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# Summary Report of the Medical Surveillance Program for the Binghamton State Office Building Decontamination Project

Prepared for
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# I. INTRODUCTION

As a result of a transformer fire on 5 February 1981, the Binghamton State Office Building (BSOB) was contaminated with polychlorinated biphenyls (PCBs), tetrachlorodibenzodioxins (TCDDs), and tetrachlorodibenzofurans (TCDFs) apparently produced by the action of the fire on the transformer fluid. With the discovery of TCDD and TCDF, the initial cleanup effort was halted, the building was shut down as of 26 February 1981, and an expert panel was convened by the New York State Department of Health on 3 April to define the conditions under which clean-up activities and eventual re-occupancy of the building could occur. The worker medical surveillance program of the BSOB decontamination project forms a part of the health and safety plans resulting from the recommendations of this panel.

The purpose of the medical surveillance program has been threefold: (1) to determine the medical suitability for participating in the BSOB cleanup, (2) to periodically monitor the health status of members of the cleanup crew, both present and future, and (3) to assess the efficacy of the health and safety plan by establishing baseline values for PCB blood levels and pertinent clinical parameters[1].

The objectives of this analysis are:

1. To describe and summarize data collected during the medical surveillance program for the cleanup of the BSOB.

2. To assess the health status of workers at risk of hazardous exposure during the cleanup.

3. To evaluate the efficacy of the protective equipment and safety procedures used to minimize potentially hazardous exposure.

## II. MATERIALS AND DATA SOURCES

### A. Study Population

All persons entering the BSOB as workers or visitors have been required to participate in the medical surveillance program. Such participation includes an entrance examination, bi-monthly interval evaluations, an annual examination, an exit examination and a follow-up evaluation. All participants are male. Individuals are assigned identification numbers based on their affiliation with the overall project. This report focuses on those employees who were in the building during the earliest phase of the cleanup, i.e. 29 September 1981 through 31 December 1983, when potential exposure was greatest. The total number of participants for whom both exposure data and medical data were available during this time period is 193: 24 Versar, 23 Office of General Services, 139 Allwash contract workers, 3 Broome County personnel, and 4 individuals designated as visitors.

The suitability of each worker to participate in the program is determined at the entrance examination. Potentially disqualifying conditions for participation in the BSOB cleanup include: alcoholism, dermatitis, liver disease, and other conditions thought to be associated with or aggravated by potentially hazardous exposures. Primary consideration was given to conditions that could interfere with the ability to use protective equipment under non-sedentary work conditions.

### B. Health Data

All health data are collected at the examination site, either in Washington, D.C. or at Wilson or Lourdes Hospital in Binghamton, New York. Blood chemistries are analyzed at one of three labs, depending on the examination site: Bionetics laboratory, Wilson laboratory, or Lourdes laboratory, respectively. Plasma PCB specimens are split and

shipped to each of the following labs: Professional Clinical Laboratories (PCL) in Wilmington, Delaware and Biomedical Reference Laboratories (BRL) in Burlington, North Carolina. The normal ranges from these labs for PCB, SGOT, SGPT, GGTP, triglycerides, cholesterol and HDL cholesterol are shown in Appendix A. Results are recorded on a standard set of forms, as described below, and transmitted to Dr. Kenneth Chase of Washington Occupational Health Associates, Inc. (WOHA). Dr. Chase then delivers the forms, in batches, to Biometric Research Institute, Inc. (BRI).

BRI has developed a system of processing forms that results in an accurate and consistent data set. All forms are processed in batches. Each batch is reviewed manually and any necessary coding is done. The batch of forms is then keypunched and machine-verified. After keypunching, the data are listed by computer and data coordinators check keypunching against the original form to identify keypunching errors. Errors identified in the visual check are corrected in the computer file. The objective of this first phase of data processing is to ensure data are entered into the computer exactly as recorded on the original forms by the physician.

The second phase of data processing involves computer listings of the data to identify missing or out-of-range values. These listings are reviewed at WOHA and the corrected copy is returned to BRI. Resolutions are entered into the system and the computer file is updated. This data bank contains all available information from the entrance, interval, annual, exit, and follow-up exams.

The entrance examination includes a complete medical, reproductive and occupational/environmental history as well as a comprehensive physical examination. Baseline laboratory parameters include a complete blood count with differential and platelet count, urinalysis, chemistry profile (modified SMAC 20), chest x-ray, pulmonary function tests, EKG, and plasma PCB level.

All participants are scheduled for bi-monthly interval evaluations. These evaluations include a determination as to whether or not there has been any unusual exposure since the previous evaluation, a determination as to the presence of any unusual or unexplained symptoms, a determination as to the presence or development of any pertinent dermatologic findings, and liver function tests (alkaline phosphatase, total bilirubin, SGOT, SGPT, GGTP). Plasma PCB levels are drawn on every other interval examination.

Annual examinations consist of all tests performed at the interval evaluation plus repeat pulmonary function tests and a chest x-ray.

Exit evaluations include all of the procedures described under the interval evaluation but in addition include serum triglyceride, cholesterol and HDL cholesterol levels and plasma PCB level.

A follow-up examination is performed approximately three months following the exit examination and is identical in scope except that plasma PCB levels are not included.

Another source of data for evaluating the potential health effects of participating in the decontamination project includes "medical incident reports". Workers were required to complete a medical incident report if they were feeling ill or if they felt that any of their symptoms were potentially associated with their work in the BSOB. The safety officer on site, who co-signed these reports, was responsible for noting any signs of skin contamination as well as any other corroborating signs of illness.

**C. Exposure Data**

As part of the overall health and safety plan, a comprehensive industrial hygiene monitoring program was developed by Versar to assess

contaminant control and worker exposure during the decontamination of the BSOB. These data are summarized and discussed in more detail in periodic reports published by Versar[2]. Industrial hygiene air samples and wipe samples have been collected periodically and analyzed to determine PCB levels. Sample selection sites were chosen to represent surfaces and locations inside the BSOB with a high probability of contamination or potential worker exposure.

According to Versar (Revised 26 January 1983 report), "the industrial hygiene sampling program has indicated that the overall level of control and containment of contamination is quite effective." "The concentration of PCBs in the air within the upper floors of the BSOB ranges from 0.3 to 2.3 $ug/m^3$ for samples with measurable concentrations except for one sample taken from the 18th floor men's room in September 1982." Only "the basement mechanical room, where the fire occurred, shows consistently higher levels (as high as 5.6 $ug/m^3$)." A report dated 18 July 1983, states that air samples collected in the subbasement area had PCB concentrations of 0.43 and 0.48 $ug/m^3$.

Routine wipe samples collected in selected areas depicted only one problem area -- the floor near the wash water dump -- which was cleaned up by November of 1982. The July 1983 batch report states that "samples collected from the floors of the subbasement and Floor-1 contain PCB-1254 in the expected range of concentrations for these areas."

In addition, as part of a monitoring program jointly conducted by Versar and the New York State Health Department Center for Laboratories and Research, "air samples collected at 15 distinct locations and/or times within the BSOB have been analyzed for various chlorinated dibenzofurans, dibenzodioxins and biphenylenes[3]". "The average 2,3,7,8-TCDF concentration from twelve locations sampled when the

building's internal air circulation system was operative was 15.0 ± 3.6 pg/m$^3$". Eadon et al.[3] developed a system for estimating 2,3,7,8-TCDD equivalents, and determined that the relative toxicity for air samples containing mixtures of chlorinated dioxins, furans and biphenylenes to be equivalent to about 14 pg/m$^3$ of 2,3,7,8-TCDD. This value was within the range of suggested guidelines for re-entry into the building, as established by the risk assessment of Kim and Hawley[4].

An additional, but unquantifiable source of potential exposure data, is "exposure incident reports" filed by Allwash employees. Workers were required to report all incidents of potential direct contact with contaminated soot as well as any malfunction of their protective equipment (e.g., tear in tyvek suit, tear in glove, or loss of respirator seal) to the on-site health and safety officer. These reports were then sent to Washington, D.C. where they were included in the employee's permanent folder. It was anticipated that working in sometimes cramped areas with bulky cleanup equipment would occasionally result in a tear or dampening of the employee's disposable tyvek suit. The usual procedure was to temporarily "break out" of their garmets, undergo appropriate personal decontamination and cleaning if necessary, and then change into a new suit and resume work. Workers were not penalized or discouraged from filing these reports so it is felt that this source of data is a fairly reliable means for evaluating the efficiency of the protective equipment and safety procedures.

## III. METHODS AND PROCEDURES

### A. Exposure Classification

When attempting to classify workers by potential occupational exposure to hazardous substances, it is preferable to assess individual exposure status rather than grouping employees by crude indices of exposure, such as general job titles or place of employment. This is especially desirable if industrial hygiene monitoring data suggests that the opportunities or routes of potential exposure differ significantly between workers. In their initial status report for the BSOB medical surveillance program, the State of New York and NIOSH investigators created an exposure index score which was computed as a multiplicative function of five factors: location in BSOB, type of activity, whether or not protective clothing was worn by workers, number of hours in the BSOB, and the actual PCB air levels on various dates in the BSOB[5]. Each factor was weighted by a number reflecting its relative magnitude, as determined from studies in the literature, with "number of hours in the BSOB" being the most significant factor.

The feasibility of developing a similar index for workers involved in the Versar medical surveillance program was investigated by on-site toxicologists and industrial hygienists. The following factors mitigate the ability to create a similar exposure index in this study population: (1) unlike the initial cleanup crew, all workers were required to wear full-face respirators and protective clothing when in the building in addition to taking other precautions to minimize potential exposure[1]; (2) PCB air levels documented during this time period (i.e., 9/81 - 12/83), were much lower than those during the initial fire fighting and immediate cleanup phase[2]; and (3) although there may be qualitative differences in the nature and opportunity for

PCB exposure between individual workers or specific job duties, workers in this study were known to rotate on various teams on a daily and weekly basis and individual job assignments were not available to confidently group workers on this basis. As part of the medical surveillance and safety program administered by Versar, the total number of hours actually spent in the building was collected on everyone who entered the BSOB. After careful consideration, this measurement was determined to be the best available indicator of potential exposure.

Differential exposure due to type of activity is accounted for by performing all analyses on two subsets of the population. One group (N=129) is composed of the Allwash contract employees, workers who have the greatest likelihood of contact with contaminated soot by virtue of their cleanup activities (e.g. scrubbing ceilings, vacuuming fireproofing, etc.). The second group (N=64) is comprised of all "other" participants in the cleanup project, namely Versar, O.G.S., Broome County personnel, visitors, and 10 Allwash employees working in a supervisory capacity. The individuals in this subset are predominantly supervisors or short-term visitors whose exposure to potentially toxic substances per hour spent in the building is likely to be less than that of the Allwash employees.

Examination of the frequency distribution of number of hours in the building indicates that reasonable cut-off points can be identified to represent different exposure categories. The Allwash employees for whom complete PCB data was available (100/129) were used to determine these cut-offs. They were then applied to the two subsets of the population for statistical analysis.

The population naturally divides itself into three groups as depicted in the histogram shown in Figure 1. These groups have the following ranges: Group I, 0-400 hours; Group II, 401-979 hours; and Group III, 980-3500 hours. These ranges hold true for the distribution of Allwash workers, as well as Other participants (see Figure 2 and 3); however, a substantial number of participants in the 200-500 hours range did not have complete PCB data. For the purpose of statistical analyses, the "least-likely" exposure category will form Group I, Group II will be comprised of the "less-likely" exposure group and Group III will represent the "most-likely" exposure category. The distribution of exposure category by study subset is depicted in Table 1. Within each subset, approximately 50% of the population falls into the lowest exposure category. Table 2 shows the distribution of study participants by job classification and exposure category.

**B. Statistical Tests**

Adopting similar procedures to those utilized by the New York State Health Department investigators, some analyses will preserve the original scaling of hours spent in BSOB, while other analyses will utilize the distinct exposure categorizations. The advantage of the first approach is that it maintains the interval nature of the data which is desirable for assessing time trends and dose-response relationships. Categorization of potential exposure status by hours in BSOB allows the use of group means to estimate the significance of differences between potential exposure status, PCB blood levels, and biochemical parameters. The data have been analyzed as follows: (1) descriptive statistics; (2) correlation analysis; (3) possible cumulative effect of potential exposure; and (4) regression analysis.

Descriptive statistics

Descriptive statistics have been calculated to provide an overview of the characteristics of the study population as a whole, as well as by exposure category (as defined above). This stage of analysis

includes frequency distributions of variables such as age, dermatogical symptoms, and history of alcohol abuse. The chi-square test of association was used to assess significant differences between exposure groups.

Plasma PCB values, biochemical parameters, and other continuous variables being analyzed have been tested for normality. Whenever appropriate, log transformations of the data have been used. If neither the original data nor the transformed data approached a normal distribution, nonparametric methods were applied.

Correlation analysis

In order to evaluate whether potential exposure to PCB contaminated soot had subclinical effects on liver function, plasma PCB levels were compared to the three most sensitive liver function tests, i.e., SGOT, SGPT and GGTP. The normal distribution and nonparametric correlation coefficients between plasma PCB levels and each of these parameters were analyzed for Allwash employees and Other participants separately. Correlation coefficients and probability values were tabulated using the latest time interval possible.

Cumulative effect of potential exposure

The cumulative effect of potential exposure in the BSOB was assessed in the following manner. All analyses described were performed twice: once for the subset of Allwash workers only, and once for the subset of Other employees. This analysis compared baseline values to values on the last exam, whether interval or exit, for each particular subject by exposure category. Because of the small number of Other employees, particularly in Group II, Group I and II were combined for statistical purposes. Ideally, Group II should have been

combined with Group III, but because of the potential exposure in Group III it was decided to report on them separately. Thus, for each parameter considered, five distinct groups of individuals were analyzed (three Allwash and two Other). The last visit date varies considerably within the population; however, this method is most likely to assess the highest cumulative dose. The null hypothesis being tested is that the difference between the baseline and final test means in each exposure category equals zero. The mean differences of each group were statistically compared using paired t-tests.

Another analysis of the cumulative effect of potential exposure evaluated possible differences in the final examination (interval or exit) values for various parameters for the three groups of Allwash employees and for the two groups of Other employees. The null hypothesis being tested is that the mean level of the groups are all equal. The analysis was performed both parametrically (Analyses of Variance) and nonparametrically (Wilcoxon).

Regression analysis

Possible time trends in the PCB and biochemical measurements as a function of the length of time t that individuals spent in the BSOB were evaluated. For each participant, the final interval or exit values were used as a proxy for the values when last in the building. Linear regression was performed to determine whether these final measurements were related to the time t.

## C. Methods for Reviewing Clinical Data

The most reliable means of monitoring potential health effects is prompt recognition and reporting of signs and symptoms of illness, both by the worker himself in the form of self initiated medical incident

reports (with appropriate follow-up) and by the examining physician at the bi-monthly interval examination. This method identifies all cases of frank toxicity as well as most cases of immediate concern, such as grossly abnormal biochemical tests and any cases of elevated plasma PCB levels. As mentioned previously in the discussion of the medical surveillance program, Dr. Chase periodically monitors summary reports of all clinical data. During this process, employees with moderately or significantly altered biochemical tests can be identified and notified for further evaluation. Two employees who were identified as having significantly altered liver function tests are discussed in section IV.

Individual records of all 129 Allwash workers employed between 29 September 1981 and 31 December 1983 were reviewed and the symptoms and signs listed on the medical incident reports were summarized. The frequency of these symptoms can only be crudely compared to those listed at the time of baseline examination because unlike the initial survey, all workers were not asked a standard set of questions at a given point in time. Instead, workers were instructed to complete a medical incident report if they felt ill. Although in most cases, these symptoms can reasonably be presumed to be associated with the circumstances of their employment on the day the report was filed, it is also necessary to keep in mind that Allwash employees, like everyone else, develop seasonal colds and are involved in non-work related accidents. These conditions could be aggravated by being garbed in a full-body tyvek suit all day while working under sometimes environmentally stressful circumstances.

Similarly, individual records of all 129 Allwash workers were examined, and all exposure incident reports were reviewed and summarized. The safety officer on-site who was responsible for signing off on exposure incident reports was obligated to note on the report if

he saw evidence of coverall or skin contamination. The distribution of Allwash employees filing exposure incident reports was then examined by exposure category in an effort to determine if workers who quit or spent few hours in the BSOB may have experienced more intensive circumstances of exposure. These workers may have filed more incident reports or may have reported more instances of direct contact. Alternatively, it would reasonably be expected that workers who were employed longer would naturally encounter more opportunities for protective equipment failure. This comparison would also investigate whether multiple exposure incident reports were filed by few or many workers.

Many previous studies have demonstrated a positive correlation between plasma PCB levels and age, length of employment (or exposure) and intensity of exposure among workers exposed to PCB fluids.[6,7,8] In lieu of personal PCB air levels, the relationship between the frequency of exposure incident reports filed by Allwash employees was compared to the PCB blood level. The hypothesis being tested is that those workers who filed more exposure incident reports should have higher plasma PCB levels. The chi square test was then used to test for a statistically significant difference.

In an effort to identify those individuals thought to be at highest risk of potential exposure, all Allwash employees who filed twenty or more exposure incident reports were identified. Their latest interval or exit laboratory tests were then examined to determine if there was any evidence of liver toxicity in those individuals who presumably were at highest risk for direct contact with contaminated soot.

## IV. STATISTICAL RESULTS

The results will be presented in five sections as described in the rationale: (A) descriptive statistics; (B) correlation analysis; (C) analysis of the cumulative effect of potential exposure; (D) regression analysis; and (E) discussion of clinical data. For Section A through D, the results for Allwash employees and Other employees are presented separately. In addition, two participants whose liver function measurements were several levels of magnitude larger than any others were excluded from all analyses other than the descriptive statistics so they would not skew the results. These two cases are discussed in Section E.

### A. Descriptive Statistics

The age distribution of Allwash employees (Table 3) reveals a relatively young population, with 88 percent less than 35 years of age. Only 2 percent of Allwash employees are 45 or older. This pattern is generally maintained among individuals in the middle and upper exposure categories, in which 50 percent of the population is 15 to 24 years old and 100 percent are younger than 45. Group I, representing workers who are least likely to be exposed to PCBs, is more diverse, having fewer people under 25 (36%) and over twice as many people age 35 or older (18% vs. 7% and 3%) than does Group II or III.

Among Other employees (Table 4) most people were 25 to 44 years of age (64%) with 14 percent under 25 and 22 percent age 45 or older. The largest variation among exposure categories occurs in Group II in which all eight employees (100%) are under 35. Group I has a relatively small number of employees under 25 (3%), but the overall age distribution is consistent with that of Group III.

The distribution of age by exposure category among Allwash employees from whom exposure category was assessed (i.e., those with complete PCB data) is similar to the subset of total Allwash employees. This distribution is depicted in Table 5.

As mentioned previously, all employees were asked to complete a detailed questionnaire at their entrance exam, before entering the building, which focused on conditions thought to be associated or aggravated by potentially hazardous exposures. It should be noted that chloracne, a specific dermatological condition requiring a tissue specimen and histological diagnosis that has been associated with exposure to chlorinated hydrocarbons, was grouped with "acne" on the original baseline questionnaire. Positive responses to this question do not necessarily imply that some workers had documented chloracne at the time of beginning work in the BSOB. Furthermore, it should be appreciated that mere reporting of ever having a history of liver hepatitis or dermatitis were not disqualifying conditions if they were not active at the time of physical examination. Baseline symptoms reported by the employee or examining physician were tested, using Chi-square, for any association with exposure category. No significant ($p < .05$) associations were found, i.e., the groups were about the same prior to entering the BSOB.

Among Allwash employees, the most commonly self-reported symptoms at the entrance exam (Table 6) were acne or chloracne in Group I (18%), thickening in Group II (25%), and both skin irritation or burning and acne or chloracne in Group III (18%). The baseline symptoms most frequently reported at the entrance exam by the physician (Table 7) were thickening in Group I (25%) and rash in Group II (32%) and III (26%).

Among Other employees, rash was the most frequently self-reported symptom at the entrance exam in Group I/II (17%). In Group III, rash was tied with skin irritation or burning and acne or chloracne at 17

percent each (Table 8). Rash was the symptom most frequently reported by physicians at the entrance exam in both exposure categories (Table 9) with 22 percent in Group I/II and 30 percent in Group III.

The case records of Allwash and Other employees in Group II and III who reported history of any hepatic-related problems were evaluated to assess their impact on the results. The presence of these conditions was not controlled for in the remaining analyses because very few employees reported these problems and those who did, experienced them many years ago without recurrence.

All participants reporting any unusual exposure or breach of safety regulations, adverse health effects, or abnormal findings were identified. The frequency and nature of these complaints are summarized in the discussion of clinical data.

**B. Correlation Analysis**

Plasma PCB levels (separately analyzed at PCL and BRL laboratories) were tested for correlation with the three biochemical parameters SGOT, SGPT, and GGTP. Data were used from the latest available time interval. The possible association of these parameters was evaluated using the normal Pearson correlation coefficient as well as the nonparametric Spearman correlation coefficient. None of the results were statistically significant ($p < .05$).

**C. Cumulative Effect of Potential Exposure**

The difference between baseline and final measurements was statistically analyzed (paired t-test) within each exposure group for the following parameters: plasma PCB (analyzed at PCL Lab and BRL Lab), SGOT, SGPT, GGTP, triglycerides, cholesterol and HDL. The value on the entrance exam was subtracted from the value on the latest interval or exit exam; therefore, when the mean difference is positive, the value of the parameter increased over time and when it is negative,

the value of the parameter decreased over time. The results are depicted in Tables 10 a & b to 17 a & b. The entrance and last exam means are based on all available data; the mean difference is based on results from the paired t-test, and so, may include fewer observations.

PCBs

Baseline and final values for plasma PCB levels were compared to normal ranges obtained from the laboratories. All values were within the normal range; most values were at or below the minimal detection limits. The ranges and means of PCB values for Allwash employees by exposure group are as follows:

| Exposure, lab | Entrance Exam Range (Mean) | Last Exam Range (Mean) |
|---|---|---|
| Group I, PCL | 0 - 15 (5.85) | 5 - 16 (5.44) |
| Group I, BRL | 3 - 13 (5.09) | 3 - 9 (4.83) |
| Group II, PCL | 5 - 9 (5.19) | 5 - 5 (5.00) |
| Group II, BRL | 3 - 9 (4.19) | 3 - 6 (3.44) |
| Group III, PCL | 5 - 8 (5.09) | 5 - 8 (5.12) |
| Group III, BRL | 3 - 11 (4.30) | 3 - 8 (4.24) |

Plasma PCB values from the PCL Laboratory did not exhibit any significant differences between baseline and final measurements. Of the five average differences, however, three are negative, one is "zero," and only one is positive (Group III Others) from baseline to final measurements. Plasma PCB values from the BRL Laboratory showed one significant difference (Group I/II Others). All five of the average differences were negative and two values (Allwash Group I and II) were close to significantly ($p = .06$) negative. Thus, in general, plasma PCB levels decreased for individuals in this study though, on average, not significantly.

Other Biochemical Parameters

Average baseline and final values for selected blood chemistry parameters were compared to normal ranges obtained from the hospitals. The group means for the liver enzyme parameters SGOT, SGPT, and GGTP were always well within the normal range. Triglyceride levels were slightly high for Group III Allwash employees (both baseline and final) relative to the Bionetics Laboratory scale but were normal for the Lourdes and Wilson Hospital scales. Both baseline and final cholesterol levels were slightly high for Other employees (Groups I/II and III) relative to the Bionetics Laboratory scale but were normal for the two hospital scales. The HDL levels were all within the normal ranges.

Values for SGOT, SGPT, triglycerides, and HDL did not exhibit any significant differences between baseline and final measurements. Average levels sometimes went up and sometimes went down.

GGTP levels changed significantly for Group III employees (both Allwash and Others) as well as for Group II Allwash employees. Individuals with high exposure, on average, had much lower values at the end than at the beginning (mean difference of 12.83 and 9.53 lower). The differences for the other two groups did not exhibit any consistent pattern. In general, GGTP levels decreased for study participants, especially for those with medium or large exposure.

Cholesterol levels changed significantly for Allwash Group I employees. Allwash individuals with low exposure, on average, had much lower (average decrease 9.44) cholesterol values at the end than at the beginning. Also, the averages for all groups of Allwash employees went down. Group III Others also decreased while Groups I/II Others groups of Allwash employees went down. Group III Others also decreased while Groups I/II Others remained the same, on average. Thus, in general, cholesterol levels declined for all study participants.

Analysis of variance and Wilcoxon tests were performed on the final measurement values for PCBs (from both labs), SGOT, SGPT, GGTP, triglycerides, cholesterol, and HDL to determine whether the mean levels for the different exposure groups were the same. The only significant ANOVA was for Allwash employees for PCBs from the BRL Lab. Furthermore, the mean levels do not vary linearly with length of exposure. The only significant Wilcoxon Rank Sum Test result was for GGTP among Allwash employees. In addition, the means decrease as exposure increases.

### D. Regression Analysis

To assess possible time trends in the PCB and biochemical data, linear regression models were run using time in the BSOB as the independent variable and final PCB levels (from both labs), SGOT, SGPT, and GGTP as dependent variables. The only statistically significant slope occurs for GGTP among Other employees (slope=-0.0003) showing a slight decline in its level with time spent in the BSOB. Two other values are almost significant (p=.07 level): these are for PCBs (BRL Lab) for Others (slope=-0.0006) and SGOT for Others (slope=0.002). All four slopes for PCBs are negative, both slopes for SGOT are positive, and both slopes for GGTP are negative (one is significant).

### E. Discussion of Clinical Data

The frequency distribution of symptoms reported by Allwash employees on the medical incident reports is summarized in Table 20. The two most prevalent findings were complaints of feeling nauseous and reports of blunt trauma and minor bruises. The latter findings are not atypical of any group of industrialized workers. Because the same individual could have filed more than one report, or could have listed more than one chief complaint on the same medical incident report, the true prevalence of these symptoms among all workers within a particular

exposure group cannot be determined. The reporting of 35 cases of feeling nauseous among 34 workers in Group III may be attributed to working longer hours under environmentally stressful conditions or may be a manifestation of the cumulative effects of low level chronic toxicity. In order to adjust for the differences in time spent in the BSOB as well as differences in the size of the populations, a crude index of the average number of reported cases per hour spent in the BSOB was calculated and used to compare across groups. By dividing the number of cases of feeling nauseous in Group I and III (6 and 35) by the average number of hours spent in the BSOB for these same groups (184 hrs. and 1757 hrs.) it was determined that there were .033 cases per hour reported for Group I compared to .020 for Group III. The results of similar calculations are shown in parentheses in Table 20. This would suggest that spending longer time in the BSOB, and therefore presumably at higher risk of potential exposure, is not necessarily associated with a higher incidence of ill symptoms. The only instance in which the Group III reports per hour were clearly higher was musculoskeletal pain. Most of these cases were due to low back pain possibly associated with long hours in the cramped work conditions at the BSOB.

The frequency distribution of all sources of equipment failure reported by Allwash employees in exposure incident reports is summarized in Table 21. Clearly, the most frequent source of "equipment failure" was tear in the outer layer of a glove or tyvek suit. If these incidents did not occur during a time when the worker was actually involved in cleaning up of contaminated soot or were not associated with evidence of skin or coverall contamination, then they were listed as such in the incident report. There were, however, a total of 44 reported incidents involving the loss of a tyvek suit seal and a total of 40 cases of a torn glove, all with evidence -- usually dampened or soiled skin -- of skin or coverall contamination. In all of these cases, however, workers underwent immediate decontamination procedures and no cases of unresolving contact dermatitis or chloracne

have been reported. Table 21 also demonstrates that, in general, Group III workers filed more reports in total; however, the number of reports per hour spent in the BSOB was not higher.

Table 22A demonstrates that individual workers in Group III were more likely to file multiple exposure incident reports. Nineteen individuals in Group III filed 11 or more exposure incident reports. Again, this occurrence is probably a reflection of the greater number of hours spent in the BSOB.

In order to investigate the relationship between PCB blood levels and length of potential exposure, PCB blood levels were compared to the frequency of reporting potential contact with contaminated soot (Table 22b). There is no evidence to suggest that the group of workers at highest risk of exposure to contaminated soot had higher plasma PCB levels. To investigate this further, all those workers who filed 20 or more exposure incident reports were identified and their latest interval or exit exam PCB blood levels and liver function studies summarized in Table 23. All laboratory values were within normal limits.

As mentioned previously, two Allwash employees were identified who had grossly abnormal liver enzyme measurements at the time of their exit examinations. Careful evaluation of these individuals' cases indicates that their work in the BSOB was probably not a cause for these abnormalities. Unfortunately, neither of these two workers reported for their three month follow-up exam, so it is unknown whether these enzyme levels have since returned to normal.

Employee number one is a 22 year old white male who had his entrance examination in January, 1982, and first entered the building in February, 1982. At that time his liver enzyme measurements were well within the normal ranges (SGOT of 17 IU/liter and SGPT of 13 IU/liter). There was no indication at that time of any liver problems. Values for these liver enzyme measurements remained relatively constant on the interval examinations on 24 March, 26 May, 3 August, and 28

September 1982. The employee last entered the BSOB in November 1982. During the time the employee was actively working in the BSOB he filed numerous minor exposure incident reports, most of which were for torn gloves and tyvek suit tears. During his March examination he did report that there had been one incident in which he felt there was potential for exposure. The exposure report for this incident stated that charcoal and water had entered the employee's tyvek suit around the wrists and that "some irritation was noted around the left wrist and lower left abdomen, but subsided after showering". The examining physician reported slightly red and swollen eyelids at the employee's March interval examination but his exam was otherwise unremarkable.

The employee denied any subsequent instances of possible exposure on his next three interval examinations as well as at the time of his exit examination. During his exit examination on 12 January 1982 the employee did complain of itching and skin irritation which the examining physician at that time described as dermatographia. Liver enzyme measurements at this time were markedly elevated: SGOT 307 IU/l, SGPT 480 IU/l and GGPT 184 IU/l. Plasma PCB blood levels as measured by the Wilmington and Burlington laboratories were 5 and 3 ppb, respectively. In view of the low PCB blood levels and no report of possible direct contact with soot for at least 9 months prior to developing these liver enzyme elevations, it is unlikely that these abnormalities are the result of any hazardous exposures while working in the BSOB. Elevated liver enzymes in this ratio are, however, suggestive of infectious hepatitis which the employee could have developed in the 2 months since his last employment in the BSOB.

Employee number two is a 21 year old white male who had his entrance examination in February, 1983, and first entered the building in February. At that time his liver enzyme measurements were well within the normal ranges (SGOT of 23 IU/l). There was no indication at that time of any liver problems. Values for SGOT remained relatively constant on the interval examinations in March and May 1983. Incidents

with dust in his mask and torn gloves were reported at the May, 1983, interval examination. At that May examination the physician reported no abnormal findings (including liver abnormalities). He last entered the building in July, 1983. At the exit examination in August, 1983, the value for SGOT jumped by a factor of fifteen to 446 IU/l. The employee's plasma PCB levels as measured by the Wilmington and Burlington laboratories were 5 and 7 ppb, respectively. Although the employee did report possible contact with some "dust" at the time of the exit examination, low plasma PCB levels and the absence of any history of substantive exposures make it unlikely that this employee was exposed to any hazardous substances. Significantly elevated SGOT and slightly elevated SGPT liver enzyme values in the absence of any other abnormal liver function tests (e.g., bilirubin, alkaline phosphatase, GGTP) is frequently seen as a response to short term binge alcohol comsumption.

## V. CONCLUSION

In conclusion, the results for specific biochemical parameters are summarized and an overall explanation of the findings is presented. Table 19 summarizes the statistically significant results.

- PCBs (PCL Lab): The t-test indicated that in general there was a tendency for the serum values to decline from baseline to final examinations. The regressions indicated a general decline of values with length of time in the BSOB.

- PCBs (BRL Lab): The results are similar to those found using the BRL data but in this case are more pronounced and sometimes significant.

- SGOT: In general, the regressions indicated a slight rise in values as the length of time increased in the BSOB. The t-tests offered no clear pattern for possible changes within groups.

- GGTP: The t-test indicated a general trend for GGTP values to decrease from baseline to final examination with significant decreases for the high and medium exposure groups. The regression analyses also indicated a general trend (significant for Others, suggestive for Allwash) for lower final examination values for those with more hours in the BSOB. Finally, the nonparametric Wilcoxon test showed a significant decline in average GGTP values for the Allwash employees with time spent in the BSOB (grouped data).

- o Cholesterol: The t-test, in general, showed declining levels from baseline to final examinations (significantly lower only for low exposure Allwash employees).

- o SGPT, Triglycerides, HDL: Nothing even suggestive can be said regarding these biochemical parameters based on our analysis.

When evaluating the significance of these results, the following must be considered. First, even though there were statistically significant findings, they may be of limited clinical importance due to the fact that the mean level for every group and every parameter were well within normal ranges. Second, the transfer of these results to other populations may be limited by the fact that the Allwash employees (and to a lesser extent, the Other employees) were younger and healthier than the average profile for American adult males. Third, all statistical tests were performed at the 5% level so that chance alone would dictate finding about 5% of the comparisons significant if there were no real effects.

In conclusion, among the employees in this study for whom protective equipment and safety procedures were used to minimize potentially hazardous exposure, the health status of the workers was not substantially affected, overall, by potential exposure to the toxic contaminants in the BSOB.

## VI. REFERENCES


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Figure 1

HISTOGRAM OF NUMBER OF HOURS IN BSOB FOR ALLWASH EMPLOYEES WITH PCB DATA
(N=100)

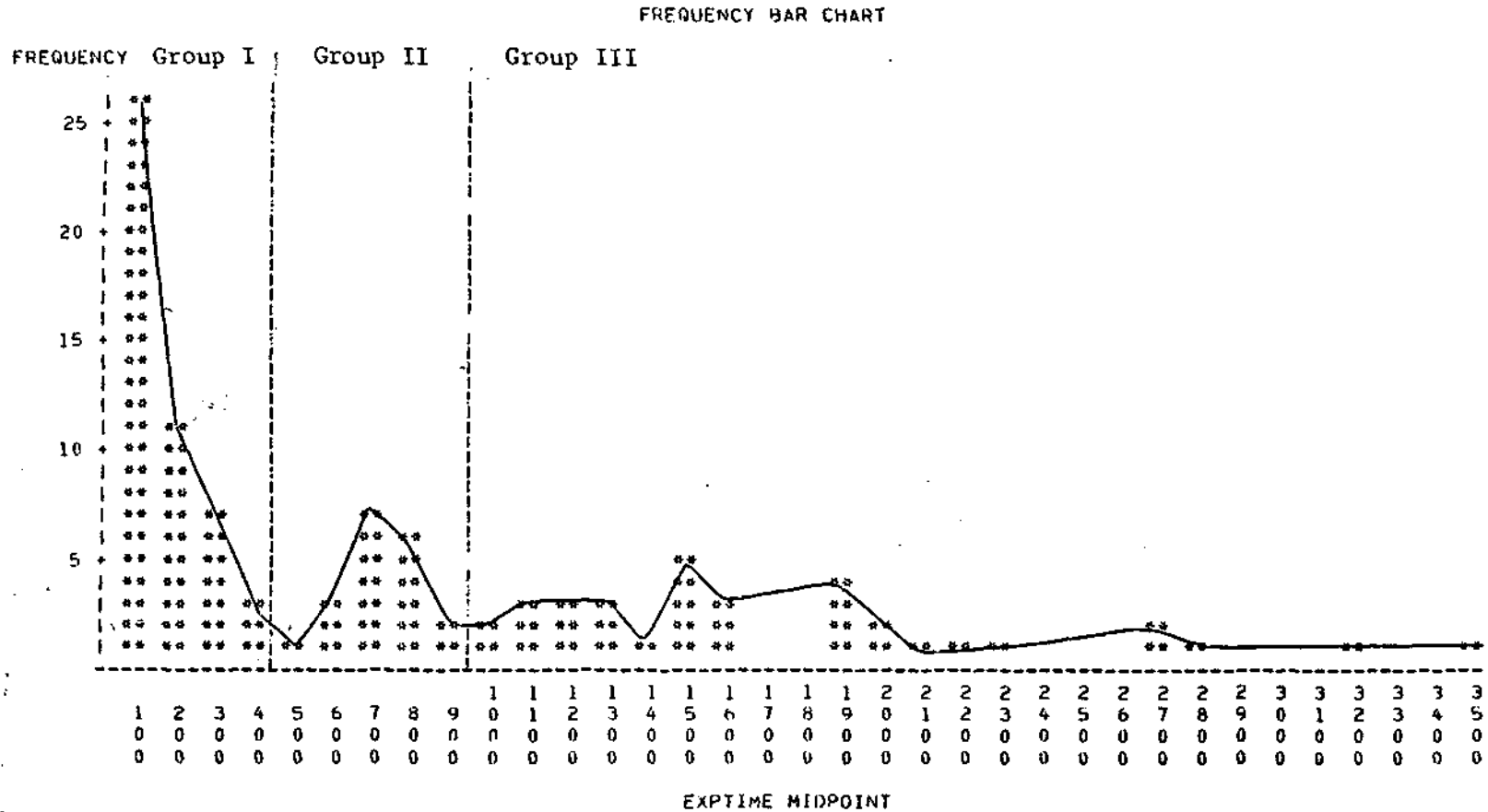

Figure 2

HISTOGRAM OF NUMBER OF HOURS IN BSUB FOR ALLWASH EMPLOYEES
(N=129)

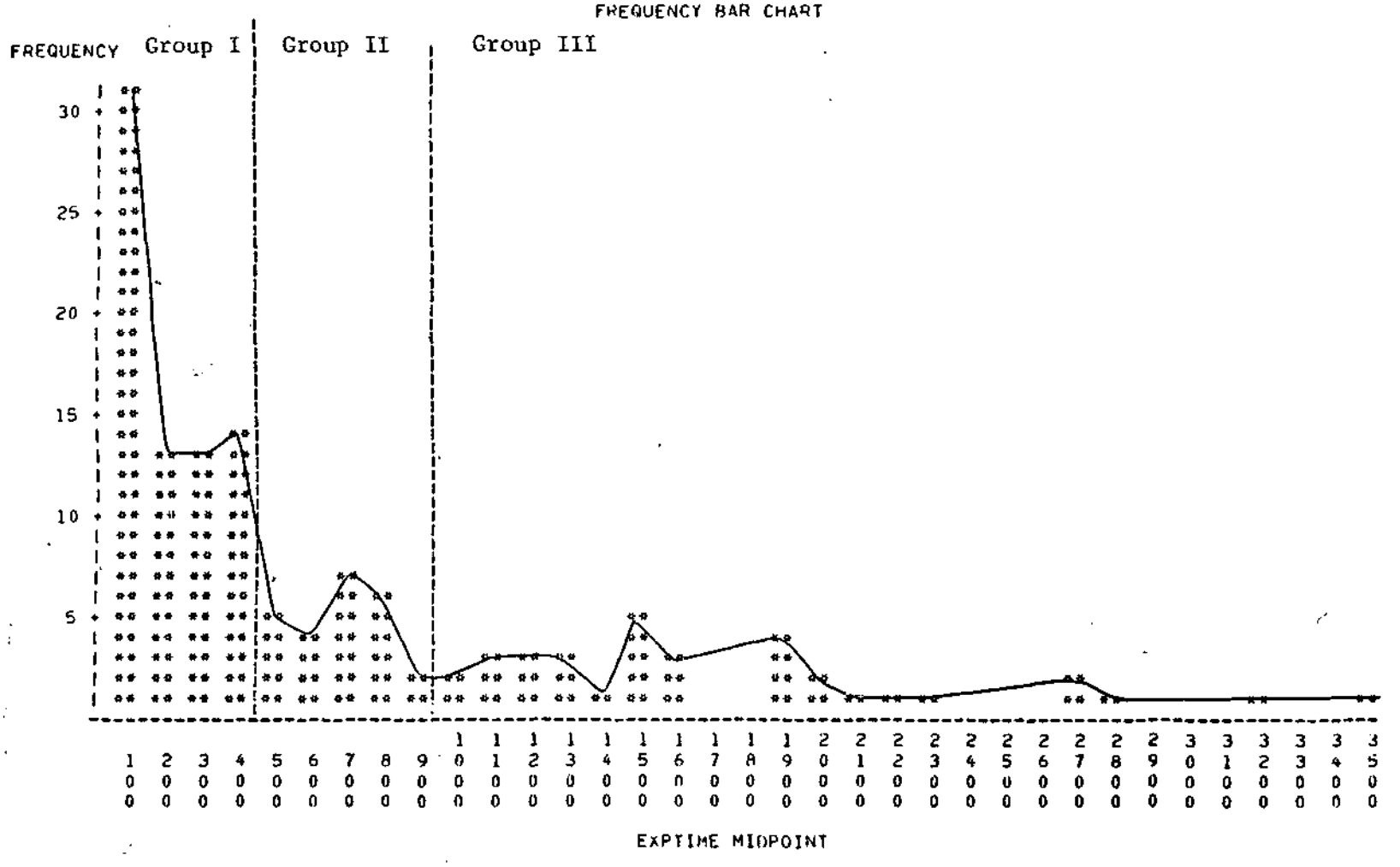

Figure 3

HISTOGRAM OF NUMBER OF HOURS IN BSOB FOR OTHER EMPLOYEES
(N=64)

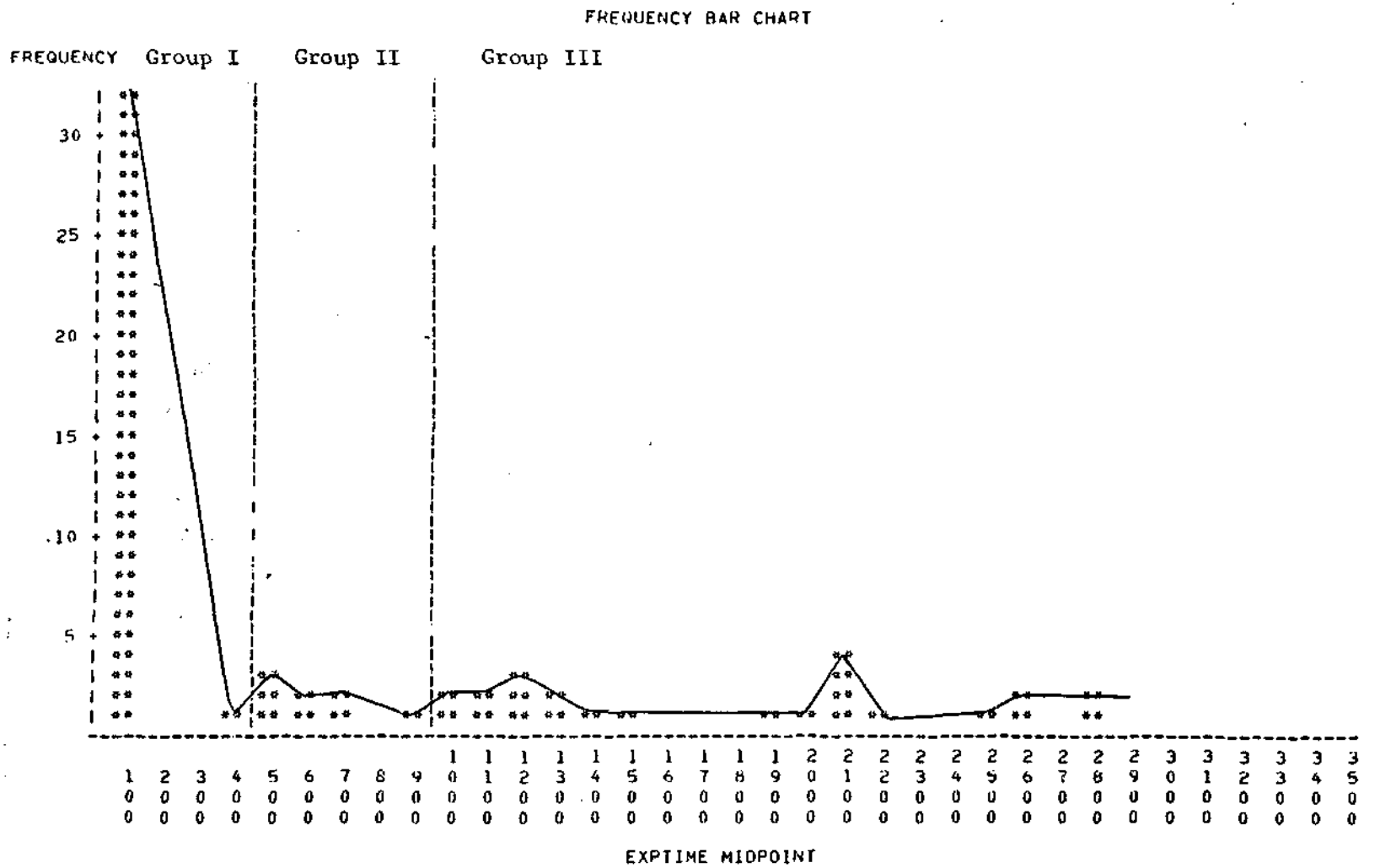

Table 1

Distribution of Exposure Category by Study Subset

| EXPOSURE CATEGORY | Subset | | | | | |
|---|---|---|---|---|---|---|
| | Allwash with PCB Data | | Total Allwash | | Other | |
| | # | (%) | # | (%) | # | (%) |
| Group I | 46 | (46) | 67 | ( 52) | 33 | (52) |
| Group II | 20 | (20) | 28 | ( 22) | 8 | (12) |
| Group III | 34 | (34) | 34 | ( 26) | 23 | (36) |
| TOTAL | 100 | (100) | 129 | (100) | 64 | (100) |

Table 2

Distribution of Study Participants
By Job Classification and Exposure Category

| EXPOSURE CATEGORY | JOB CLASSIFICATION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SUBSET | | | | | OTHER | | | | | | |
| | Allwash | | Other | | TOTAL | Versar | | O.G.S. | | Supervisory | | Misc.* | |
| | N | (%) | N | (%) | N (%) | N | (%) | N | (%) | N | (%) | N | (%) |
| Group I | 67 | ( 52) | 33 | ( 52) | 100 ( 52) | 15 | ( 62) | 9 | ( 39) | 2 | ( 20) | 7 | (100) |
| Group II | 28 | ( 22) | 8 | ( 12) | 36 ( 19) | 4 | ( 17) | 3 | ( 13) | 1 | ( 10) | 0 | ( 0) |
| Group III | 34 | ( 26) | 23 | ( 36) | 57 ( 29) | 5 | ( 21) | 11 | ( 48) | 7 | ( 70) | 0 | ( 0) |
| TOTAL #(%) | 129 | (100) | 64 | (100) | 193 (100) | 24 | (100) | 23 | (100) | 10 | (100) | 7 | (100) |

* Includes 3 Broome County personnel and 4 visitors

Table 3

Age Distribution of Allwash Employees by Exposure Category

| Age (Yrs.) | Exposure Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Group I | | Group II | | Group III | | Total | |
| | # | (%) | # | (%) | # | (%) | # | (%) |
| 15-24 | 24 | (36) | 14 | (50) | 17 | (50) | 55 | (42) |
| 25-34 | 31 | (46) | 12 | (43) | 16 | (47) | 59 | (46) |
| 35-44 | 10 | (15) | 2 | ( 7) | 1 | ( 3) | 13 | (10) |
| 45-54 | 2 | ( 3) | 0 | ( 0) | 0 | ( 0) | 2 | ( 2) |
| 55-64 | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) |
| ≥65 | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) |
| TOTAL | 67 | (100) | 28 | (100) | 34 | (100) | 129 | (100) |

Table 4

Age Distribution of Other Study Participants by Exposure Category

| Age (Yrs.) | Exposure Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Group I | | Group II | | Group III | | Total | |
| | # | (%) | # | (%) | # | (%) | # | (%) |
| 15-24 | 1 | ( 3) | 1 | (12) | 7 | (30) | 9 | (14) |
| 25-34 | 9 | (27) | 7 | (88) | 5 | (22) | 21 | (33) |
| 35-44 | 14 | (43) | 0 | ( 0) | 6 | (26) | 20 | (31) |
| 45-54 | 5 | (15) | 0 | ( 0) | 3 | (13) | 8 | (12) |
| 55-64 | 3 | ( 9) | 0 | ( 0) | 2 | ( 9) | 5 | ( 8) |
| ⩾65 | 1 | ( 3) | 0 | ( 0) | 0 | ( 0) | 1 | ( 2) |
| TOTAL | 33 | (100) | 8 | (100) | 23 | (100) | 64 | (100) |

Table 5

Age Distribution of Allwash Employees by Exposure Category
for Those with Complete PCB Data

| Age (Yrs.) | Exposure Category | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Group I | | Group II | | Group III | | Total | |
| | # | (%) | # | (%) | # | (%) | # | (%) |
| 15-24 | 15 | ( 33) | 11 | ( 55) | 17 | ( 50) | 43 | ( 43) |
| 25-34 | 21 | ( 45) | 9 | ( 45) | 16 | ( 47) | 46 | ( 46) |
| 35-44 | 9 | ( 20) | 0 | ( 0) | 1 | ( 3) | 10 | ( 10) |
| 45-54 | 1 | ( 2) | 0 | ( 0) | 0 | ( 0) | 1 | ( 1) |
| 55-64 | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) |
| ≥65 | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) |
| TOTAL | 46 | (100) | 20 | (100) | 34 | (100) | 100 | (100) |

Table 6

Frequency Distribution of Baseline Symptoms
Reported by Allwash Employees
According to Exposure Category

| SYMPTOMS | EXPOSURE CATEGORY | | | | | |
|---|---|---|---|---|---|---|
| | Group I (N=67) | | Group II (N=28) | | Group III (N=34) | |
| | # | (%) | # | (%) | # | (%) |
| Skin irritation or burning | 9 | (13) | 6 | (21) | 6 | (18) |
| Rash | 6 | ( 9) | 3 | (11) | 3 | ( 9) |
| Acne or chloracne | 12 | (18) | 6 | (21) | 6 | (18) |
| Thickening | 9 | (13) | 7 | (25) | 4 | (12) |
| Hyperpigmentation | 3 | ( 4) | 3 | (11) | 2 | ( 6) |
| Nail discoloration | 2 | ( 3) | 0 | ( 0) | 2 | ( 0) |
| Other dermatologic symptoms | 12 | (18) | 9 | (32) | 5 | (15) |
| Eye irritation or burning | 4 | ( 6) | 1 | ( 4) | 3 | ( 9) |
| Eye discharge | 2 | ( 3) | 0 | ( 0) | 2 | ( 6) |
| Swelling of eyelids | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) |
| Other ophthalmic symptoms | 2 | ( 3) | 2 | ( 7) | 1 | ( 3) |
| Any history of liver dysfunction | 2 | ( 3) | 0 | ( 0) | 0 | ( 0) |
| Any history of hepatitis | 2 | ( 3) | 0 | ( 0) | 0 | ( 0) |
| Any history of yellow jaundice | 2 | ( 3) | 0 | ( 0) | 0 | ( 0) |
| Any history of alcohol abuse | 1 | ( 1) | 1 | ( 4) | 2 | ( 6) |
| Other hepatic symptoms | 2 | ( 3) | 0 | ( 0) | 2 | ( 6) |
| Persistent body odor | 1 | ( 1) | 0 | ( 0) | 0 | ( 0) |
| History of hyperlipidemia | 1 | ( 1) | 0 | ( 0) | 0 | ( 0) |
| History of cancer | 2 | ( 3) | 0 | ( 0) | 0 | ( 0) |

Table 7

Frequency Distribution of Baseline Physical Findings
Reported by Physician for Allwash Employees
According to Exposure Category

| PHYSICAL FINDINGS | EXPOSURE CATEGORY | | | | | |
|---|---|---|---|---|---|---|
| | Group I (N=67) | | Group II (N=28) | | Group III (N=34) | |
| | # | (%) | # | (%) | # | (%) |
| Erythema | 1 | ( 1) | 2 | ( 7) | 2 | ( 6) |
| Rash | 12 | (18) | 9 | (32) | 9 | (26) |
| Chloracne | 0 | ( 0) | 1* | ( 4) | 0 | ( 0) |
| Hyperpigmentation | 7 | (10) | 1 | ( 4) | 1 | ( 3) |
| Thickening | 17 | (25) | 8 | (29) | 4 | (12) |
| Nail discoloration | 6 | ( 9) | 1 | ( 4) | 4 | (12) |
| Other dermatologic findings | 36 | (54) | 19 | (68) | 23 | (68) |
| Conjunctival Infection | 3 | ( 4) | 1 | ( 4) | 0 | ( 0) |
| Eye discharge | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) |
| Swelling of lids | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) |
| Jaundice | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) |
| Hepatomegaly | 1 | ( 1) | 0 | ( 0) | 0 | ( 0) |
| Other hepatic findings | 0 | ( 0) | 0 | ( 0) | 0 | ( 0) |

*This case was not confirmed by histological diagnosis or by a dermatologist.

Table 8

Frequency Distribution of Baseline Symptoms
Reported by Other Employees
According to Exposure Category

| SYMPTOMS | EXPOSURE CATEGORY | | | |
|---|---|---|---|---|
| | Group I/II (N=41) | | Group III (N=23) | |
| | # | (%) | # | (%) |
| Skin irritation or burning | 5 | (12) | 4 | (17) |
| Rash | 7 | (17) | 4 | (17) |
| Acne or chloracne | 5 | (12) | 4 | (17) |
| Thickening | 1 | ( 2) | 0 | ( 0) |
| Hyperpigmentation | 1 | ( 2) | 0 | ( 0) |
| Nail discoloration | 1 | ( 2) | 0 | ( 0) |
| Other dermatologic symptoms | 5 | (12) | 2 | ( 9) |
| Eye irritation or burning | 4 | (10) | 0 | ( 0) |
| Eye discharge | 1 | ( 2) | 0 | ( 0) |
| Swelling of eyelids | 1 | ( 2) | 0 | ( 0) |
| Other ophthalmic symptoms | 3 | ( 7) | 1 | ( 4) |
| Any history of liver dysfunction | 0 | ( 0) | 0 | ( 0) |
| Any history of hepatitis | 1 | ( 2) | 0 | ( 4) |
| Any history of yellow jaundice | 1 | ( 2) | 0 | ( 0) |
| Any history of alcohol abuse | 0 | ( 0) | 0 | ( 0) |
| Other hepatic symptoms | 0 | ( 0) | 0 | ( 0) |
| Persistent body odor | 1 | ( 2) | 0 | ( 0) |
| History of hyperlipidemia | 0 | ( 0) | 0 | ( 0) |
| History of cancer | 0 | ( 0) | 1 | ( 4) |

Table 9

Frequency Distribution of Baseline Physical Findings
Reported by Physician for Other Employees
According to Exposure Category

| PHYSICAL FINDINGS | EXPOSURE CATEGORY | | | |
|---|---|---|---|---|
| | Group I/II (N=41) | | Group III (N=28) | |
| | # | (%) | # | (%) |
| Erythema | 5 | (12) | 1 | ( 4) |
| Rash | 9 | (22) | 7 | (30) |
| Chloracne | 0 | ( 0) | 1* | ( 4) |
| Hyperpigmentation | 2 | ( 5) | 1 | ( 4) |
| Thickening | 3 | ( 7) | 6 | (26) |
| Nail discoloration | 4 | (10) | 0 | ( 0) |
| Other dermatologic findings | 19 | (46) | 4 | (17) |
| Conjunctival Infection | 2 | ( 5) | 2 | ( 9) |
| Eye discharge | 0 | ( 0) | 0 | ( 0) |
| Swelling of lids | 1 | ( 2) | 1 | ( 4) |
| Jaundice | 0 | ( 0) | 0 | ( 0) |
| Hepatomegaly | 0 | ( 0) | 0 | ( 0) |
| Other hepatic findings | 0 | ( 0) | 0 | ( 0) |

*This case was not confirmed by histological diagnosis or by a dermatologist.

Table 10a

Plasma PCB Levels by Exposure Category
for Allwash Employees

| Plasma PCB Level (Lab=PCL) | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 5.85 (62) | 5.19 (27) | 5.09 (33) |
| Last Exam Mean (N) | 5.44 (41) | 5.00 (19) | 5.12 (33) |
| Mean Difference | - 0.29 | - 0.26 | 0.03 |

Table 10b

Plasma PCB Levels by Exposure Category
for Other Employees

| Plasma PCB Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 6.64 (33) | 5.75 (8) | 4.96 (23) |
| Last Exam Mean (N) | 5.97 (29) | 5.25 (8) | 5.43 (23) |
| Mean Difference | - 0.90 | - 0.50 | 0.48 |

*$p < 0.05$
**$p < 0.01$

†Analysis of Variance $p < .05$
††Wilcoxon $p < .05$

Table 11a

Plasma PCB Levels by Exposure Category
for Allwash Employees

| Plasma PCB Level (Lab=BRL) | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 5.09 (64) | 4.19 (27) | 4.30 (33) |
| Last Exam Mean (N) | 4.83 (46) † | 3.44 (18) † | 4.24 (33) † |
| Mean Difference | -0.73 | -0.94 | -0.06 |

Table 11b

Plasma PCB Levels by Exposure Category
for Other Employees

| Plasma PCB Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 6.52 (33) | 5.25 (8) | 5.36 (22) |
| Last Exam Mean (N) | 5.62 (29) | 4.50 (8) | 4.57 (23) |
| Mean Difference | -1.48 | -0.75 | -0.86 |

*$p < 0.05$
**$p < 0.01$

† Analysis of Variance $p < .05$
†† Wilcoxon $p < .05$

Table 12a

SGOT Levels by Exposure Category
for Allwash Employees

| SGOT Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 27.62 (67) | 26.78 (27) | 25.39 (33) |
| Last Exam Mean (N) | 26.94 (67) | 24.67 (27) | 27.03 (33) |
| Mean Difference | -0.68 | -2.11 | 1.64 |

Table 12b

SGOT Levels by Exposure Category
for Other Employees

| SGOT Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 23.33 (33) | 21.44 (8) | 23.46 (23) |
| Last Exam Mean (N) | 25.18 (33) | 22.00 (8) | 27.26 (23) |
| Mean Difference | 1.85 | 0.56 | 3.80 |

*$p < 0.05$
**$p < 0.01$

† Analysis of Variance $p < .05$
†† Wilcoxon $p < .05$

Table 13a

SGPT Levels by Exposure Category
for Allwash Employees

| SGPT Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 26.33 (66) | 24.56 (27) | 19.39 (33) |
| Last Exam Mean (N) | 26.66 (67) | 21.56 (27) | 22.09 (33) |
| Mean Difference | 0.42 | -3.00 | 2.70 |

Table 13b

SGPT Levels by Exposure Category
for Other Employees

| SGPT Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 27.96 (33) | 19.31 (8) | 21.55 (23) |
| Last Exam Mean (N) | 24.67 (33) | 20.50 (8) | 22.70 (23) |
| Mean Difference | -3.29 | 1.19 | 1.14 |

*$p < 0.05$
**$p < 0.01$

†Analysis of Variance $p < .05$
††Wilcoxon $p < .05$

Table 14a

GGTP Levels by Exposure Category
for Allwash Employees

| GGTP Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 27.47 (61) | 33.38 (26) | 33.70 (30) |
| Last Exam Mean (N) | 31.15 (67)†† | 27.89 (27)†† | 20.48 (33)†† |
| Mean Difference | 4.20 | -5.88* | -12.83* |

Table 14b

GGTP Levels by Exposure Category
for Other Employees

| GGTP Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 25.88 (32) | 17.30 (8) | 26.53 (20) |
| Last Exam Mean (N) | 22.30 (33) | 19.00 (8) | 16.87 (23) |
| Mean Difference | -3.50 | 1.70 | -9.53** |

*$p < 0.05$
**$p < 0.01$

†Analysis of Variance $p < .05$
††Wilcoxon $p < .05$

Table 15a

Triglyceride Levels by Exposure Category
for Allwash Employees

| Triglyceride Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 122.19 (67) | 104.63 (27) | 153.33 (33) |
| Last Exam Mean (N) | 116.91 (32) | 73.29 ( 7) | 153.27 (15) |
| Mean Difference | 14.03 | -15.14 | 19.20 |

Table 15b

Triglyceride Levels by Exposure Category
for Other Employees

| Triglyceride Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 113.27 (33) | 75.88 (8) | 131.57 (23) |
| Last Exam Mean (N) | 109.13 ( 8) | 57.50 (4) | 113.17 ( 6) |
| Mean Difference | -14.50 | -16.25 | -2.50 |

*$p < 0.05$
**$p < 0.01$

†Analysis of Variance $p < .05$
††Wilcoxon $p < .05$

Table 16a

Cholesterol Levels by Exposure Category
for Allwash Employees

| Cholesterol Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 190.57 (67) | 172.89 (27) | 193.00 (33) |
| Last Exam Mean (N) | 179.03 (32) | 165.14 (7) | 189.35 (17) |
| Mean Difference | -9.44* | -15.00 | -7.12 |

Table 16b

Cholesterol Levels by Exposure Category
for Other Employees

| Cholesterol Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 218.82 (33) | 199.75 (8) | 207.30 (23) |
| Last Exam Mean (N) | 199.50 ( 8) | 200.00 (4) | 201.17 ( 6) |
| Mean Difference | -6.75 | 15.00 | -9.33 |

*$p < 0.05$
**$p < 0.01$

† Analysis of Variance $p < .05$
†† Wilcoxon $p < .05$

Table 17a

HDL Levels by Exposure Category
for Allwash Employees

| HDL Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 49.10 (67) | 51.04 (27) | 50.76 (33) |
| Last Exam Mean (N) | 49.22 (32) | 51.14 ( 7) | 64.82 (17) |
| Mean Difference | -1.88 | -5.43 | 14.41 |

Table 17b

HDL Levels by Exposure Category
for Other Employees

| HDL Level | Exposure Category | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| Entrance Exam Mean (N) | 47.54 (33) | 54.50 (8) | 51.46 (23) |
| Last Exam Mean (N) | 48.75 ( 8) | 55.25 (4) | 47.17 ( 6) |
| Mean Difference | 0.54 | 2.50 | -1.67 |

*p < 0.05
**p < 0.01

†Analysis of Variance p <.05
††Wilcoxon p <.05

Table 18a
Summary of Regression Analysis for
Allwash Employees

| Parameter | Sample Size | Intercept | Slope |
|---|---|---|---|
| PCB (PCL lab) | 92 | 5.33 | -0.0001 |
| PCB (BRL lab) | 96 | 4.56 | -0.0002 |
| SGOT | 126 | 26.29 | 0.0003 |
| SGPT | 126 | 24.77 | -0.0006 |
| GGTP | 126 | 31.39 | -0.0054 |

Table 18b
Summary of Regression Analysis for
Other Employees

| Parameter | Sample Size | Intercept | Slope |
|---|---|---|---|
| PCB (PCL lab) | 59 | 5.88 | -0.0003 |
| PCB (BRL lab) | 59 | 5.55 | -0.0006 |
| SGOT | 63 | 23.99 | 0.0021 |
| SGPT | 63 | 23.03 | 0.0005 |
| GGTP | 63 | 22.25 | -0.0031* |

*$p < .05$

Table 19
Summary of Statistically Significant Results ($p < .05$)

| Name of Test | Subset and Parameter | Sample Size | p Value |
|---|---|---|---|
| Paired t-test | Allwash, Group I, Cholesterol | 32 | .0483 |
| | Allwash, Group II, GGTP | 26 | .0230 |
| | Allwash, Group III, GGTP | 30 | .0133 |
| | Others, Group I/II, PCB (BRL) | 37 | .0374 |
| | Others, Group III GGTP | 20 | .0001 |
| Analysis of Variance | Allwash, PCB (BRL) | 97 | .0257 |
| Wilcoxon Rank Sum | Allwash, GGTP | 127 | .0333 |
| Regression | Others, GGTP | 63 | .0424 |

Table 20

Frequency Distribution of Symptoms Reported by
Allwash Employees on Medical Incident Reports*
According to Exposure Category

| SYMPTOMS | EXPOSURE CATEGORY | | | | | |
|---|---|---|---|---|---|---|
| | Group I | | Group II | | Group III | |
| | # | (**) | # | (**) | # | (**) |
| Dermatological: | | | | | | |
| skin irritation/itching | 0 | ( 0) | 1 | (.002) | 2 | (.001) |
| acne/rash | 1 | (.005) | 0 | ( 0) | 2 | (.001) |
| Ophthalmological: | | | | | | |
| eye irritation/burning | 2 | (.011) | 3 | (.005) | 9 | (.005) |
| Respiratory: | | | | | | |
| dyspnea | 0 | ( 0) | 1 | (.002) | 3 | (.002) |
| chest pain | 0 | ( 0) | 1 | (.002) | 3 | (.002) |
| congestion | 0 | ( 0) | 0 | ( 0) | 4 | (.002) |
| sore throat | 0 | ( 0) | 0 | ( 0) | 3 | (.002) |
| Musculoskeletal: | | | | | | |
| lacerations/abrasions | 2 | (.011) | 3 | (.005) | 4 | (.002) |
| blunt trauma/bruises and minor accidents | 9 | (.049) | 0 | ( 0) | 33 | (.019) |
| musculoskeletal pain | 0 | ( 0) | 0 | ( 0) | 25 | (.014) |
| Other: | | | | | | |
| dizziness/lightheadedness | 1 | (.005) | 3 | (.005) | 9 | (.005) |
| nausea/vomiting | 6 | (.033) | 6 | (.009) | 35 | (.020) |
| abdominal pain | 2 | (.011) | 2 | (.003) | 1 | (.001) |
| heat stress/diaphoresis | 3 | (.016) | 3 | (.005) | 5 | (.003) |
| headache | 1 | (.005) | 4 | (.006) | 14 | (.008) |
| palpitations | 0 | ( 0) | 0 | ( 0) | 2 | (.001) |

*More than one report may be included for the same individual.

**Number of reports divided by average number of hours in BSOB for each group: I=184, II=634, III=1757.

Table 21

Frequency Distribution of Sources of Equipment Failure Reported by Allwash Employees on Exposure Incident Forms* According to Exposure Category

| TYPE OF EQUIPMENT FAILURE | EXPOSURE CATEGORY | | | | | |
|---|---|---|---|---|---|---|
| | Group I | | Group II | | Group III | |
| | # | (**) | # | (**) | # | (**) |
| Tear in Tyvek Suit with Little Likelihood of Skin Contact | 17 | (.092) | 30 | (.047) | 74 | (.042) |
| Dampening or Soiling of Tyvek Suit with No Break in Seal | 11 | (.060) | 15 | (.024) | 70 | (.040) |
| Tear in Tyvek Suit with Evidence of Skin Contact | 6 | (.033) | 12 | (.019) | 26 | (.015) |
| Tear in Outer Layer of Glove | 18 | (.098) | 48 | (.076) | 128 | (.073) |
| Tear in Glove With Evidence of Skin Contact | 6 | (.033) | 12 | (.019) | 22 | (.013) |
| Malfunction of Respirator (i.e., loss of seal) | 16 | (.087) | 25 | (.039) | 60 | (.034) |
| Accidental or Deliberate Removal of Respirator | 10 | (.054) | 19 | (.030) | 26 | (.015) |
| Reported Safety Violation with No Potential for Direct Contact | 1 | (.005) | 0 | ( 0) | 1 | (.001) |

*More than one report may be included for the same individual.

**Number of reports divided by average number of hours in BSOB for each group: I=184, II=634, III=1757.

Table 22a

Distribution of Allwash Employees Filing
Exposure Incident Reports According to Exposure Category

| Number of Exposure Reports Filed | Number of Allwash Employees | | |
|---|---|---|---|
| | Group I | Group II | Group III |
| 0 - 5 | 60 | 15 | 5 |
| 6 - 10 | 6 | 10 | 11 |
| 11 - 30 | 1 | 3 | 19 |

Table 22b

Relationship Between PCB Blood Levels*
and Frequency of Exposure Incident Reports Filed
by Allwash Employees

| Frequency of Reported Potential Contact | PCB Blood Level (ppb) | | |
|---|---|---|---|
| | ND - 5 | 6 - 10 | 10 - 16 |
| Rarely (0 - 5) | 39 | 18 | 1 |
| Occasionally (6 - 10) | 12 | 9 | 0 |
| Frequently (11 - 30) | 17 | 4 | 0 |

*PCB blood levels are the highest values reported by either laboratory at the time of exit exam or most recent interval exam.

Table 23

Summary of PCB Blood Levels and Liver Function Tests
for those Individuals Filing More Than Twenty Exposure Incident Reports

| ID # | # of Hrs. in BSOB | ALK. PHOS. | BILI | SGOT | SGPT | GGTP | PCB (PCL) | PCB (BRL) |
|---|---|---|---|---|---|---|---|---|
| 3097 | 2157 | 44 | 1.1 | 22 | 18 | 25 | - | 6 |
| 3145 | 759 | 72 | 0.5 | 23 | 15 | 16 | 5 | 4 |
| 3159 | 2726 | 42 | 0.6 | 33 | 39 | 12 | - | 3 |
| 3217 | 1912 | 44 | 0.7 | 22 | 18 | 12 | - | - |
| 3269 | 1349 | 49 | 0.4 | 21 | 15 | 9 | - | 3 |
| 3289 | 1574 | 46 | 0.7 | 20 | 9 | 11 | - | 3 |

Appendix A
Normal Ranges for Selected Biochemical Parameters

| Parameter | Bionetics | Wilson | Lourdes | PCL | BRL |
|---|---|---|---|---|---|
| PCB (ppb) | N/A | N/A | N/A | 0-20 | 0-30 |
| SGOT (IU/l) | 7-46 | 8-36 | 8-44 | N/A | N/A |
| SGPT (IU/l) | 0-50 | 2-32 | 3-38 | N/A | N/A |
| GGTP (IU/l) | 8-37 | 0-42 | 15-85 | N/A | N/A |
| Triglycerides (mg/dl) | 10-150 | 47-180 | 20-200 | N/A | N/A |
| Cholesterol (mg/dl) | 120-200 | 150-250 | 150-250 | N/A | N/A |
| HDL cholesterol (mg/dl) | 30-65 | - | 25-58 | N/A | N/A |