaboration from researchers experienced in the area of exposure assessment and industry professionals, the strategy that was developed used a committee of experts from each participating company to assign potential exposure levels to job titles/occupational categories for each of the five chemicals of interest. This method, like any other, had

its advantages and disadvantages but satisfied the study limitations and availability of exposure data.

Chemical Assessment Packet

A chemical assessment packet was developed for both the participating companies. The packet included (1) a letter describing the objectives of the study, (2) an occupational category manual giving a brief description of each occupational category, (3) a company job history summary indicating the most common job titles in each occupational category, and (4) five job exposure surveys describing each chemical and the potential exposure levels that could be assigned for each decade of the study period. A copy of the chemical assessment packet is contained in the appendix.

An introductory letter was attached to the packet explaining the objectives of the chemical assessment study. The letter also contained a description of the criteria for selection of committee members, the three exposure levels, and the supplementary information (occupational category manual and company job history summary). It was necessary that each company understand the importance of the study and the background information contained in the chemical assessment packet prior to the meeting of the company experts.

The job titles from each company were classified into 28 occupational categories. The job titles were gathered from company records covering the period of study. Each

Table 3.1 - List of Occupational Categories

1 - Senior Managers and Executives
2 - Engineers, Professionals, and Specialist
3 - Technical Workers
4 - Field / Craft / Trade Supervisors
5 - Administrative Supervisors
6 - Administrative Support / Clerical Workers
7 - Sales, Marketing and Business Workers
8 - Services
9 - Mechanics
11 - Machinists
12 - Boilermakers / Steamfitters
13 - Electricians
14 - Linemen
15 - Instrument and Control Technicians
16 - Relay Technicians
17 - Telecommunication Technicians
18 - Cable Splicers
19 - Power Plant Operators
20 - Substation Operators
21 - Riggers
22 - Auto and Truck Mechanics
23 - Painters
24 - Pipe Coverers
25 - Welders
26 - Heavy Vehicle Operators
27 - Material Handlers
28 - Laborers
29 - Other Craft / Trades Workers

participating utility company had thousands of job titles over the entire study period. The organization of these job titles into occupational categories allowed for greater manageability because the abstraction of job titles from company records resulted in large number of past and present job titles. The occupational categories (Table 3.1) were developed to reflect work activities, work environment, and occupational status and served as the primary organizing framework for the assignment of chemical exposures. The occupational categories used for this study were similar to

those being used for the electric and magnetic field exposure study. The classification of job titles was conducted by the project research staff.

A description of each occupational category was attached to the chemical assessment packet to assist the company committees in their assignment of potential exposure levels. This allowed the committee members to understand the criteria used in classifying job titles. For example, the job title "foremen" can be classified in category 4, field/craft/trade supervisors, but specialized foremen like "mechanics foremen" were classified in category 9, mechanics. This was done because those specialized foremen were working foremen who were likely to have exposures similar to those workers under his supervision.

A company job history summary was enclosed in the packet to further aid the company committee members in assigning potential exposure levels. The summary listed the most common job titles based on person-years (the number of workers multiplied by the average number of years in that job title). The total person-years for the job titles listed and the occupational category were also given for comparison. This was used to give the committee an idea of the percentage of person-years comprised by the most common job titles.

The committee was also given a job exposure survey for each of the five chemicals. The survey contained a brief description of the chemical and the possible routes of exposure (ingestion, inhalation, or dermal contact). A

description of each exposure level was also included: (3) routine exposure (the agent of interest was regularly used by workers in the job titles within each occupational category or is regularly present in their workplace), (2) incidental/occasional exposure (the workers in the job titles within each occupational category were intermittently exposed to the agent of interest or it may have been present sometimes in their workplace), and (1) low or no exposure (the workers in the job titles within each occupational category were very rarely or not exposed to the agent of interest). The exposure levels were included on the survey form to provide further emphasis and to ensure the committee understood the three exposure levels.

Selection of Committee Members

It was important that each member of the committee meet certain criteria of knowledge of the industry and years of service with the company. The members were considered "expert" in their field for the purpose of the study. Certain types of employees were sought as members of the committee.

The first was the company industrial hygienist. Industrial hygienists are concerned with recognition, evaluation, and control of hazards in the work environment. Their knowledge of plant processes, materials used, toxic properties of materials, and engineering controls can be useful in the assignment of potential exposure levels.

Other employees that were sought included company or plant safety coordinators, supervisors and managers, and retired workers. Individuals who have worked with the company for a number of years were considered invaluable members of the expert committee. Their overall knowledge of the company, various jobs and tasks, chemicals used, equipments used, and historical changes were considered useful in the assignment of exposure levels.

Exposure Estimation

A company contact person was asked to select and convene the committee members. Prior to the meeting, the chemical assessment packet was distributed to the committee member. Thus, the member had an opportunity to review the information contained in the packet. Representatives from the University of North Carolina at Chapel Hill, who were involved with the study, were in attendance to conduct the meeting and answer any questions from the committee members.

The company committee was asked to assign exposure levels of routine, incidental/occasional, or low/none to the twenty-eight occupational categories for each decade of the study. In their assignment of exposure, the committee members were reminded to consider several of the following factors:

i. Employee work practices - past work practices may have resulted in high exposure levels but advances in the

recognition of hazards in the work environment may have changed work practices and current worker exposure levels.

ii. Use of personal protective equipment - respirators, gloves.

iii. Control technology - local exhaust ventilation

vi. Environmental regulations - similar to work practices, advances in hazard recognition may have prompted changes or new legislation to protect the worker by reducing their exposures.

v. Company policy - the policy of individual companies toward safety may vary from one to the other. Use of some materials may be prohibited or severely restricted due to company policy.

The committee was also asked to concentrate on those job titles that had the greatest number of person-years when making their assignments of exposures. This ensured that exposure assignments made for each occupational category were based on the job titles which comprised the majority of the person-years within an occupational category. Any conflicts regarding the assignment of exposure levels were discussed until a final consensus was reached.

The exposure information obtained from the two companies will be reviewed to assess homogeneity and differences between the two companies. The strategy of using experts panels to assign exposures will be evaluated for its strengthens and weaknesses.

Chapter IV - Results

The exposure data was gathered from two committees, one from each of the participating companies. The committee from company A was comprised of five members, two industrial hygienists and three retired supervisors, with an average of twenty-seven years of experience with the company. Company B had a committee of thirteen members; three linemen, three engineers, two industrial hygienists, two lab technicians, two cable splicers, and a chemist; with an average of twenty-one years of experience with the company.

Benzene

Both company committees indicated no exposure to benzene for the entire study period. They were less confident of the earlier decades, but felt if there were any benzene exposure, it was isolated to workers in the laboratories and meter and repair shops.

Herbicides

The company committees had varying opinions about exposure to herbicides. The members from company A had indicated herbicide exposure to be seasonal throughout the entire study period and was occasional (exposure level two) during that three or four month period of the spring and

summer. The occupational categories exposed to herbicides during this period were 9-mechanics, specifically substation mechanics, 13-electricians specifically substation electricians, 21-riggers, and 28-laborers, specifically those working around the substation (Table 4.1 and Figure 4.1). The types of herbicide used were mostly phenoxyacetic acids, amides, uracils, and others. Since the 1970s, the application of herbicides for right of way construction has been contracted to other companies and not done by company A employees but the application of herbicides around substations was done by company employees.

The occupational categories exposed to herbicides for company B were 8-services, 9-mechanics, 14-linemen, and 28-laborers. The committee members from company B indicated that exposure to herbicides was not seasonal but was occasional (exposure level two) for the entire study period except for category 9-mechanics who had routine exposure (level three) from the 1930s to 1960s and category 14-linemen which had routine exposure in the 1970s (Table 4.2 and Figure 4.2 - 4.4). These two categories exposure changed during those periods because the committee indicated that workers in those occupational categories directly applied herbicides for the right of way construction and for weed control around substations. The herbicides used were similar to those used by company A.

Table 4.1 - Herbicide Exposure for Company A throughout Entire Study Period*

	Decade					
	1930's	1940's	1950's	1960's	1970's	1980's
OC**	Exposure***	Exposure***	Exposure***	Exposure***	Exposure***	Exposure***
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	2	2	2	2	2	2
11	1	1	1	1	1	1
12	1	1	1	1	1	1
13	2	2	2	2	2	2
14	1	1	1	1	1	1
15	1	1	1	1	1	1
16	1	1	1	1	1	1
17	1	1	1	1	1	1
19	1	1	1	1	1	1
20	1	1	1	1	1	1
21	2	2	2	2	2	2
22	1	1	1	1	1	1
23	1	1	1	1	1	1
25	1	1	1	1	1	1
26	1	1	1	1	1	1
27	1	1	1	1	1	1
28	2	2	2	2	2	2
29	1	1	1	1	1	1

* Exposure is only during the spring and summer months.
** Occupational Category Number
*** Exposure Levels 3 - Routine, 2 -Occasional, and 1 - Low/None

Figure 4.1 - Herbicide Exposure for Company A throughout Entire Study Period

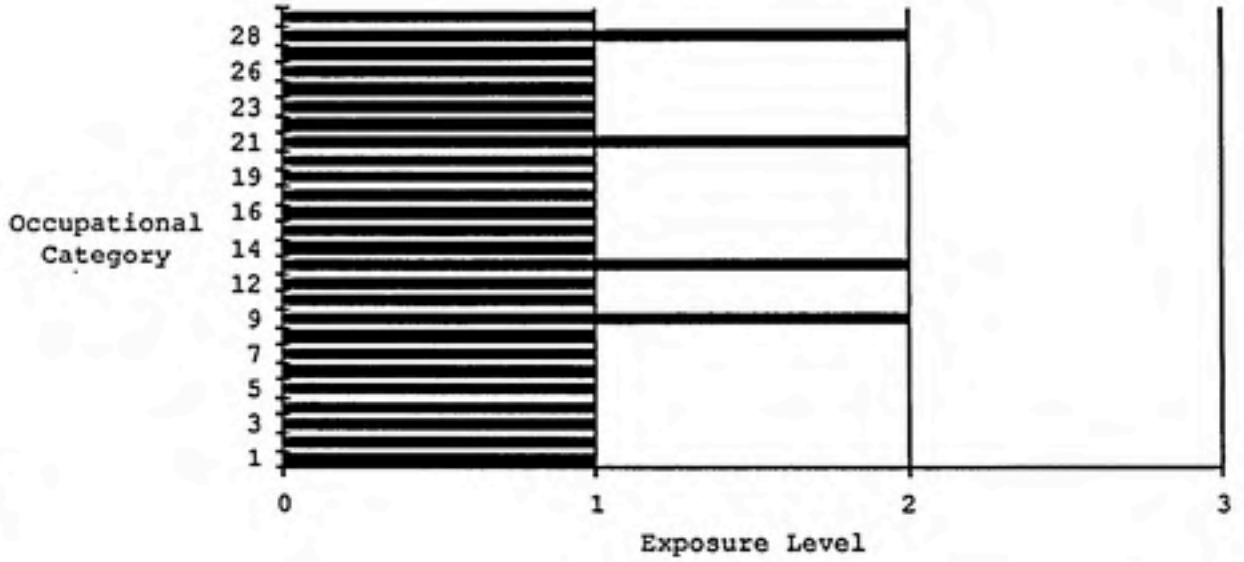


Table 4.2 - Herbicide Exposure for Company B throughout Entire Study Period

	Decade					
OC*	1930's Exposure**	1940's Exposure**	1950's Exposure**	1960's Exposure**	1970's Exposure**	1980's Exposure**
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	2	2	2	2	2	2
9	3	3	3	3	2	2
11	1	1	1	1	1	1
12	1	1	1	1	1	1
13	1	1	1	1	1	1
14	2	2	2	2	3	2
15	1	1	1	1	1	1
16	1	1	1	1	1	1
18	1	1	1	1	1	1
19	1	1	1	1	1	1
20	1	1	1	1	1	1
21	1	1	1	1	1	1
22	1	1	1	1	1	1
23	1	1	1	1	1	1
24	1	1	1	1	1	1
25	1	1	1	1	1	1
26	1	1	1	1	1	1
27	1	1	1	1	1	1
28	2	2	2	2	2	2
29	2	2	2	2	2	2

* Occupational Category Number

** Exposure Levels 3 - Routine, 2 -Occasional, and 1 - Low/None

Figure 4.2 - Herbicide Exposure for Company B during the 1930s to 1960s

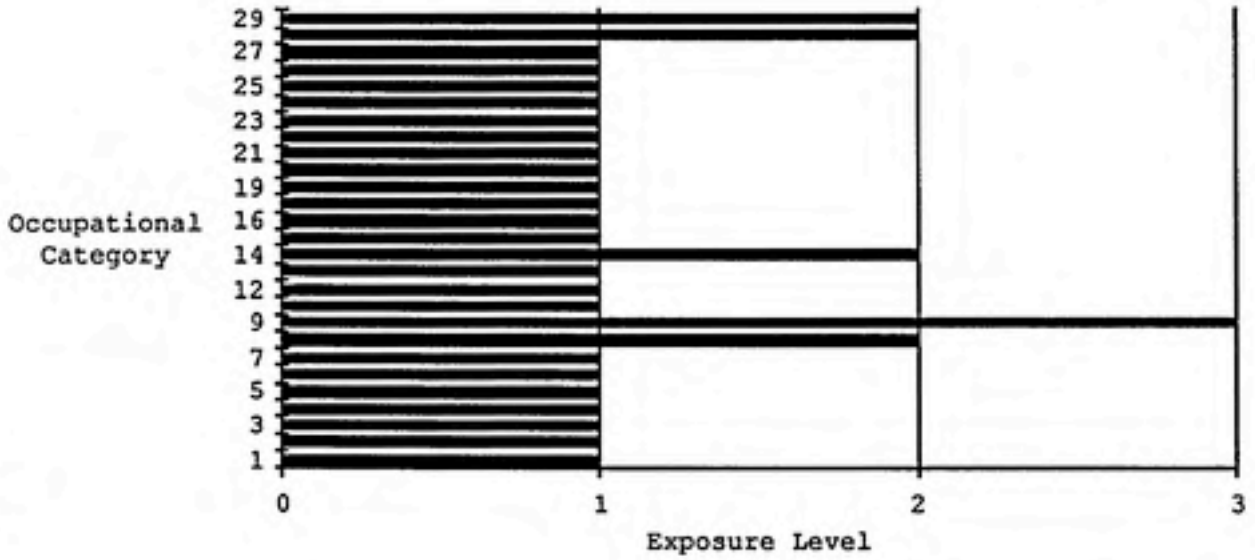


Figure 4.3 - Herbicide Exposure for Company B during the 1970s

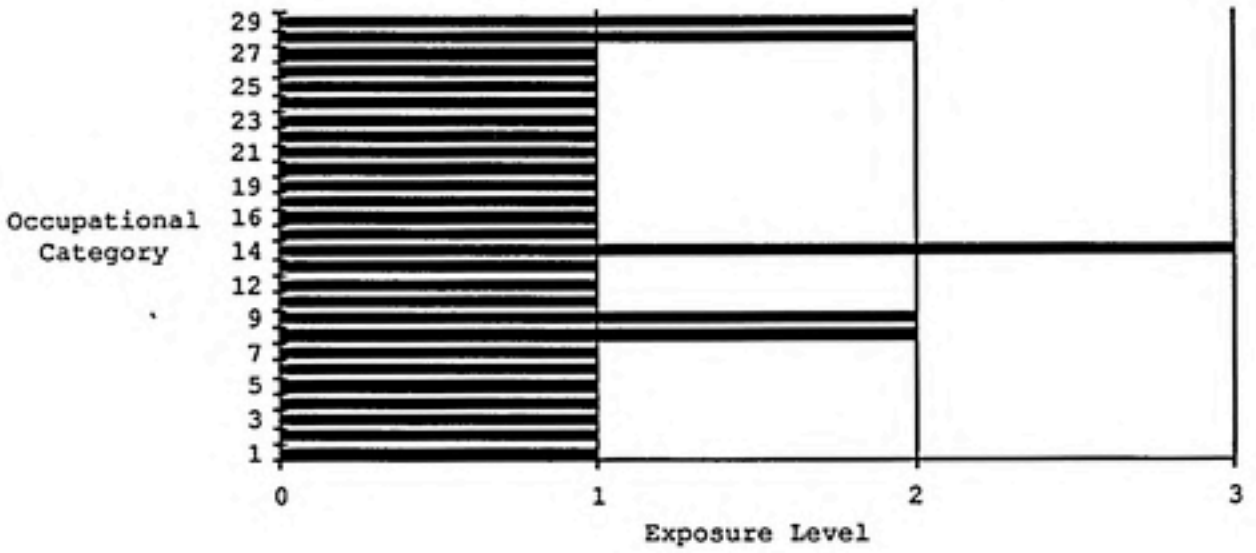
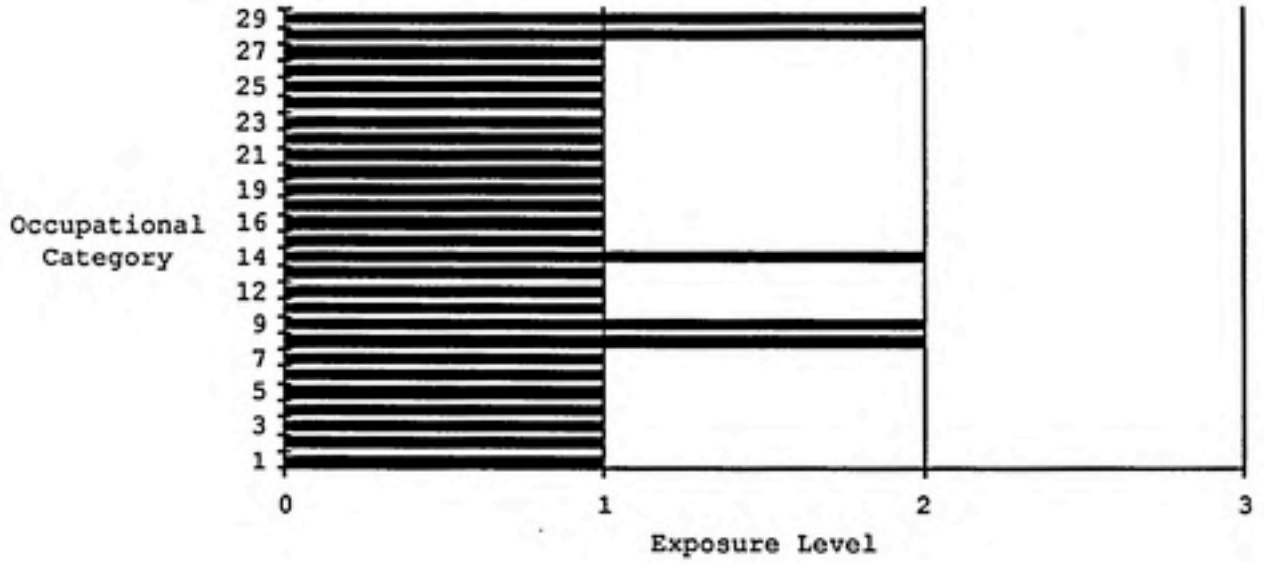


Figure 4.4 - Herbicide Exposure for Company B during the 1980s



Creosote

Company A committee members indicated that five occupational categories were exposed to creosote. Only one category, 14-linemen, had constant exposure of routine (level three) for the entire study period. The other four categories; 9-mechanics, 13-electricians, 21-riggers, and 28-laborers had similar exposure, but it was variable throughout the entire study period. The assigned exposures were routine (level three) from the 1930s to 1960s and occasional (level two) from the 1970s to 1980s (Table 4.3 and Figure 4.5 and 4.6). This change was a result of the use of alternative types of wood preservatives on utility poles.

As for company B, the committee members indicated four occupational categories were exposed to creosote during the study period. Two categories, 14-linemen and 28-laborers, had routine exposure (level three) for the entire study period. The other two, 9-mechanics and 18-cable splicers, had occasional exposure (level two) for the entire study period (Table 4.4 and Figure 4.7).

Polychlorinated Biphenyls (PCBs)

Exposure to PCBs for company A was similar for all the specified occupational categories. There were five categories exposed to PCBs; 9-mechanics, 13-electricians, 14-linemen, 21-riggers, and 28-laborers. These categories were the same as those for creosote exposure. The exposures to these categories were variable for the entire study period.

Table 4.3 - Creosote Exposure for Company A throughout Entire Study Period

	Decade					
	1930's	1940's	1950's	1960's	1970's	1980's
OC*	Exposure**	Exposure**	Exposure**	Exposure**	Exposure**	Exposure**
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	3	3	3	3	2	2
11	1	1	1	1	1	1
12	1	1	1	1	1	1
13	3	3	3	3	2	2
14	3	3	3	3	3	3
15	1	1	1	1	1	1
16	1	1	1	1	1	1
17	1	1	1	1	1	1
19	1	1	1	1	1	1
20	1	1	1	1	1	1
21	3	3	3	3	2	2
22	1	1	1	1	1	1
23	1	1	1	1	1	1
25	1	1	1	1	1	1
26	1	1	1	1	1	1
27	1	1	1	1	1	1
28	3	3	3	3	2	2
29	1	1	1	1	1	1

* Occupational Category Number

** Exposure Levels 3 - Routine, 2 -Occasional, and 1 - Low/None

Figure 4.5 - Creosote Exposure for Company A during the 1930s to 1960s

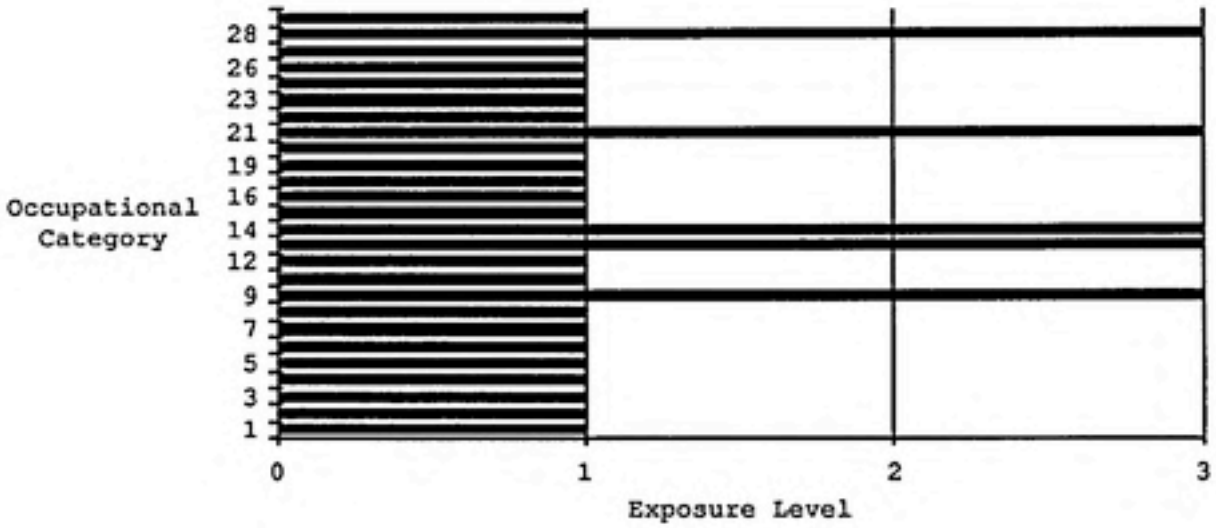


Figure 4.6 - Creosote Exposure for Company A during the 1970s and 1980s

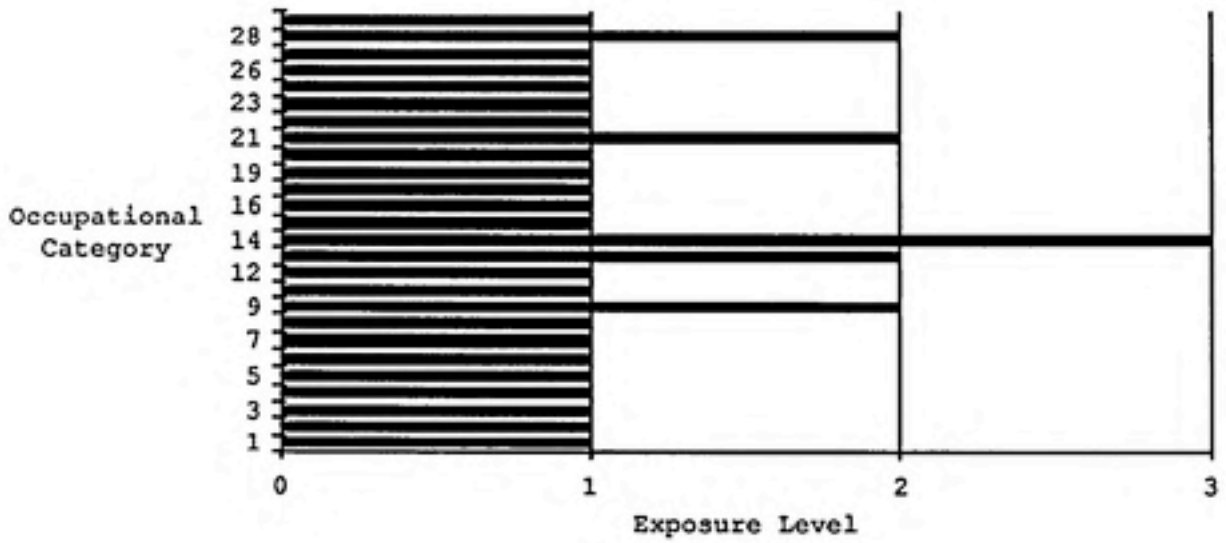


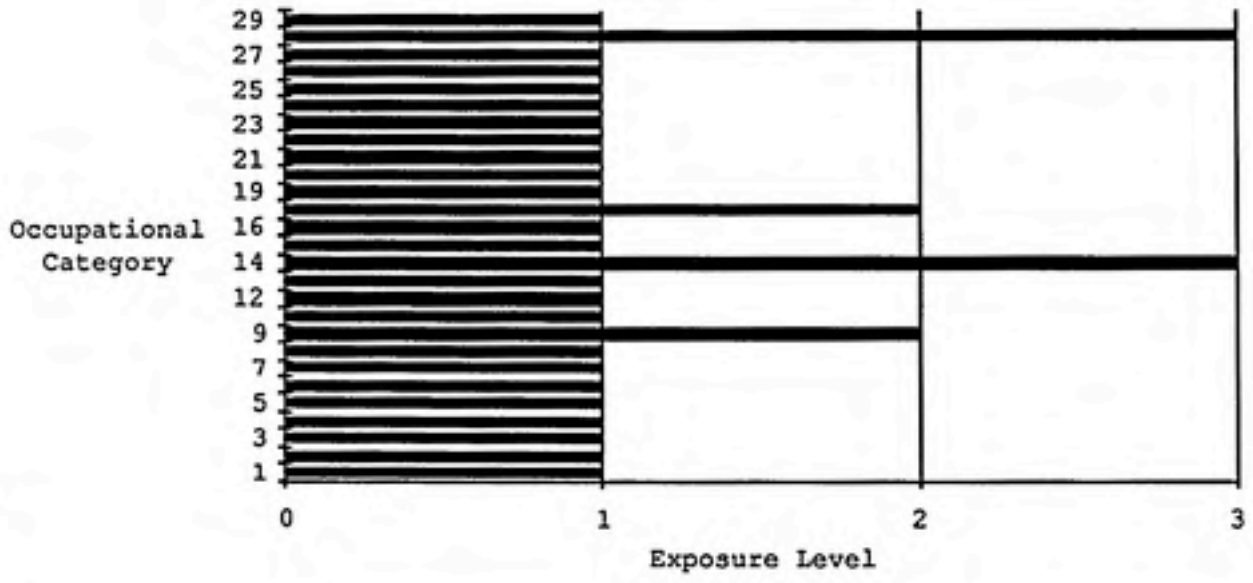
Table 4.4 - Creosote Exposure for Company B throughout Entire Study Period

	Decade					
OC*	1930's Exposure**	1940's Exposure**	1950's Exposure**	1960's Exposure**	1970's Exposure**	1980's Exposure**
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	2	2	2	2	2	2
11	1	1	1	1	1	1
12	1	1	1	1	1	1
13	1	1	1	1	1	1
14	3	3	3	3	3	3
15	1	1	1	1	1	1
16	1	1	1	1	1	1
18	2	2	2	2	2	2
19	1	1	1	1	1	1
20	1	1	1	1	1	1
21	1	1	1	1	1	1
22	1	1	1	1	1	1
23	1	1	1	1	1	1
24	1	1	1	1	1	1
25	1	1	1	1	1	1
26	1	1	1	1	1	1
27	1	1	1	1	1	1
28	3	3	3	3	3	3
29	1	1	1	1	1	1

* Occupational Category Number

** Exposure Levels 3 - Routine, 2 -Occasional, and 1 - Low/None

Figure 4.7 - Creosote Exposure for Company B throughout Entire Study Period



The exposure from the 1930s to 1960s was routine (level three). The exposure to PCBs in the 1970s and 1980s changed to occasional (level two) and low/none (level one) respectively (Table 4.5 and Figure 4.8 and 4.9). This was a result of health concerns indicated by early studies showing possible health risk resulting from PCB exposure.[39,40] Thus, there was change in use of PCB as an dielectric fluid.

Company B committee members indicated six occupational categories were exposed to PCBs; 9-mechanics, 13-electricians, 14-linemen, 16-relay technicians, 20-substation operators, and 28-laborers. The members indicated that exposure to these categories did not start until the 1950s because the company did not use PCB containing equipment until then. Routine exposure (level three) was assigned for the entire study period starting at 1950 to three categories; 9-mechanics, 13-electricians, and 28-laborers. The other three categories were assigned occasional exposure (level two) for that same period (Table 4.6 and Figure 4.10). The members from company B felt no change in exposure assignment was needed because there was still enough PCB contaminated equipment to keep exposure levels the same.

Solvents

Potential exposure to solvents encompassed a greater number of occupational categories as indicated by the members of each company committee. Company A indicated ten occupational categories exposed to solvents (Table 4.7 and

Table 4.5 - PCB Exposure for Company A throughout Entire Study Period

	Decade					
	1930's	1940's	1950's	1960's	1970's	1980's
OC*	Exposure**	Exposure**	Exposure**	Exposure**	Exposure**	Exposure**
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	3	3	3	3	2	1
11	1	1	1	1	1	1
12	1	1	1	1	1	1
13	3	3	3	3	2	1
14	3	3	3	3	2	1
15	1	1	1	1	1	1
16	1	1	1	1	1	1
17	1	1	1	1	1	1
19	1	1	1	1	1	1
20	1	1	1	1	1	1
21	3	3	3	3	2	1
22	1	1	1	1	1	1
23	1	1	1	1	1	1
25	1	1	1	1	1	1
26	1	1	1	1	1	1
27	1	1	1	1	1	1
28	3	3	3	3	2	1
29	1	1	1	1	1	1

* Occupational Category Number

** Exposure Levels 3 - Routine, 2 -Occasional, and 1 - Low/None

Figure 4.8 - PCB Exposure for Company A during the 1930s to 1960s

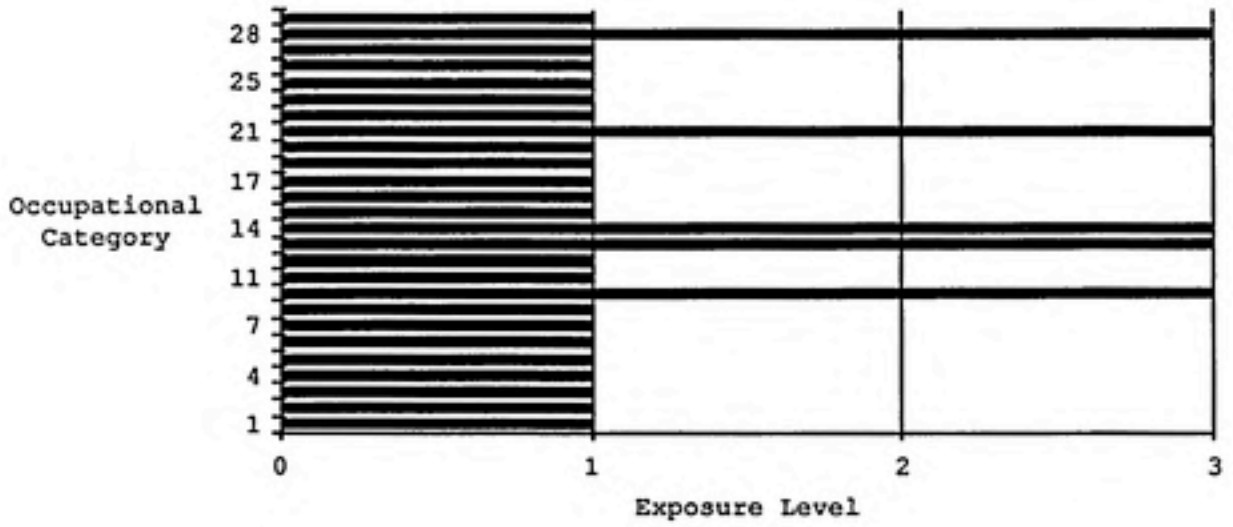


Figure 4.9 - PCB Exposure for Company A during the 1970s

Table 4.6 - PCB Exposure for Company B throughout Entire Study Period

	Decade					
OC*	1930's Exposure**	1940's Exposure**	1950's Exposure**	1960's Exposure**	1970's Exposure**	1980's Exposure**
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	1	1	1	1	1
9	1	1	3	3	3	3
11	1	1	1	1	1	1
12	1	1	1	1	1	1
13	1	1	3	3	3	3
14	1	1	2	2	2	2
15	1	1	1	1	1	1
16	1	1	2	2	2	2
18	1	1	1	1	1	1
19	1	1	1	1	1	1
20	1	1	2	2	2	2
21	1	1	1	1	1	1
22	1	1	1	1	1	1
23	1	1	1	1	1	1
24	1	1	1	1	1	1
25	1	1	1	1	1	1
26	1	1	1	1	1	1
27	1	1	1	1	1	1
28	1	1	3	3	3	3
29	1	1	1	1	1	1

* Occupational Category Number

** Exposure Levels 3 - Routine, 2 -Occasional, and 1 - Low/None

Figure 4.10 - PCB Exposure for Company B during the 1950s to 1980s

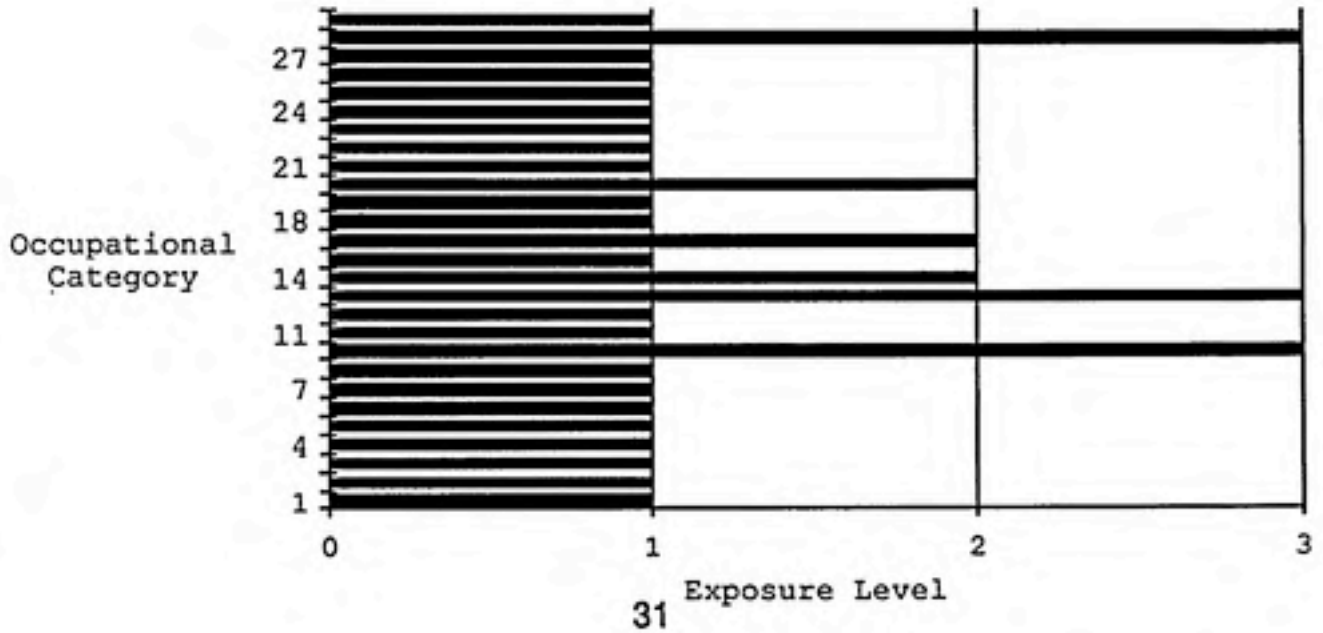


Figure 4.11 and 4.12). They were 8-services, 9-mechanics, 12-boilermakers/steamfitters, 13-electricians, 14-linemen, 16-relay technicians, 21-riggers, 22-auto and truck mechanics, 23/24-painter/pipe coverers, and 28-laborers. The exposures assigned to these categories were occasional for the entire study period with the exception of relay technicians because this category did not come into existence until the 1960s.

Company B committee members also indicated numerous occupational categories exposed to solvents (Table 4.8 and Figure 4.13). The members indicated seventeen categories had exposure. They were 3-technical workers, 8-services, 9-mechanics, 11-machinists, 12-boilermakers/steamfitters, 13-electricians, 14-linemen, 15-instrument and control technicians, 16-relay technicians, 18-cable splicers, 19-power plant operators, 20-substation operators, 22-auto and truck mechanics, 23-painter, 24-pipe coverers, 28-laborers, and 29-other crafts/trade workers. All of the categories were assigned routine exposure (level three) except 20-substation operators, 24-pipe coverers, and 9-other crafts/trade workers which were assigned occasional exposures (level two).

Exposure by Person-Years

The person years information was applied to the occupational categories with potential exposures to each chemical for each decade. Table 4.9 shows company A's person

Table 4.7 - Solvent Exposure for Company A throughout Entire Study Period

	Decade					
OC*	1930's Exposure**	1940's Exposure**	1950's Exposure**	1960's Exposure**	1970's Exposure**	1980's Exposure**
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	1	1	1	1	1	1
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	2	2	2	2	2	2
9	2	2	2	2	2	2
11	2	2	2	2	2	2
12	2	2	2	2	2	2
13	2	2	2	2	2	2
14	2	2	2	2	1	1
15	1	1	1	1	1	1
16	1	1	1	2	2	2
17	1	1	1	1	1	1
19	1	1	1	1	1	1
20	1	1	1	1	1	1
21	2	2	2	2	2	2
22	2	2	2	2	2	2
23	2	2	2	2	2	2
25	1	1	1	1	1	1
26	1	1	1	1	1	1
27	1	1	1	1	1	1
28	2	2	2	2	2	2
29	1	1	1	1	1	1

* Occupational Category Number

** Exposure Levels 3 - Routine, 2 -Occasional, and 1 - Low/None

Figure 4.11 - Solvent Exposure for Company A during the 1930s to 1960s

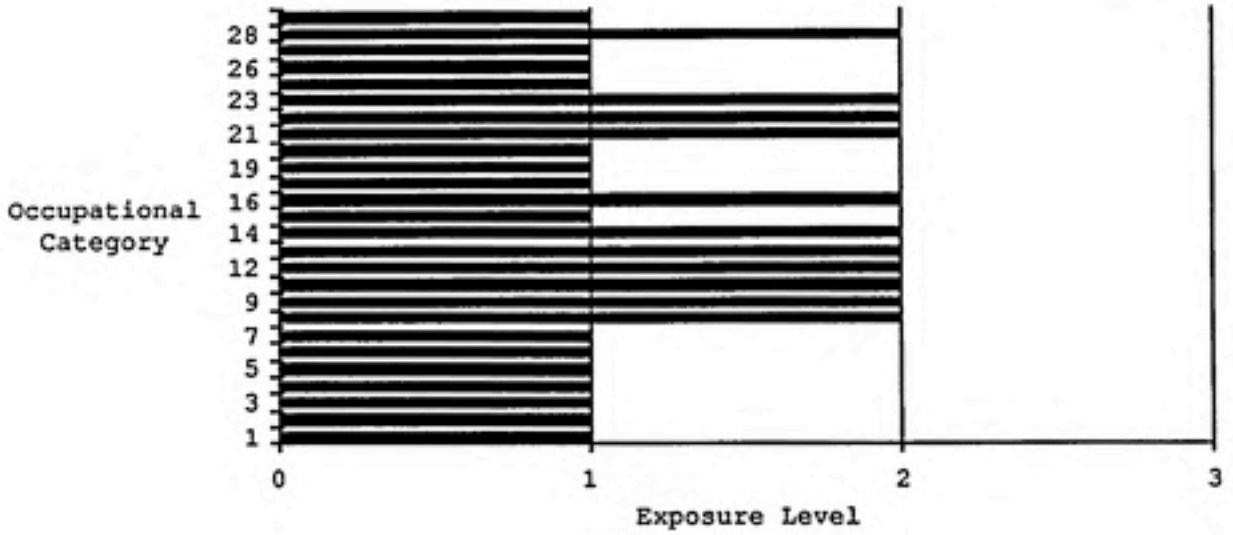


Figure 4.12 - Solvent Exposure for Company A during the 1970s and 1980s

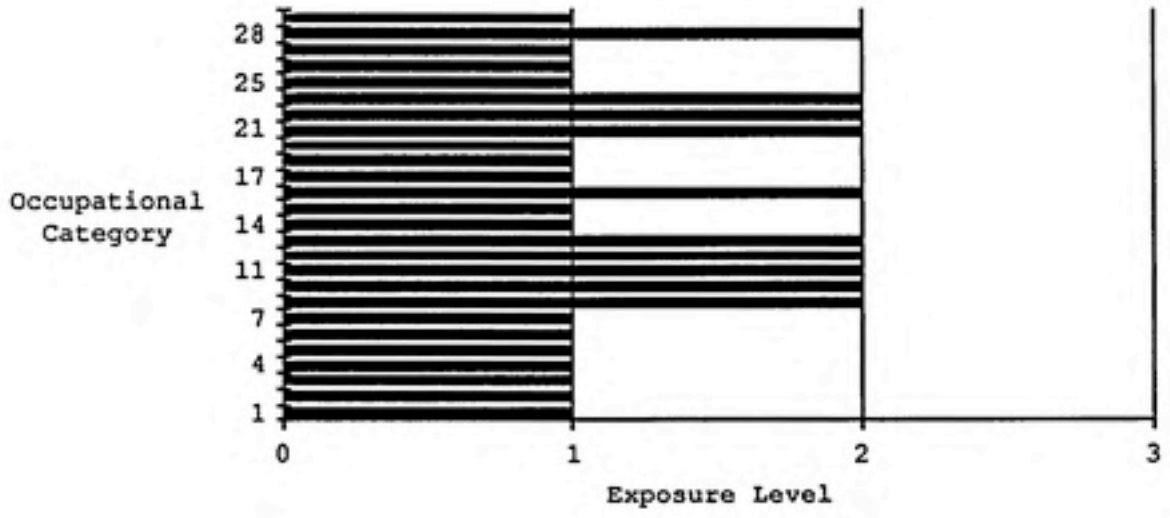


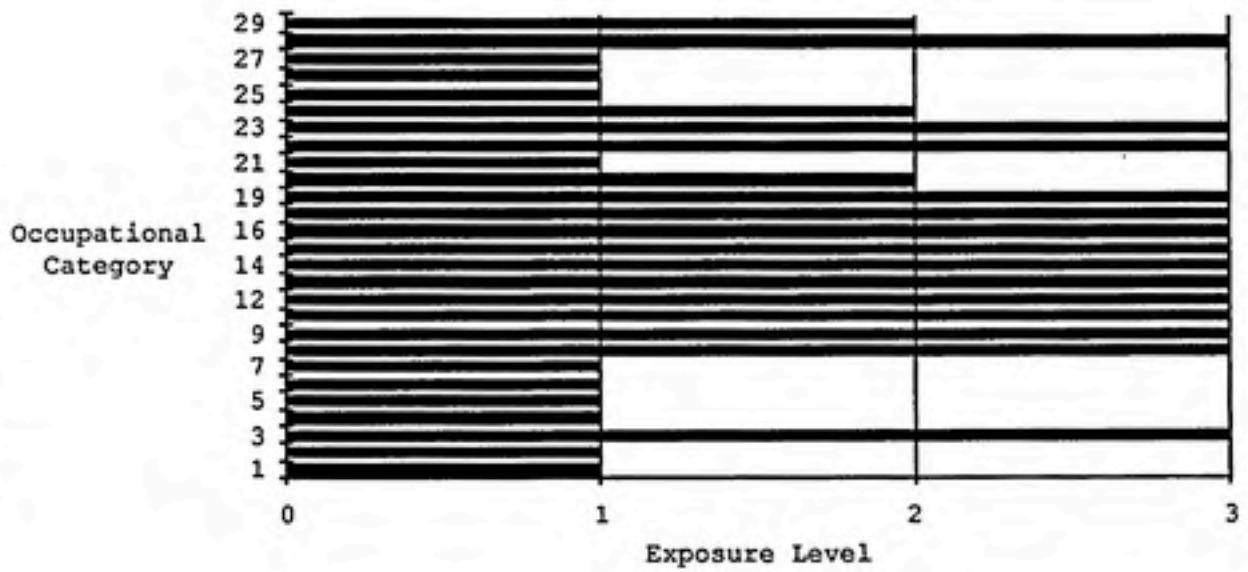
Table 4.8 - Solvent Exposure for Company B throughout Entire Study Period

	Decade					
	1930's	1940's	1950's	1960's	1970's	1980's
OC*	Exposure**	Exposure**	Exposure**	Exposure**	Exposure**	Exposure**
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	3	3	3	3	3	3
4	1	1	1	1	1	1
5	1	1	1	1	1	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	3	3	3	3	3	3
9	3	3	3	3	3	3
11	3	3	3	3	3	3
12	3	3	3	3	3	3
13	3	3	3	3	3	3
14	3	3	3	3	3	3
15	3	3	3	3	3	3
16	3	3	3	3	3	3
18	3	3	3	3	3	3
19	3	3	3	3	3	3
20	2	2	2	2	2	2
21	1	1	1	1	1	1
22	3	3	3	3	3	3
23	3	3	3	3	3	3
24	2	2	2	2	2	2
25	1	1	1	1	1	1
26	1	1	1	1	1	1
27	1	1	1	1	1	1
28	3	3	3	3	3	2
29	2	2	2	2	2	2

* Occupational Category Number

** Exposure Levels 3 - Routine, 2 -Occasional, and 1 - Low/None

Figure 4.13 - Solvent Exposure for Company B throughout Entire Study Period



years information for each occupational category for each decade of the study period. Table 4.10 shows the percent of exposure by person years for each decade. Percent of exposure was determined by combination all person years of those occupational categories with exposure of routine (level three) and occasional (level two). Figures 4.14 - 4.17 shows the percent of exposure for company A across the entire study period for each chemical except benzene. The range of exposure was from fourteen to fifty-three percent with the solvent having the greatest percentage of exposure. Creosote and PCB had the same exposure while herbicide had the lowest percentage of person years of exposure.

Table 4.11 and 4.12 shows company B's person years information for each occupational categories for each decade of the study period and its percent exposure information. Figure 4.18 - 4.21 shows the percent of exposure for company B across the entire study period for each chemical except benzene. The range of exposure was from eighteen to fifty-five percent. The distribution of exposure was similar to company A with solvent having the greatest percentage of exposure while creosote and PCBs had the similar exposure and herbicides having the lowest percentage of person years of exposure.

Table 4.9 - Summary of Company A's Person Years for Entire Study Period

	Decade						
OC*	1930's Per-yrs	1940's Per-yrs	1950's Per-yrs	1960's Per-yrs	1970's Per-yrs	1980's Per-yrs	Total Per-Yrs
1	245	436	489	586	1528	3385	6668
2	177	428	1121	1621	6406	12260	22013
3	59	157	455	543	1703	3449	6365
4	11	67	101	131	650	969	1929
5	10	91	138	296	907	1436	2879
6	175	426	1303	1277	1817	2717	7715
7	57	104	312	647	611	424	2155
8	41	189	341	319	279	193	1362
9	87	326	511	653	2013	3623	7213
11	0	11	5	0	37	64	118
12	0	37	46	0	0	0	83
13	67	293	710	74	1722	1892	4759
14	433	1159	3059	3337	5421	6280	19689
15	0	0	23	40	449	1553	2066
16	0	2	1	11	149	343	506
17	0	10	22	12	272	626	943
19	108	357	864	938	1559	2292	6117
20	38	151	200	245	528	206	1367
21	0	0	0	2	68	107	177
22	167	509	58	17	81	599	1431
23	8	41	105	104	136	259	653
25	0	2	0	0	0	8	9
26	7	95	229	193	187	210	921
27	11	39	101	169	533	943	1798
28	110	281	726	645	716	395	2873
29	96	150	121	50	129	126	672
Total	1905	5363	11043	11910	27902	44359	102481

* Occupational Category Number

Table 4.10 - Company A's Percent of Person Years Exposure for Each Chemical*

	Decade						
Chemical	1930's	1940's	1950's	1960's	1970's	1980's	Overall
Creosote	37	38	45	40	36	28	34
Herbicides	14	17	18	12	0	0	15
PCBs	37	38	45	40	36	28	34
Solvents	48	53	50	43	38	30	37

* Percent of exposure was calculated by combining all the person years from the occuaptional categories indicated to have potential exposure (only routine and occasional exposures) to the chemical then dividing by the total person years for that decade.

Figure 4.14 - Herbicide Exposure for Company A by % of Per-Yrs for Each Decade of the Study Period

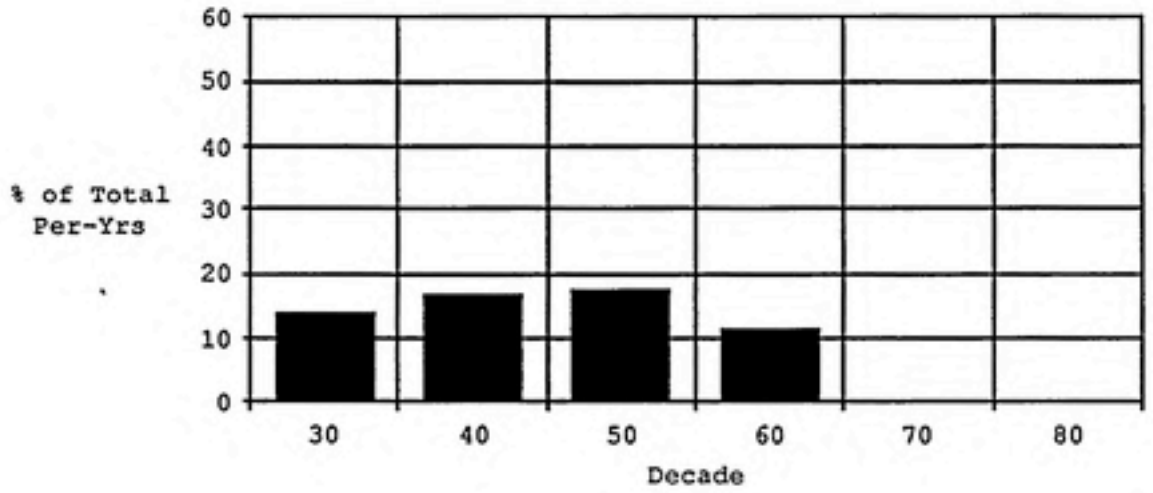


Figure 4.15 - Creosote Exposure for Company A by % of Per-Yrs for Each Decade of the Study Period

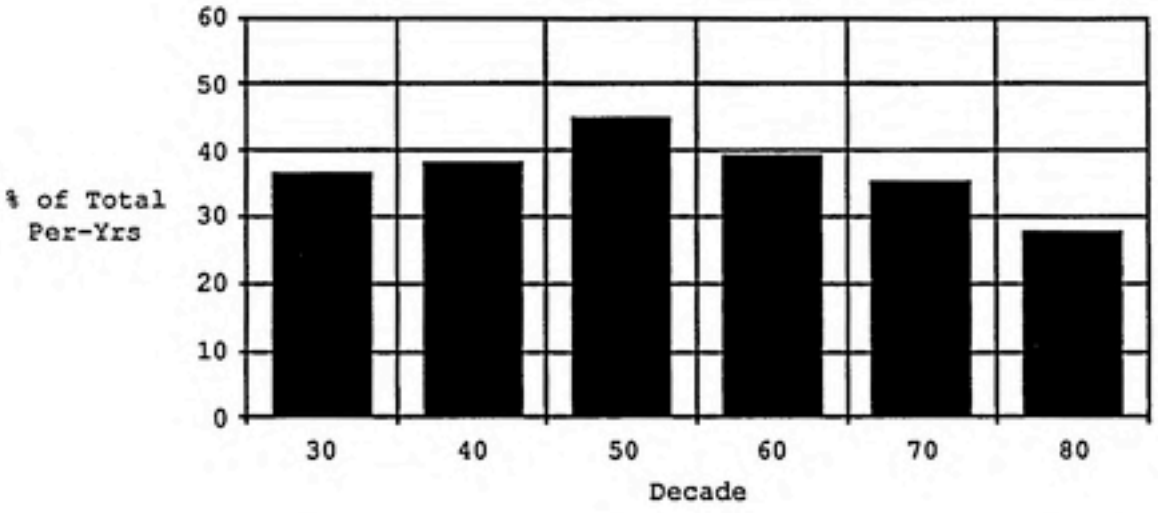


Figure 4.16 - PCB Exposure for Company A by % of Per-Yrs for Each Decade of the Study Period

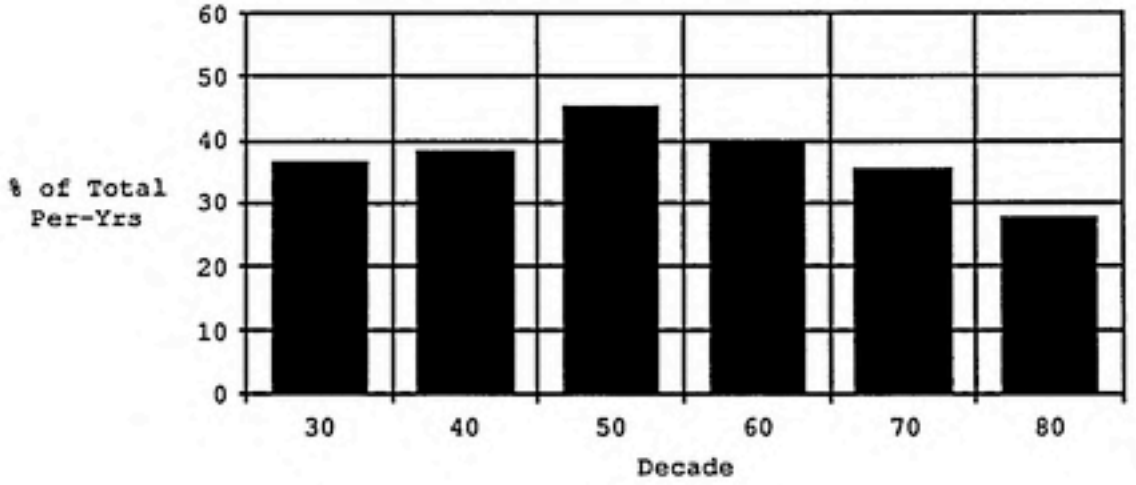


Figure 4.17 - Solvent Exposure for Company A by % of Per-Yrs for Each Decade of the Study Period

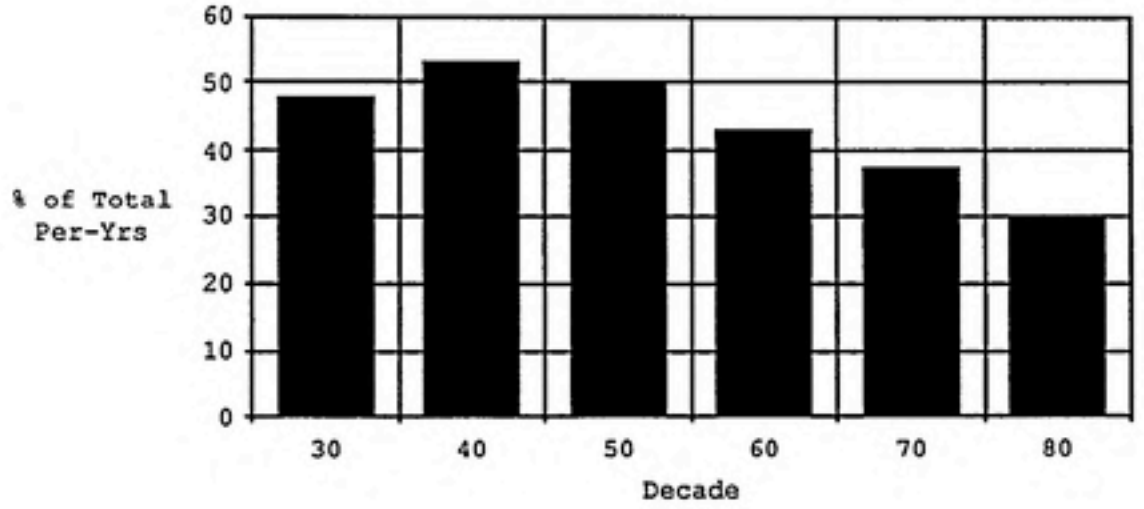


Table 4.11 - Summary of Company B's Person Years for Entire Study Period

	Decade						
OC*	1930's Per-yrs	1940's Per-yrs	1950's Per-yrs	1960's Per-yrs	1970's Per-yrs	1980's Per-yrs	Total Per-Yrs
1	986	1478	2197	2568	2494	2234	11958
2	1792	3088	6481	8432	10298	11902	41993
3	1801	2060	3226	4223	5379	5497	22185
4	771	1109	1933	2797	3904	3672	14186
5	802	1200	1901	2520	2373	2047	10843
6	5168	5175	6760	7972	9800	9576	44452
7	954	1262	1624	2446	2265	1891	10443
8	878	1430	2956	3775	3410	1726	14176
9	851	1180	2735	5204	7022	6087	23079
11	315	625	950	1048	1392	888	5218
12	229	959	1660	1472	1232	955	6507
13	1110	1251	1812	1867	2147	1829	10016
14	1821	3469	6036	9136	10358	7288	38108
15	81	111	83	146	80	29	530
16	127	181	166	4	0	0	478
18	237	393	758	946	986	651	3971
19	217	981	1649	1632	2108	3193	9780
20	891	1215	1514	1585	1209	515	6929
21	5	66	256	368	412	579	1686
22	289	308	503	740	1261	1046	4147
23	98	186	240	221	147	28	920
24	10	36	58	88	149	309	648
25	105	300	540	761	979	1018	3702
26	195	170	178	108	166	53	870
27	927	1371	2455	2493	2628	2577	12451
28	1095	1014	1931	3173	4374	3264	14853
29	946	1262	1524	1580	1433	748	7494
Total	22701	31881	52125	67305	78006	69603	321622

* Occupational Category Number

Table 4.12 - Company B's Percent of Person Years Exposure for Each Chemical*

	Decade						
Chemical	1930's	1940's	1950's	1960's	1970's	1980's	Overall
Creosote	18	19	22	27	29	25	25
Herbicides	25	26	29	34	34	27	30
PCBs	26	26	27	31	32	27	29
Solvents	48	52	53	55	55	49	53

* Percent of exposure was calculated by combining all the person years from the occuaptional categories indicated to have potential exposure (only routine and occasional exposures) to the chemical then dividing by the total person years for that decade.

Figure 4.18 - Herbicide Exposure for Company B by % of Per-Yrs for Each Decade of the Study Period

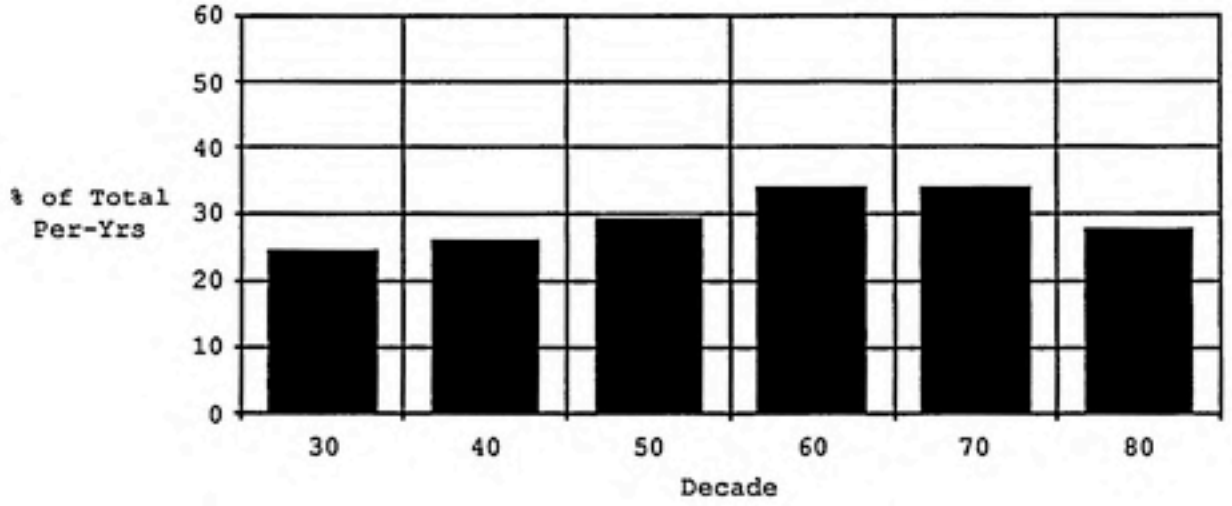


Figure 4.19 - Creosote Exposure for Company B by % of Per-Yrs for Each Decade of the Study Period

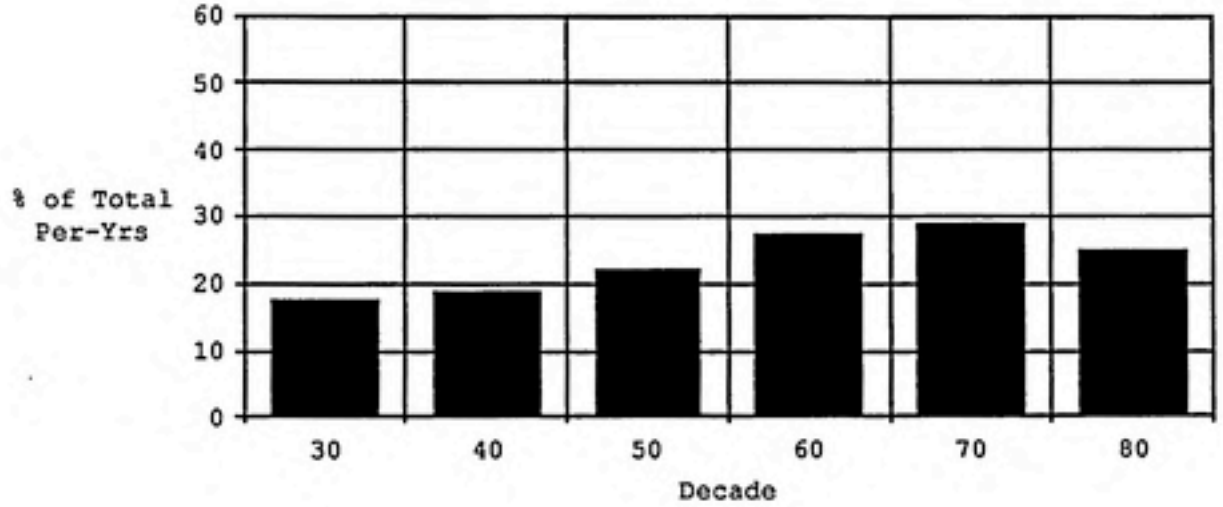


Figure 4.20 - PCB Exposure for Company B by % of Per-Yrs for Each Decade of the Study Period

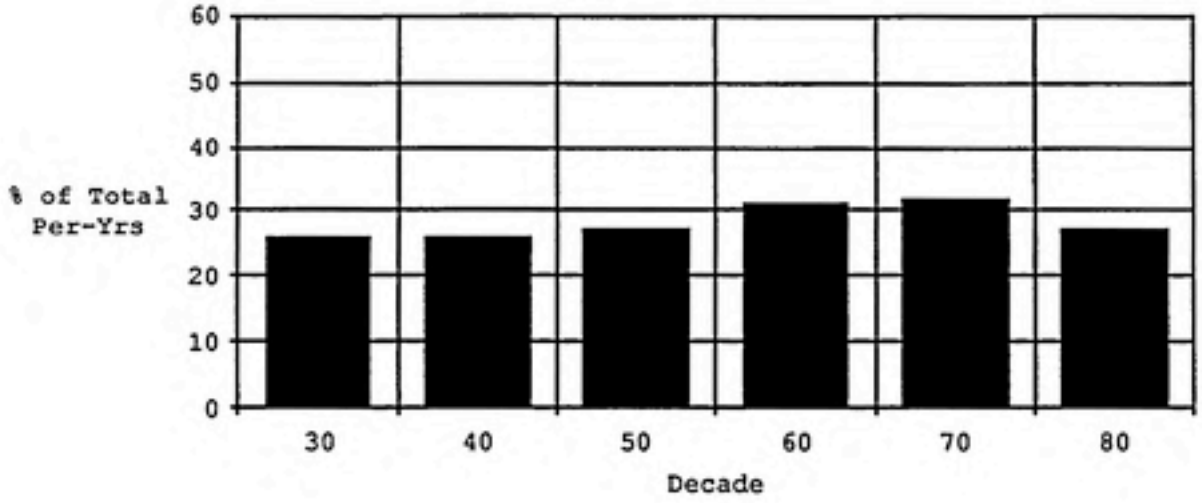
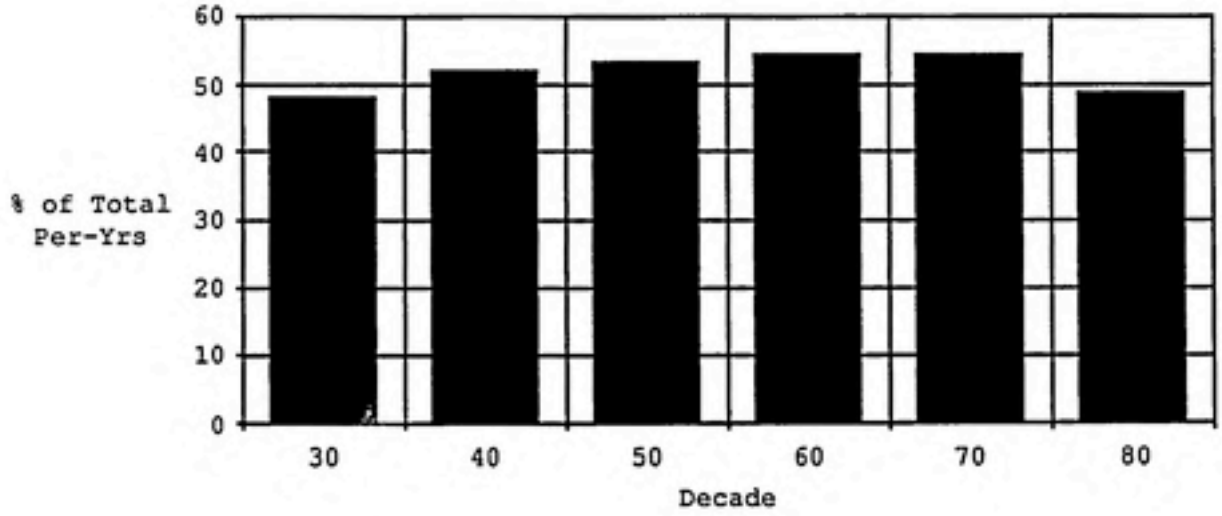


Figure 4.21 - Solvent Exposure for Company B by % of Per-Yrs for Each Decade of the Study Period



Chapter V - Discussion

The exposure to benzene is of great concern because of its strong association with leukemia. The use of benzene in the early decade of the study is vague. Those members from both companies with over thirty years of experience indicated the reluctance of using benzene dating back to 1950 because of its high flammability. Most often chlorinated solvents, carbon tetrachloride, were used instead of benzene. However, further investigation by interviewing retired employees is needed especially for those isolated groups of workers in laboratories and repair shops who may have potential benzene exposure.

Further investigation is also needed for those occupational categories with herbicide exposure. Detailed information concerning frequency of exposure is needed since previous studies show an increasing risk of leukemia with increasing frequency of exposure. A recent French study by Bastuji-Garin of workers exposed to electromagnetic fields indicates a possible relationship between exposure to weed-killers (herbicides) and acute leukemia.[46]

Discrepancies between the two companies in the determination of exposure to the five chemicals may have resulted from various factors. These factors were differences between company committees members, differences

in tasks performed by the most common job titles in occupational categories, regulatory changes and their effects, technological changes, and unclear definitions of exposure levels.

There are bound to be discrepancies arising from differences between the company committees and their members. The committee for company A consisted of fewer members so that the decision making process was less cumbersome. Unlike company A, the committee for company B consisted of thirteen members which made the decision making process more difficult. For example, the exposures assigned for PCBs at company A were reduced during the 1970s and 1980s as a result of regulatory limits on PCBs and work practices reducing exposure. Company B's assignment of exposures to PCB remained constant throughout the entire study period because the majority of the members felt that PCB contaminated equipment was still abundant and exposure was significant. This also occurred for creosote except the change in exposure was a result of the use of different types of wood preservatives for utility pole and railroad ties. The majority of the members from company B felt the changes in wood preservative was not enough to reduce the exposure to those specified occupational categories.

These regulatory and technological changes contributed to the differences between the company committees. The significance of these changes in terms of their impact on exposure varied between the company committees. In the case

of PCBs, which was banned from commercial use, the allowable limit of PCB contamination in transformer oil is 50 ppm. Transformer oil is recycled so contamination of other equipment is likely to occur. Thus, company B may be valid by not reducing exposure in the 1970s and 1980s because PCB exposure may still be significant.

Similar to regulatory changes, technological changes may have had similar impact on the exposure results. Creosote exposure involves contact with creosote treated wood products including utility poles and railroad ties used for supporting transformers and capacitors. The reduction in the use of creosote treated poles did not start until the 1970s. Some of the compounds used as alternatives were zinc chloride, mercuric chloride, copper sulphate, sodium flouride, and arsenic. The reduction in creosote treated poles was not significant in the minds of those committee members in company B and made no change in exposure for the 1970s and and 1980s unlike company A which reduced their assigned exposure.

The differences in tasks performed by the most common job titles within occupational categories may help explain why for each chemical except benzene, for which no assignments were made, there were always different groups of occupational categories that were assigned exposure to the same chemical for each company. In the case of herbicides, category 8 (services) for company B and category 21 (riggers) for company A were assigned exposure because their job task

caused potential exposure to herbicides. Services for company B are sometimes involved with the landscaping of areas around company facilities. Riggers for company A are involved with right of way construction where there is potential of exposure to herbicide residual on dead foliage.

Unclear descriptions of potential exposure levels may have contributed to different assignment exposures, especially for solvents. The exposures assigned by the members from company B were mostly routine compared to company A which were mostly occasional. Some of the occupational categories for company B like 9-mechanics, 13-electricians, 16-relay technicians, and 18-cable splicers because of their work in underground substation vaults have greater potential for solvent exposure in their confined work environment. The routine exposures assigned to other occupational categories may be debatable. One criterion for exposure was the presence of the chemical in the work environment. This may have been misinterpreted by the company B committee members. The chemical, in this case solvents, may be present in the work environment but in order for exposure to occur the potential for exposure to a worker to the chemical needs to exist.

Despite the discrepancies in the results, the company committees were able to provide some information on the mechanism of exposure to the chemicals. This simplified the job of asking questions about exposure but there was still

the inability to fully understand all the job tasks and which job titles performed them.

The use of person-years did relieve some of the burdens in distinguishing between job titles and assigning the proper exposure to occupational categories. Misclassification of exposure is difficult to prevent in historical exposure assessment. The person-years information was used to find the most common job titles which were supplied to the the committees in the assignment of exposures. Thus, the exposures assigned to the occupational categories were based on the most common job titles. This allowed the misclassification of exposure to be isolated to those job titles that were less likely to occur.

The person years were used to determine the percentage of exposure and showed differences between the two companies. For company A, figures 4.14 - 4.17 show high percentage of exposure in the 1950s and a subsequent decline. This may have resulted from the need for workers with more specialized skills such as engineers and specialist, especially with the growth of the company and the use of nuclear power.

As for company B, figures 4.18 - 4.21 show high percentage of exposure in the 1970s then a decline in the 1980s. Company B has a great dependence on the city that is part of their service area. The metropolitan area may have restricted the technological growth of the company. Retrofitting old plants and underground systems would be difficult in a city.

The reliability of the exposure assignments made by the company committees is still undetermined so the accuracy of the exposure information unknown. Despite this, the use of committees to assess exposures was advantageous in terms of saving both money for the study and time when company personnel provided their assistance, knowledge, and experience to accomplish the difficult task of exposure assessment.

Chapter VI - Conclusions

It is important to understand that the assigned exposure levels by the company committees are indications of potential exposures to the five specific chemicals. The members have no way of accurately assessing actual exposure levels, especially historical exposures. The intent of the study was not to obtain actual exposure levels but to gather potential exposure information to determine if a relationship exists between exposure to chemicals and the diseases of interest (leukemia and brain cancer).

The results were useful in indicating those occupational categories with potential exposure to the creosote, herbicides, PCBs, and solvents. Occupational categories in company B appeared to have greater potential for exposure than company A. This may be due to some problems in the strategy which utilized expert judgment to assess potential exposure levels or it may be due to the fact that the companies are just different.

Refinements in the current strategy can strengthen the accuracy of the exposure information since the use of expert judgment by company committees raises questions concerning the reliability of the exposure assignments. Questionnaires, interviews, and walk through surveys can be used prior to the meeting with company committee members to gather detailed

information about job tasks, chemicals used, frequency of exposure to specific chemicals, work practices, and historical changes. All of this information can then be used to improve the assignment of exposures by the company committees. Better understanding of the different companies and job tasks performed can bring about more concise questions further isolating potential exposures. The change in strategy makes the company committee serve as a validation committee which would review all the exposure information obtained from the questionnaires, interviews, and walk through surveys.

For the purpose of validation, monitoring data can be obtained. This information would only be relevant to current exposure and serve to validate only those exposures. The data might show low exposure intensity but can show the presence of the chemicals in the work environment. The combination of monitoring data and information gathered from questionnaires, interviews, and walk through surveys can serve to validate current exposure levels. This validation of current exposures would then increase the reliability of the past exposure estimates.

The validity of the exposure information is important because of its implications to the effects of electric and magnetic fields exposure. Chemicals may confound the association between electric and magnetic fields exposure and cancer for those occupational categories who are involved with the actual servicing of electricity, transmission and

distribution. These categories include 9-mechanics, 13-electricians, 14-linemen, and 28-laborers. These categories have fairly routine potential exposure to creosote, herbicides, polychlorinated biphenyls, and solvents and are involved with various aspects in transmission and distribution of electricity.

The application of the strategy to the other three utility companies involved in the electric and magnetic fields study can bring more information and help answer the questions concerning similarities and differences between electric utility companies and potential confounding by the chemicals of interest.

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APPENDIX

Job Exposure Survey

As you know, the study of electric utility workers is focused on potential effects of electric and magnetic fields. However, assessment of exposure to chemicals in the workplace that may cause cancer is critical for two reasons: 1) Past studies of electrical workers failed to consider the possibility that chemicals rather than electromagnetic fields may have been responsible for the excess cancer risks that were found, and this study will be among the first to address that possibility; 2) Several chemicals are of concern in their own right (e.g. PCBs) and this study should help to determine whether utility workers have been affected by those exposures. For these reasons, we want the best information we can get concerning those exposures and this questionnaire is a crucial part of that assessment.

It is very important, especially when obtaining subjective information, that everyone understand what is asked of them. The following information and recommendations we hope will help clarify and aid in some areas that may be vague or unclear.

Exposure Assessment Committee

Part of the process for the assessment of chemical exposure is the selection of a committee of company professionals/employees who have knowledge of the utility industry and history of the company. It is recommended that the any of following would be appropriate:

1) company industrial hygienist
2) company or plant safety coordinator/professional
3) supervisors and/or managers
4) retired employees

For the purpose of knowing the committee's level of knowledge and experience, please supply the following background information on each committee member.

1) current position with the company
2) list of prior positions held with the company
3) years with the company
4) education

Supplemental Information:

Occupational Category Methodology - This manual/codebook describes the guidelines and process of how the job titles were organized into occupational categories. We hope this will answer many of your questions concerning placement of job titles.

Occupational Categories with appropriate Job Titles - This is a list of only some illustrative job titles classified within each occupational category. We hope that this list will help in your assessment of exposure for the occupational categories. The list is based on the most common titles based on person-years (number of workers x average number of years in that job). The total person-years for the occuaptional category is also given. If your committee feels that there are any job titles that have been

misclassified, please specify the job title and the category that is appropriate for the misclassified job title.

Job Exposure Survey

Description of Exposure to the Agent: The description involving exposure to the specific chemicals may not cover all forms of exposure to the agent. There may be other forms of exposure with the agent. Please consider all possible forms of exposure and contact with the specific agent (ie. inhalation, ingestion, and dermal contact)

Exposure levels: Your estimate of exposure should take into account several of the following factors.

i. employee work practices - this includes historical practices. Some past work practices may have caused workers to have high exposure levels, but because of advances in recognition of health hazards, work practices may have changed to reduce the workers level of exposure. Please indicate this in the comments section.

ii. personal protection equipment - respirators, gloves

iii. control technology - local exhaust ventilation

iv. environmental regulations - similar to the work practices, advances in health hazard recognition may have prompted changes or new legislation to protect the worker by reducing their exposures.

v. company policy - the policy of individual companies toward safety may vary from one to the other. Use of some materials may be prohibited or severely restricted.

Routine exposure - the explanation on the survey describes the exposure parameters necessary for this level. Exposure may be through inhalation, dermal contact, or ingestion.

Incidental/occasional - this exposure level encompasses all types of exposure between the routine exposure and no exposure levels. Exposure many be a few times a week, a month, or a year.

None - this exposure level is self explanatory.

Monitoring or Sampling Information: With your estimate of exposure, please indicate if any form of monitoring for the agent of interest was performed at any time by the company itself, NIOSH (National Institute of Occupational Safety and Health), or OSHA (Occupational Safety Health Agency).

Comment: Please use the comment section to describe any circumstances that may have caused an occupational category to have unusually high or low exposure. For example, past practice for lineman may have involved burning of PCB to supply heat during the cold months or employees may have used carbon tetrachloride to remove oil, grease, and/or dirt from their hands.

OCCUPATIONAL CATEGORIES - MANUAL/CODEBOOK

1 - SENIOR MANAGERS AND EXECUTIVES

The most important characteristic of management is decision making. Top management is concerned with achieving a company's goals through planning and policy making. They supervise the ways in which their policies are carried out. Middle management is made up of department heads, plant managers and superintendents. Their primary function is executive. The category of Senior Managers and Executives includes both top and middle management but does not include those managers who do some of the same work as the personnel they supervise.

The category Senior Managers and Executives includes Assistant Directors and Acting Directors. For example, the category would include the following job title:
ASST. DIR SALES, PROMOTION & ADVERTISING

2 - ENGINEERS, PROFESSIONALS, SPECIALISTS

These occupations involve technical/scientific or other specialized skills and usually require advanced academic training. They are distinguished from managers by education and socio-economic status. This group contains the seniority/pay grade scale of Jr., Sr., Project, and Principal. Analysts are also included in this category.

3 - TECHNICAL WORKERS

Technical workers perform much of the hands-on professional and technical work and are often in training for professional work. There are numerous technicians for the many specialists, scientists and analysts in the industry. Technicians do not supervise other workers.

This field does not include technicians from the categories of Communications Technicians or Relay Technicians or Instrumentation and Control Technicians.

4 - FIELD/CRAFT/TRADE SUPERVISORS

This category is made up of supervisors, foremen and unit heads. Their chief responsibility is the direct supervision of workers. In addition, they may be responsible for budget planning, training personnel, and defining operating procedures. They also may perform some of the work of the personnel they are supervising. Foremen, who do the same work as the personnel they supervise are placed with the workers they supervise. This category is distinguished from Administrative Supervisors because of occupational environment. FIELD/CRAFT/TRADE SUPERVISORS are primarily out-of-office supervisors or the workers they supervise are out-of-office workers.

5 - ADMINISTRATIVE SUPERVISORS

These are in-office supervisors. Their responsibilities are similar to Field/Craft/Trade supervisors but are distinguished by occupational location or department. They are also responsible for the direct supervision of workers as well as budget planning, training and definition and implementation of operating procedures. These supervisors may perform some the same type of work of the personnel they supervise.

6 - ADMINISTRATIVE SUPPORT/CLERICAL WORKERS

These occupations are concerned with the many aspects of written, typed and electronic communication and record keeping. They provide the support services to Managers, Supervisors and Professionals.

7 - SALES, MARKETING AND BUSINESS WORKERS

The workers in this category are concerned with activities that get the product to the consumer. The basic elements of marketing are price, distribution and promotion. Activities representing these elements are advertising, sales promotion, buying as well as public relations. Workers not included are clerical support workers for these fields. These would be placed in ADMINISTRATIVE SUPPORT/CLERICAL.

Supervisors and managers belong with SUPERVISORS or SENIOR MANAGERS AND EXECUTIVES.

8 - SERVICES

Workers in this category provide support such as housekeeping, cooking, security, personal services, driving, etc. for in-house activities.

Chief or foreman, as in chief security or chief janitor would be placed in the SERVICES occupational group and not in the FIELD/CRAFT/TRADE SUPERVISORS.

9 - MECHANICS (Plant and Substation)

This category includes those mechanics who work in the plant and substation. The category includes all APPRENTICE MECH or MECH TECHNICIANS. MECHANIC FOREMAN is classified as a MECHANIC. The other occupational category of mechanics is AUTO AND TRUCK MECHANICS. This is a separate category.

Any apprentice mechanic or mechanic technician will be placed in the Mechanics category. Mechanics Foreman is put in the MECHANICS category and not in the SUPERVISORS category.

11 - MACHINISTS

Workers that sets up and operates machine tools such as lathes, grinders or shapers and assembles or repairs metal parts, tools or machines.

12 - BOILERMAKERS/STEAMFITTERS
The workers work on boilers and the steam lines which carry steam to push the generators.

13 - ELECTRICIANS
Electricians work both in the power station and in the substations on construction of electrical equipment and its maintenance. Foremen in this occupational group are placed within the group and not with SUPERVISORS.

14 - LINEMEN
These workers include both distribution and transmission linemen. Distribution lineman work on both the high voltage "primary" circuit that delivers power from the substation to local pole-mounted or underground distribution transformer and on the secondary circuit that delivers power from the local transformer to the home (OTA 1989). These voltage lines range from 35-5kV down through to 115/230 volts. Transmission linemen work on the high voltage transmission lines. These lines operate at voltages from 69kV up to 765kV. These high voltages insure efficient transfer of power over long distances. Note that foremen are placed within this category and not in SUPERVISORS. In many cases we will not be able to distinguish distribution from transmission linemen by their job titles because they are called T&D linemen or their titles have changed historically and we will not know whether LINEMAN was a distribution or transmission lineman.

15 - INSTRUMENTATION AND CONTROL TECHNICIANS
These are highly specialized electricians who work with digital closed circuit boards in the power plant.

16 - RELAY TECHNICIANS
These are highly specialized workers who work in and around breakers in the substation and in the power plant. As in other electrical and mechanical work, there are two aspects of relay operations: construction and maintenance. Relay construction workers put together the relay cabinets while relay maintenance workers insure the operation of this equipment. Foremen in this occupational group are placed within the group and not with SUPERVISORS.

17 - TELECOMMUNICATIONS TECHNICIANS
These workers are involved with the construction and operation of communications systems and facilities. Foremen in this job category are included with the workers.

18 - CABLE SPLICERS
Works on cable systems used to conduct electricity between substations and consumers. This worker, also known as an underground lineman, usually splices service line cables in vaults.

19 - POWER PLANT OPERATOR
These workers operate the power plant where electricity is generated from fuel. Electric generators in power stations produce electric power at about 20kv. Power plant operators operate feedwater pumps, circuits and watch boilers. Note that foremen in this occupational group are not placed with SUPERVISORS.

20 - SUBSTATION OPERATORS
Works in substations where power is transferred from high power transmission lines to lower voltage distribution lines. This worker opens and closes lines, shifts loads, operates breakers and 230kv airbreak switches and puts on headway stop tests.

Note that Foremen are included within this category. Substation maintenance supervisors are placed in the FIELD/CRAFT/TRADE SUPERVISOR category. Student operators are placed in SUBSTATION OPERATOR category.

21 - RIGGERS
These are specialized movers of very large equipment, usually transformers. Note that foremen of this category are placed within the category and not with SUPERVISORS.

22 - AUTO AND TRUCK MECHANICS
These distinguished from the substation and power plant mechanics.

23 - PAINTERS
These workers have been separated from the PIPE COVERERS.

24 - PIPE COVERERS
These workers remove insulation from pipes which need to be repaired and then replace the insulation. In a number of job descriptions, this work is done along with painting.

25 - WELDERS
These workers are usually found in the utilities plant. Note that the foremen of this category are placed within this category and not in SUPERVISORS.

26 - HEAVY EQUIPMENT OPERATORS
The primary responsibility of these workers is to move coal. They run locomotives, bulldozers and coal car shakers. Heavy equipment operators include 18-wheel long-distance drivers. Note that the foremen of this category are placed within the category and not with SUPERVISORS.

27 - MATERIALS HANDLERS
These workers are involved with loading, unloading and distribution of materials. Fork-lift operators and storekeepers in the power plant are included here as well as drivers. Note that FOREMEN of this occupational category are placed with the workers and not with SUPERVISORS.

28 - LABORERS
These are workers who do not have a specialized trade and do a variety of jobs. A major criterion is the amount of skill brought to a job. The work of laborers is generally less skilled than the work of tradespeople.

29 - OTHER CRAFTS/TRADES WORKERS
This category includes those workers who are in trades not listed in above. Specialized tradespeople who are generally not found in the utility industry or who are found in very small numbers would be included in this category.

98 - SICK/ON LEAVE/DISABLED EMPLOYEE

99 - OCCUPATION UNKNOWN

COMPANY B JOB HISTORY DATA SUMMARY
TOP JOB TITLES BY PERSON YEARS

Occupational Category 1 - Senior Managers & Executives (12241.8)

Person-Years	Job Title
1410.8	SHIFT SUPT
1317.8	MGR
839.0	SUPT
551.0	ASST MGR
408.9	SHIFT SUPT A
391.4	ASST SUPT
316.7	GENL SUPT
291.2	ASST STATION SUPT
281.0	ELECTRIC SUPT
255.2	POWER DIRECTOR
241.8	STATION SUPT
228.2	ASST TO MGR
225.6	GAS SUPT
195.6	DIRECTOR
183.2	VP
181.0	DIV SUPT
128.1	ASST SERVICE MANAGER
106.8	DISTRICT MANAGER
Total 7553.3	

Occupational Category 2 - Engr, Professionals & Specialist (43284.6)

Person-Years	Job Title
10088.5	ENGR
3700.4	SR ENGR
1264.8	JR ENGINEER
804.9	HOISTING ENGINEER
785.5	DESIGNER
684.2	ASST ENGR
660.8	2ND ASST RUNNING ENGR A
658.8	ASST RUNNING ENGR
625.2	CONTRACT INSPECTOR
598.9	ANALYST
574.0	SUPERVISING ENGR
486.5	PROGRAMMER
465.8	2ND ASST RUNNING ENGR
443.7	SR ANALYST
437.0	ASST RUNNING ENGR A
426.8	SR MAP DRAFTSMAN
409.1	RUNNING ENGR
404.6	JR PROGRAMMER
Total 23519.8	

Occupational Category 3 - Technical Workers (23216.0)

Person-Years	Job Title
3143.6	TECH ASST
1670.6	SPECIAL TESTER A
1611.5	SR CONSTR DETAILER
1269.2	METER TESTER
1157.9	PRIMARY METERMAN
986.7	JR TECH ASST
767.9	CONSTR DETAILER
732.5	SR METER TESTER
700.7	LOAD DISPATCHER A
686.5	TESTER
678.2	SPECIAL TESTER B
666.8	SR TECH ASST
648.6	ELECT DESIGNER
643.6	METERMAN
542.3	ASST TESTER
542.3	ASSISTANT TESTER
536.1	FIELDMAN
396.5	SR ENGRG TECHNICIAN
362.5	ENGINEERING ASSISTANT
267.2	SR SHOP METERMAN
244.9	SR CONSTRUCTION DETAILER T & D
237.6	METER FOREMAN
220.7	SR TESTER
Total 18714.4	

Occupational Cayegory 4 - Field/ Craft/ Trade Supervisors (14545.8)

Person-Years	Job Title
2027.2	SHIFT SUPV
1893.7	SERVICE FOREMAN
1661.8	MAINT & SERVICE FOREMAN
772.9	ASST FOREMAN
552.0	FOREMAN UNDERGROUND
470.6	FOREMAN UTILIZATION
435.5	DISTRICT SUPV LINES
429.7	ASST DISTRICT SUPV LINES
381.5	FIELD ASST
258.6	SUPV FIELD OPS SVC MAINT SEC
246.0	GANG LEADER
242.9	BUILDING SUPV
220.4	SR FIELD ASST
196.3	FOREMAN
188.3	METER SUPV
187.9	ASST BLDG SUPV
179.0	ASST FIELD SUPV
177.8	SUPERVISING STOREKEEPER
172.0	CHIEF TROUBLE DISPATCHER
169.1	DISTRICT SUPV SUBSTATIONS
Total 10863.2	

Occupational Category 5 - Administrative Superviosrs (11095.7)

Person-Years	Job Title
1879.3	SUPV (SUPERVISOR)
437.5	OFFICE MGR
375.8	SUPV CUST SERV & ACCTG
349.9	GENL SUPV
331.4	ASST SUPV CREDIT & COLLECTIONS
330.7	SUPV METER READING
330.6	CLERICAL SUPV
307.2	ASST SUPERVISOR
292.9	CUST SER SUPV
267.1	DISTRICT SUPV
236.3	SUPV CUSTOMERS ACCTG
228.1	ASST SUPV M & S
215.8	ASST SUPV CUST ACCTG
211.9	ASST CUST SER SUPV
206.7	SUPV CREDIT & COLL
188.7	SQUAD CHIEF MAP & REC SEC
129.5	ASST SUPV METER READING
103.3	CHIEF CUST SERVICEMAN
96.1	ASST SUPV UTILIZATION
89.6	SUPV UTILIZATION
Total 6608.2	

Occupational Category 6 - Administrative Support/Clerical (47105.7)

Person-Years	Job Title
8209.0	METER READER
3572.2	CLERK A
2671.2	WORK DISPATCHER
1722.1	CLERK B
1705.8	SWITCHBOARD OPER
1527.7	JR CLERK
1386.4	CLERK C
1341.2	SR CLERK
1274.6	CUST SERVICEMAN
871.5	ASST SWITCHBOARD OPER
863.0	SR CLERK B
829.9	SR BOOKKEEPER
638.9	SR CLERK A
603.6	APPRENTICE MTR RDR
560.2	ASST CLERK
550.5	BOOKKEEPER
536.6	CREDIT REP A
518.7	SPECIAL BOOKKEEPER A
513.3	FIELD INVESTIGATOR
503.5	SR PROPERTY ACCTG CLERK
Total 30399.9	

Occupational Category 7 - Sales, Marketing & Bus. Workers (10789.0)

Person-Years	Job Title
1514.5	COLLECTOR
812.9	MERCHANDISE REPRESENTATIVE
550.8	SR BUSINESS REPRESENTATIVE
458.6	HOME SERVICE REPRESENTATIVE
364.4	BUSINESS REPRESENTATIVE
342.3	MAJOR ACCTS REP
316.4	COMMERCIAL SALESMAN
294.1	SR COMMERCIAL SALESMAN
259.1	RETAIL SALESMAN
203.4	MARKETING REPRESENTATIVE
197.6	BUYER
192.7	SR BUILDERS REPRESENTATIVE
186.5	COLLECTOR B
182.1	CUSTOMERS REPRESENTATIVE A
180.3	SUPV MERCH REP
164.9	RETAIL REPRESENTATIVE
142.7	SR CUST REPRESENTATIVE
137.0	ASST BUSINESS REP
122.0	SR GRP REPRESENTATIVE
116.6	SALES ENGINEER
Total 6739.1	

Occupational Category 8 - Services (14441.8)

Person-Years	Job Title
2265.0	JANITOR
1488.7	BUILDING ATTENDANT
920.3	MAINT HELPER 2/C
884.2	TRUCK CHAUFFEUR A
829.4	GATEMAN
746.2	CHAUFFEUR C
730.0	BUILDING MEC A
695.0	BUILDING MECHANIC
624.1	ATTENDANT
612.7	ASST BLDG MECHANIC
415.5	SERVICE MANAGER
313.2	CHAUFFEUR B
242.4	HELPER MAINT
233.7	HEAD BUILDING ATTENDANT
218.7	CHAUFFEUR SPECIALIZED EQUIP
216.7	WATCHMAN
209.8	DRIVER B
200.8	ELEVATOR OPERATOR
197.0	HEAD JANITOR
191.9	DRIVER A
188.3	ASST HEAD JANITOR
175.8	HELPER SERVICE MAINT SEC
119.4	ASST SUPVG CASHIER B
Total 12718.8	

Occupational Category 9 - Mechanics (Plant & Substation) (23411.3)

Person-Years	Job Title
5220.7	STREET MEC A
1402.6	INSTALLATION MEC A
1390.1	MECHANICAL OPER
1270.9	STREET MEC HELPER
1147.8	SR UTILIZATION MECH
999.8	STREET MEC B
863.8	ASST MAINT FOREMAN
785.4	WATER TENDER
709.3	UTILIZATION MEC A
700.8	MAINT FOREMAN
614.1	WATER TENDER A
613.7	OILER
531.8	PLANT MEC
506.4	MAINT HELPER 1/C
490.9	STOKER OPERATOR
472.6	MECH HELPER 2/C
438.1	GENL MEC 1ST CLASS
391.2	STOKER OPER 1/C
362.9	COMPRESSOR OPER
324.3	SR DISTRIBUTION MEC
Total 19237.2	

Occupational Category 11 - Machinists (5350.8)

Person-Years	Job Title
2712.2	MACHINIST 1ST CLASS
804.7	MACHINIST 2ND CLASS
400.6	MACHINIST 3RD CLASS
264.8	MACHINE OPERATOR
243.9	MACHINIST
238.3	SHEETMETAL WORKER 1ST CLASS
127.0	MACHINIST HELPER
97.9	MACHINE OPER A
90.2	SR MACHINE OPER
62.4	SHEETMETAL WORKER 2ND CLASS
58.1	MACHINIST &SUBFOREMAN
56.7	MACHINE OPER C
47.2	MACHINIST'S APPRENTICE
45.0	SHEETMETAL WORKER 3RD CLASS
44.6	MACHINE OPER B
14.1	SUBFOREMAN & MACHINIST(USE 10861)
10.4	SHEET METAL WORKER
8.4	MACH HELPER 2/C
6.6	ASST MACH OPER
4.8	MACHINIST A
Total 5337.9	

Occupational Category 12 - Boliermakers/ Steamfitters (6834.4)

Person-Years	Job Title
1348.8	STEAMFITTER 1ST CLASS
814.9	BOILERMAKER 1ST CLASS
677.5	BOILER ROOM HELPER
330.5	STEAMFITTER 2ND CLASS
312.7	BOILER ROOM HELPER 1/C
173.2	STEAMFITTER 3RD CLASS
155.5	BOILER REPAIRMAN 1ST CLASS
154.8	BOILER ROOM HELPER 2/C
129.3	BOILERMAKER 2ND CLASS
112.3	ASST STEAM LINE REPAIRMAN
94.6	BOILER CLEANER
86.6	FITTER
83.7	CHIEF BOILER REPAIRMAN
73.4	BOILER CLEANER HELPER
71.5	BOILERMAKER
67.8	BOILERMAKER 3RD CLASS
50.2	BOILER REPARIMAN 2/C
46.0	STEAMFITTER & SUBFOREMAN
Total 4783.3	

Occupational Category 13 - Electricians (10738.8)

Person-Years	Job Title
2263.4	ELECTRICIAN 1ST CLASS
1419.1	ELECTRICAL MEC A
1403.8	ELECTRIC MECHANIC
830.9	CHIEF ELECTRICIAN
769.7	CONNECTED LOAD INSPECTOR
667.1	ELECTRICAL MEC T & D SUBSTATION
475.9	ELECTRICIAN 2ND CLASS
397.0	ELECTRIC HELPER
290.8	ELECTRICIAN 3RD CLASS
249.8	ELEC MECH B
203.9	CONNECTED LOAD INSPECTOR A
175.6	ELECTRICIAN
171.0	EXCITERMAN
165.0	ELECTRIC TESTER
149.6	TRANSFORMER REPAIRMAN
93.2	SQUAD CHIEF ELEC
87.6	ELEC MECH 1/C SUBSTA
80.6	CHIEF ELEC MECHANIC
72.3	CONNECTED LOAD INSPECTOR B
67.7	INVESTIGATOR HIGH VOLT CUST SVC
Total 10034.0	

Occupational Category 14 - Linemen (39130.9)

Person-Years	Job Title
13545.9	LINEMAN 1ST CLASS
4406.8	ELEC MEC 1ST CLASS
4212.3	LINE FOREMAN
3522.0	TROUBLEMAN
3156.8	LINEMAN'S HELPER
1955.5	ELEC MEC 2ND CLASS CONSTR
1524.1	LINEMAN 3RD CLASS
1177.1	LINEMAN 2ND CLASS
988.2	TROUBLEMAN A
978.3	ELEC MEC 3RD CLASS CUST INSTL
759.2	LINEMAN
650.3	ELEC MEC HELPER
253.3	LINE FOREMAN A
210.2	SR TROUBLEMAN
193.4	T & D APPRENTICE
154.0	CUSTOMERS INSTALLATION FOREMAN
146.8	SR LINE FOREMAN
142.0	ASST WORKS FOREMAN
134.0	STREET LIGHTING INSPECTOR
121.9	LINE FOREMAN B
Total 38232.1	

Occupational Category 15 - Instr. & Control Technicians (575.6)

Person-Years	Job Tilte
277.8	INSTRUMENT MAN
99.4	INSTRUMENT HELPER
53.6	INSTRUMENT MAN A
42.7	INSTRUMENTMAN 2ND CLASS
34.7	INSTRUMENTMAN 1ST CLASS
19.1	INSTRUMENT MAN B
17.0	INSTRUMENTMAN 3RD CLASS
16.2	ASST INSTRUMENT MAN
12.0	INSTRUMENT MAN ELECTRIC OPERATIONS
2.5	INSTRUMENT REPAIRMAN
0.8	INSTRUMENT CONTROL OPERATOR
Total 575.6	

Occupational Category 16 - Relay Technician (533.2)

Person-Years	Job Title
245.1	ASST INVESTIGATOR PLANT TESTS
143.5	INVESTIGATOR PLANT TESTS
75.3	INVESTIGATOR STA PERFORMANCE
34.0	ASST INVESTIGATOR PLANT TESTS
12.1	ASST INVESTIGATOR STATION PERFORMANCE
7.3	ACTING INVESTIGATOR OF PLANT TESTS
5.1	TEST FOREMAN
4.1	ASST POWER TESTER
3.8	RELAY ENGINEER HELPER
3.0	ASST PLANT INVESTIGATOR
Total 533.2	

Occupational Category 18 - Cable Splicer (5087.7)

Person-Years	Job Title
1873.1	SPLICER 1ST CLASS
378.9	SPLICER HELPER
251.1	SPLICER 2ND CLASS
190.0	SPLICER IN TRAINING
176.7	SPLICER 3RD CLASS
162.5	GENL UNDERGROUND FOREMAN
139.4	TROUBLEMAN & SPLICER
131.8	SPLICER FOREMAN
110.5	SUBFOREMAN UG
102.8	CONDUIT FOREMAN B
95.0	LOCATOR A
85.6	CABLE FOREMAN
65.3	CONDUIT FOREMAN A
47.5	ELEC MECH 1/C UG
44.3	SPLICER
38.4	SPLICER 1/C(DO NOT USE, USE 01073)
35.5	LOCATOR
18.0	CONDUIT & CABLE MAN
16.7	SPLICER UNDERGROUND
15.5	UNDGR LINE FOREMAN
Total 5087.7	

Occupational Category 19 - Power Plant Operators (10395.3)

Person-Years	Job Title
1662.5	AUXILIARY OPER
1428.0	BOILER OPERATOR
1101.9	AUXILIARY OPERATOR 1/C
1053.6	PLANT OPERATOR
838.8	ASST MECHANICAL OPER
497.9	ASST PLANT OPER
488.8	OPER A
452.9	SHIFT FOREMAN
449.9	AUXILIARY OPERATOR 2/C
441.2	GAS MAKER
400.3	CHIEF OPER
225.3	GAS SYSTEM OPER
158.1	BY PRODUCT OPER
151.0	SR OPER
147.1	ASST GAS SYS OPER
141.7	ASST BOILER OPERATOR
138.0	HYDRO TURBINE OPR
129.7	CONTROL OPERATOR
127.5	STATION OPER B
120.1	STATION OPER A
117.2	OPERATOR
116.1	OPER B
90.6	ASST CONTROL OPERATOR
58.8	ASST STATION OPERATOR
Total 10395.3	

Occupational Category 20 - Substation Operators (7318.9)

Person-Years	Job Title
1026.7	SUBSTATION OPERATOR
952.4	SUBSTATION OPER D
771.5	SUBSTATION OPER B
763.1	SUBSTATION OPER A
705.9	ASST SUB(SUBSTATION) OPERATOR
640.7	SUBSTATION OPER C
581.4	SUBSTATION OPER E
390.7	SUBSTATION MAINT FOREMAN
224.3	SR SUBSTATION OPER D
166.0	SUBSTATION FOREMAN A
123.8	SUBSTATION FOREMAN B
100.0	SR SUBSTATION OPERATOR E
91.8	SR SUBSTATION OPER C SUBSTATION DIV
87.5	SR SUBSTATION OPER
79.3	RELIEF SUBSTATION OPERATOR
61.6	RELEIF SUB OPERATOR A
53.9	SUBFOREMAN SUBSTA
Total 6820.6	

Occupational Category 21 - Riggers (1696.1)

Person-Years	Job Title
1118.4	RIGGER 1ST CLASS
209.5	RIGGER'S HELPER
145.2	RIGGER 2ND CLASS
99.2	RIGGER 3RD CLASS
50.9	RIGGER SUBFOREMAN
41.2	RIGGER
14.1	RIGGER FOREMAN
9.1	RIGGER B
8.6	RIGGER A
Total 1696.1	

Ocupational Category 22 - Auto & Truck Mechanics (4257.5)

Person-Years	Job Title
952.8	TRANSPORTATION MEC A
750.2	AUTO MECHANIC A
487.4	AUTO MECHANIC B
292.2	AUTO MECHANIC HELPER
292.2	AUTO MECHANIC
233.6	SR TRANSPORTATION MEC
152.0	TRANSPORTATION MEC B
143.7	TRANSPORTATION MEC C
122.9	SR AUTO MECHANIC
113.0	GARAGE FOREMAN
106.5	BODY MEC A
103.0	GARAGE ATTENDANT
97.2	AUTO SHOP FOREMAN
57.2	AUTO SHOP SUBFOREMAN
52.2	TRANSPORTATION SERVICEMAN
45.5	AUTO MECHANIC SERVICEMAN
28.3	AUTO INSPECTOR
27.7	AUTO GREASER
27.2	AUTO TRIMMER
Total 4084.6	

Occupational Category 23 - Painters (940.3)

Person-Years	Job Title
419.9	PAINTER 1ST CLASS
181.4	PAINTER
71.1	PAINTER SUBFOREMAN
70.7	PAINTER FOREMAN
60.2	SIGN PAINTER
41.0	PAINTER 2ND CLASS
20.9	ASST GENL PAINTER FOREMAN
16.3	TRANSPORTATION PAINTER
16.0	PAINTER'S HELPER
15.8	AUTO PAINTER
12.1	PAINTER'S HELPER 1/C
8.3	PAINTER'S HELPER 2/C
2.7	PAINTER'S APPRENTICE
2.0	SUBFOREMAN PAINTER(USE 10737)
2.0	POLE PAINTER
Total 940.3	

Occupational Category 24 - Pipe Coverers (648.6)

Person-Years	Job Title
450.3	PIPECOVERER 1ST CLASS
112.8	PIPECOVERER 2ND CLASS
73.9	PIPECOVERER 3RD CLASS
11.5	PIPE COVERER
Total 648.6	

Occupational Category 25 - Welders (3881.2)

Person-Years	Job Title
1731.3	WELDER 1ST CLASS
826.7	WELDER A
342.4	ELEC WELDER 1/C
238.9	WELDER 2ND CLASS
117.5	WELDER 3RD CLASS
114.8	WELDER B
108.2	WELDER
59.9	GAS WELDER B
59.9	WELDER B GAS
46.2	GAS WELDER A
46.2	WELDER A GAS
39.0	ELEC WELDER A
37.5	ELEC WELDER 2/C
24.1	ELEC WELDER B
23.0	MACH HELPER 1/C
16.9	ELEC WELDER
14.0	CAULKER & WELDER
9.7	WELDER SUBFOREMAN
8.9	WELDER & SERVICEMAN
6.7	PIPELINE WELDER
Total 3871.8	

Occupational Category 26 - Heavy Vechicle Operators (940.4)

Person-Years	Job Title
443.9	CRANE OPER
288.4	TRUCK CHAUFFEUR B
97.8	TRUCK DRIVER
34.5	EQUIP OPER B
31.1	EQUIP OPER A
18.6	TRACTOR OPERATOR
6.3	SR OPER B TRANSP
5.4	ELEC CRANE OPERATOR
3.1	BRAKEMAN(DO NOT USE, USE 11360)
2.7	CRANE OPER GAS
2.4	CHIEF CRANE OPERATOR
2.1	PIER CRANE OPERATOR
1.2	LOCOBRAKEMAN
1.1	OPERATOR A TRANS
0.9	BRAKEMAN
0.6	CRANE LINEMAN
0.4	COAL APPARATUS OPERATOR
Total 940.4	

Occupational Category 27 - Material Handlers (12824.3)

Person-Years	Job Title
3329.1	STOCKMAN
1741.3	SUBFOREMAN FUELS EP
1125.2	STOREKEEPER
913.0	ORDERMAN A
417.0	ORDERMAN'S HELPER
405.9	CONVEYORMAN
367.5	YARDMAN A
355.3	STOCKMAN B
347.4	STOCKMAN A
301.9	GENL STOREKEEPER
301.0	TOOLROOM ATTENDENT
294.2	ORDERMAN B
286.7	YARDMAN
271.4	FUEL HANDLER
249.9	STOREKEEPER B
248.8	YARDMASTER
187.3	MATERIAL MAN 1/C
151.4	STOREKEEPER A
134.9	YARDMAN B
120.4	ORDERMAN
Total 11549.6	

Occupational Category 28 - Laborers(15938.6)

Person-Years	Job Title
3744.5	HELPER
3530.2	CHAUFFEUR GROUNDMAN
1142.2	SPECIAL LABORER
982.9	LABORER
893.8	UTILITYMAN
883.1	HELPER GEN STA
717.9	CONSTR SUBFOREMAN
588.8	HELPER ELECTRIC T & D
450.4	CONSTR FOREMAN
389.9	PLANT HELPER
235.0	WIREMAN
208.6	CLIMBER
191.4	STEAM HEAT HELPER
135.0	VACATION HELPER
132.8	ELECTRIC LABORER
117.1	HEAD ASHMAN
94.1	GROUNDHAND
93.2	ELEC MECH'S HELPER T & D
92.1	SANDBLASTER
Total 14623.0	

Occupational Category 29 - Other/ Trade Workers (7791.9)

Person-Years	Job Title
2785.4	APPLIANCE SERVICEMAN A
544.7	MILL OPERATOR
536.2	APPLIANCE SERVICEMAN B
322.6	CARPENTER 1ST CLASS
238.1	AIR CONDITIONING MEC A
236.0	CAULKER
221.3	APPLIANCE SERVICEMAN'S HELPER
159.7	APPLIANCE SERVICEMAN
159.1	BLACKSMITH 1ST CLASS
155.9	TROUBLEMAN GAS
145.7	REPAIRMAN
132.4	REPAIR SHOP FOREMAN
122.4	CARPENTER
120.3	CAULKER A
115.5	BRICKLAYER 1/C
107.3	DISTRIBUTION FOREMAN
98.6	CAULKER B
96.1	ELEVATOR MEC A
95.2	CHECKER
94.4	APPLIANCE SERVICEMAN'S APPRENTICE
Total 6486.9	

Job Exposure Survey - Benzene

Exposure to benzene involves its use as a solvent (technical grade benzene). It excludes exposure to benzene when it is a constituent of petroleum products.

Exposure Levels

3 - Routine - The agent of interest is regularly used by workers in the job titles within each occupational category or is routinely present in their workplace.

2 - Incidental/Occasional - Workers in the job titles within each occupational category are intermittently exposed to the agent of interest or it may be sometimes be present in their workplace.

1 - No Exposure - Workers in the job titles within each occupational category have no exposure to the agent of interest.

		DECADES					
O.C.	Occupational Category	30-39	40-49	50-59	60-69	70-79	80-88
1	Senior Managers and Executive	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
2	Engr, Profess, and Specialist	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
3	Technical Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
4	Field/Craft/Trade Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
5	Administrative Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
6	Admin Support/Clerical Worker	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
7	Sales, Market. & Bus. Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
8	Services	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
9	Mechanics (plants and subs.)	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
11	Machinists	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
12	Boilermakers/Steamfitters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
13	Electricians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
14	Linemen	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
15	Instr. and Control Tech	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
16	Relay Technicians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
18	Cable Splicers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

O.C.	Occupational Category	DECADES 30-39	40-49	50-59	60-69	70-79	80-88
19	Power Plant Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
21	Riggers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
20	Substation Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
22	Auto and Truck Mechanics	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
23	Painters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
24	Pipe Coverers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
25	Welders	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
26	Heavy Vehicle Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
27	Materials Handlers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
28	Laborers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
29	Other Crafts/Trades Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

Comments:

Job Exposure Survey - Creosote

Exposure to creosote involves exposure to wooden poles treated with creosote. Exposure would be dermal or by ingestion.

Exposure Levels

3 - Routine - the agent of interest is regularly used by workers in the job titles within each occupational category or is routinely present in their workplace.

2 - Incidental/Occasional - Workers in the job titles within each occupational category are intermittently exposed to the agent of interest or it may be sometimes be present in their workplace.

1 - No Exposure - Workers in the job titles within each occupational category have no exposure to the agent of interest.

		DECADES					
O.C.	Occupational Category	30-39	40-49	50-59	60-69	70-79	80-88
1	Senior Managers and Executive	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
2	Engr, Profess, and Specialist	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
3	Technical Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
4	Field/Craft/Trade Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
5	Administrative Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
6	Admin Support/Clerical Worker	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
7	Sales, Market. & Bus. Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
8	Services	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
9	Mechanics (plants and subs.)	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
11	Machinists	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
12	Boilermakers/Steamfitters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
13	Electricians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
14	Linemen	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
15	Instr. and Control Tech	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
16	Relay Technicians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
18	Cable Splicers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

O.C.	Occupational Category	DECADES 30-39	40-49	50-59	60-69	70-79	80-88
19	Power Plant Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
21	Riggers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
20	Substation Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
22	Auto and Truck Mechanics	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
23	Painters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
24	Pipe Coverers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
25	Welders	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
26	Heavy Vehicle Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
27	Materials Handlers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
28	Laborers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
29	Other Crafts/Trades Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

Comments:

Job Exposure Survey - Herbicides

Exposure to herbicides involves those jobs that are involved with right of way maintenance and construction.

Exposure Levels

3 - Routine - the agent of interest is regularly used by workers in the job titles within each occupational category or is routinely present in their workplace.

2 - Incidental/Occasional - Workers in the job titles within each occupational category are intermittently exposed to the agent of interest or it may be sometimes be present in their workplace.

1 - No Exposure - Workers in the job titles within each occupational category have no exposure to the agent of interest.

		DECADES					
O.C.	Occupational Category	30-39	40-49	50-59	60-69	70-79	80-88
1	Senior Managers and Executive	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
2	Engr, Profess, and Specialist	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
3	Technical Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
4	Field/Craft/Trade Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
5	Administrative Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
6	Admin Support/Clerical Worker	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
7	Sales, Market. & Bus. Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
8	Services	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
9	Mechanics (plants and subs.)	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
11	Machinists	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
12	Boilermakers/Steamfitters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
13	Electricians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
14	Linemen	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
15	Instr. and Control Tech	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
16	Relay Technicians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
18	Cable Splicers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

O.C.	Occupational Category	DECADES 30-39	40-49	50-59	60-69	70-79	80-88
19	Power Plant Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
21	Riggers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
20	Substation Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
22	Auto and Truck Mechanics	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
23	Painters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
24	Pipe Coverers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
25	Welders	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
26	Heavy Vehicle Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
27	Materials Handlers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
28	Laborers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
29	Other Crafts/Trades Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

Comments:

Job Exposure Survey - PCBs

Exposure to PCBs involves contact with tranformer, circuit breaker, and recloser oils. Exposure would be dermal, by ingestion, or by inhalation.

Exposure Levels

3 - Routine - the agent of interest is regularly used by workers in the job titles within each occupational category or is routinely present in their workplace.

2 - Incidental/Occasional - Workers in the job titles within each occupational category are intermittently exposed to the agent of interest or it may be sometimes be present in their workplace.

1 - No Exposure - Workers in the job titles within each occupational category have no exposure to the agent of interest.

		DECADES					
O.C.	Occupational Category	30-39	40-49	50-59	60-69	70-79	80-88
1	Senior Managers and Executive	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
2	Engr, Profess, and Specialist	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
3	Technical Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
4	Field/Craft/Trade Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
5	Administrative Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
6	Admin Support/Clerical Worker	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
7	Sales, Market. & Bus. Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
8	Services	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
9	Mechanics (plants and subs.)	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
11	Machinists	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
12	Boilermakers/Steamfitters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
13	Electricians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
14	Linemen	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
15	Instr. and Control Tech	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
16	Relay Technicians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
18	Cable Splicers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

O.C.	Occupational Category	DECADES 30-39	40-49	50-59	60-69	70-79	80-88
19	Power Plant Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
21	Riggers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
20	Substation Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
22	Auto and Truck Mechanics	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
23	Painters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
24	Pipe Coverers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
25	Welders	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
26	Heavy Vehicle Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
27	Materials Handlers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
28	Laborers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
29	Other Crafts/Trades Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

Comments:

Job Exposure Survey - Solvents

Exposure to solvents involves contact with thinners, degreasers, adhesives, lubricants, cleaners/removers, and paints/lacquers. Some often used constituents for solvents include tri, tetra-chloroethylene (TCE), methylene chloride, carbon tetrachloride (carbontet), methly ethyl ketone (MEK), chloroform, methyl chloroform, polyvinyl chloride, vinyl chloride, and others (see attachment for more examples).

Exposure Levels

3 - Routine - the agent of interest is regularly used by workers in the job titles within each occupational category or is routinely present in their workplace.

2 - Incidental/Occasional - Workers in the job titles within each occupational category are intermittently exposed to the agent of interest or it may be sometimes be present in their workplace.

1 - No Exposure - Workers in the job titles within each occupational category have no exposure to the agent of interest.

		DECADES					
O.C.	Occupational Category	30-39	40-49	50-59	60-69	70-79	80-88
1	Senior Managers and Executive	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
2	Engr, Profess, and Specialist	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
3	Technical Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
4	Field/Craft/Trade Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
5	Administrative Supervisors	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
6	Admin Support/Clerical Worker	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
7	Sales, Market. & Bus. Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
8	Services	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
9	Mechanics (plants and subs.)	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
11	Machinists	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
12	Boilermakers/Steamfitters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
13	Electricians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
14	Linemen	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
15	Instr. and Control Tech	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

O.C.	Occupational Category	DECADES 30-39	40-49	50-59	60-69	70-79	80-88
16	Relay Technicians	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
18	Cable Splicers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
19	Power Plant Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
21	Riggers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
20	Substation Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
22	Auto and Truck Mechanics	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
23	Painters	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
24	Pipe Coverers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
25	Welders	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
26	Heavy Vehicle Operators	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
27	Materials Handlers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
28	Laborers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3
29	Other Crafts/Trades Workers	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3	1 2 3

Comments:

SOLVENTS

The following is a more detailed list of common solvents used throughout industries.

Chemical Name of Solvent

Aromatic Hydrocarbons
- Benzene
- Toluene
- Xylenes
- Ethylbenzene
- 1,3,5-Trimethylbenzene
- Styrene

Alcohols
- Methanol
- Ethanol
- n-Butanol
- iso-Butanol
- iso-Propanol
- Diacetone alcohol (4-Methyl-2-pentanone-4-ol)

Alkanes
- n-Hexane
- n-Heptane

Esters
- Methyl acetate
- Ethyl acetate
- Butyl acetate
- Isobutyl acetate
- Ethylene glycol monomethyl ether, acetate
- Ethylene glycol monoethyl ether, acetate
- Ethylene glycol monobutyl ether, acetate

Ethers
- Ethylene glycol monoethyl ether
- Ethylene glycol monobutyl ether

Chlorinated Hydrocarbons
- Carbon Tetrachloride
- Chloroform
- Dichloromethane (methylene chloride)
- Trichlorofluoromethane
- 1,1,1-Trichloroethane (methylene chloroform)
- 1,1,2-Trichlorotrifluoroethane
- Trichloroethylene (TCE)
- Perchloroethylene
- Pentachlorophenol
- Polyvinyl Chloride
- Vinyl chloride

Ketones

Acetone
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone
Cyclohexanone

Solvent Mixtures

Low boiling petroleum distillate fractions
High boiling petroleum distillate fractions
Gasoline
High boiling oils
Turpentine

The following is a list of the most common solvent combinations.

Combinations

1) Aromatic hydrocarbons - Esters
2) Aromatic hydrocarbons - Chlorinated hydrocarbons
3) Aromatic hydrocarbons - High/Low boiling petroleum distillate fractions
4) Aromatic hydrocarbons - Esters - Alcohols
5) Aromatic hydrocarbons - Esters - Ketones
6) Aromatic hydrocarbons - Alcohols - Ketones
7) Aromatic hydrocarbons - Esters - High/Low boiling petroleum distillate fractions
8) Aromatic hydrocarbons - Ketones - High/Low boiling petroleum distillate fractions
9) Aromatic hydrocarbons - Halogenated Hydrocarbons - High/Low boiling petroleum distillate fractions
10) Aromatic hydrocarbons - Esters - Alcohols - Ketones
11) Aromatic hydrocarbons - Esters - Alcohols - Ketones - High/Low boiling petroleum distillate fractions