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Office of Toxic Substances
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Attn: Section 8(e) Coordinator (CAP Agreement)

Subject: 8ECAP-0024

Dear Section 8(e) Coordinator:

Enclosed are the original and two copies of an epidemiology study CIBA-GEIGY Corporation is submitting pursuant to the TSCA Section 8(e) Compliance Audit Program and CAP Agreement number 8E CAP-0024. The information being submitted is not considered Confidential Business Information.

We are submitting the following information, as required by the CAP Agreement:

Company Name, Address and Telephone No.:

CIBA-GEIGY Corporation
Attn.: Mr. Anthony Di Battista
Toxicology, Regulatory Auditing and Compliance Dept.
444 Saw Mill River Road
Ardsley, New York 10502-2699

Tel. No. 914-479-2776

Tested Chemicals and CAS Registry Nos. (where known):

a) Azo dyes (CAS No. not relevant since it is a generic category)
b) Anthraquinone dye manufacturing area (CAS No.84-65-1 for Anthraquinone itself)
c) Chlorine: CAS No. 7782-50-5
d) Epichlorohydrin: CAS No. 106-89-8

Title: A Case-Control Study of Lung Cancer and Central Nervous System Neoplasms Among Chemical Workers, June 1, 1990. (Elizabeth Delzell, et al; University of Alabama at Birmingham).

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Summary (cont.) Interpretation of the results of this study is further complicated by the fact that subjects tended to have worked in several different areas and did not have "pure" exposures. Also, it was not possible to identify specific chemicals responsible for increased risks found for certain work areas because work in each area entailed potential exposure to many substances.

Category: Unit II.B.2.a.

Prior Reporting: Not Applicable

Please call the undersigned at telephone number (914) 479-4288 if you have any questions about this submittal.

Very truly yours,

Karen Fassuliotis, PhD.

Karen Fassuliotis, Ph.D.
Manager, Toxicology
Toxicology, Regulatory Auditing & Compliance

Enclosure: (Two additional copies of this letter and three copies of the submitted study)

cc: A. Di Battista (with cover page of enclosure)

TM - None

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A CASE-CONTROL STUDY OF LUNG CANCER AND CENTRAL NERVOUS SYSTEM NEOPLASMS AMONG CHEMICAL WORKERS

Submitted to

Ciba-Geigy Corporation

by

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June 1, 1990

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CONTENTS

Summary: This was a follow-up case control study to a larger epidemiologic study of employees of our Toms River Plant in New Jersey. The larger study, which was published March 1989, in the Journal of Occupational Medicine, was submitted to Lee Thomas of EPA, inter alia, on June 18, 1987 and assigned Document Control No. FYI-AX-0787-0558. On March 29, 1990 a draft summary of the enclosed submission was sent to the EPA FYI Coordinator under the above cited FYI Document Control number. The report of the case control study itself, however, was not submitted to EPA. To the best of our knowledge, this information first became reportable January 15, 1990, which is the date of an earlier draft.

The case-control study evaluated the relation between lung cancer and central nervous system neoplasms (CNSN) and occupational factors among employees at the plant. No industrial hygiene information was used in chemical exposure estimations. Rather, work histories, medical records and interviews with long-term employees were used to characterize potential occupational exposures. The study included 51 lung cancer cases and 11 CNSN cases who were members of a cohort of workers investigated in the previous retrospective follow-up study. Two and four comparison subjects, or controls, were selected for each lung cancer and CNSN case, respectively.

The study demonstrated that smoking is the main cause of lung cancer among the employees studied.

The study also found an elevated odds ratio for lung cancer for subjects who worked in the anthraquinone (AQ) dye manufacturing area of the plant. There was no trend of increasing odds ratio with increasing length of employment in the AQ area.

An elevated odds ratio for lung cancer was also observed for employees who were acutely exposed to chlorine, however, the results are based on a small population (6 exposed cases and 3 exposed controls), so chance or other confounders cannot be ruled out.

The study also identifies several elevated odds ratios for CNSN in analyses which included an evaluation of the azo dye manufacturing area (5 cases) and potential exposure to epichlorohydrin (4 cases). However, all of the analyses done for CNSN are based on small numbers of subjects, and the results are, therefore, quite imprecise.

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SUMMARY

This case-control study evaluated the relation between lung cancer and central nervous system neoplasms (CNSN) and occupational factors among employees at a dye and resin manufacturing plant. The study included 51 lung cancer cases and 11 CNSN cases who were members of a cohort of workers investigated in a previous retrospective follow-up study. Two and four comparison subjects, or controls, were selected for each lung cancer and CNSN case, respectively, from among cohort members who had the same year of birth as the matching case and who were alive on the date of death or diagnosis of the case. Information on area of employment and on potential exposure to certain chemicals was obtained from plant personnel and medical records and from interviews with long-term employees. No industrial hygiene data were used in chemical exposure estimation. Information on potential confounders, including cigarette smoking, was obtained by interviewing study subjects or their next-of-kin. The odds ratio (OR) was used as the measure of association in analyses comparing the work or exposure histories of cases and controls.

Information on smoking was available for 43 (84%) of the lung cancer cases and for 82 (80%) of their 102 controls. In the group of subjects for whom this information was available, lung cancer occurred only among smokers. The OR for heavy smokers compared to light or nonsmokers was 5.9. This result was statistically significant at the 0.05 probability level, with a

95% confidence interval (CI) of 2.4 to 15.

An elevated OR for lung cancer was observed for subjects who worked in the anthraquinone (AQ) dye manufacturing area of the plant (OR = 2.4; 95% CI = 1.1-5.2), based on 21 of 51 cases compared to 24 of 102 controls employed in this area. There was no trend of increasing ORs with increasing length of employment in the AQ area, and there are no other published reports of a positive association between lung cancer and AQ, AQ intermediates or AQ dye production. A follow-up study of workers at another AQ dye plant found no excess of respiratory cancer, based on 64 observed and 66 expected deaths from this disease during a 25-year observation period.

An elevated OR for lung cancer also was observed for employees who were seen at the plant infirmary for acute exposure to chlorine (OR, adjusted for smoking = 27; 95% CI = 3.5-205). This result was based on 6 exposed cases and 3 exposed controls, and it may be due to chance or to confounding by an unidentified agent which is correlated with chlorine exposure. There are no other epidemiologic or toxicologic investigations which have reported an association between chlorine and lung cancer.

Several elevated ORs for CNSN were observed in analyses evaluating possible associations with work areas or chemical exposures. These analyses were based on small numbers of subjects, and the results were, therefore, quite imprecise.

Interpretation of the results of this study is complicated by the fact that subjects tended to have worked in several different areas and buildings and did not have "pure" exposures. Also, it was not possible to identify specific chemicals responsible for increased risks found for certain work areas, such as the AQ dye area, because work in each area entailed potential exposure to many substances. In addition, smoking information was unavailable for about 20% of lung cancer cases and controls. Because smoking is a strong determinant of lung cancer, it is possible that missing data on smoking resulted in incomplete control of confounding by this factor.

This report describes a case-control study of lung cancer and central nervous system neoplasms (CNSN) among employees of the Ciba-Geigy chemical plant in Toms River, New Jersey. The study is a further investigation of mortality patterns previously examined in a retrospective follow-up study, which was completed in 1987 (1).

BACKGROUND

The Toms River plant, which began operating in 1952, has three main production areas: (a) south dyes, where AQ dye intermediates and dyes were produced from 1952 to 1983; (b) north dyes, where azo dye intermediates and dyes were produced from 1959 to 1988; and (c) plastics and additives (P&A), where the production of epoxy resins, additives and other chemicals started in 1959 and has continued to the present. Other activities included: maintenance, waste treatment, energy operations, laboratories (research and development, analytical and quality control), warehouse facilities, engineering services and administration.

The follow-up study evaluated the mortality experience of 2,642 white men who had worked at the plant for at least six months between January 1, 1952, and January 1, 1985. The overall mortality rate of the cohort during the period of 1952 through 1985 was lower than the rate of men in the general United States population. The standardized mortality ratio for all cancer was 109 (95% CI = 89-132), and there were no statistically significant excesses of site-specific cancers in the overall cohort. However, increased numbers of deaths from several specific cancers were observed among subjects in certain work areas, including lung cancer among subjects in maintenance, epichlorohydrin production and P&A and CNSN among subjects in azo dye production.

The follow-up study did not evaluate possible confounding by variables such as smoking and exposures to lung carcinogens sustained outside of the Toms River plant. If subjects in the plant work areas associated with excesses of lung cancer were relatively heavy smokers or had experienced carcinogenic exposures at other workplaces, this could explain the excess. In addition, the study did not evaluate exposure to specific chemicals at the Toms River plant. Several substances which were used or produced at the plant, such as asbestos and epichlorohydrin, could have played a role in the etiology of lung cancer and CNSN.

The purpose of the case-control study was to examine further the relation between lung cancer and CNSN and occupational factors at the Toms River plant. The specific objectives were: (a) to assess the roles of work area assignments and chemical exposures at the plant, (b) to evaluate the importance of employment at other workplaces and (c) to determine if nonoccupational factors, which were not evaluated in the previous study, explained the observed excesses of lung cancer or CNSN.

METHODS

Case definition

The lung cancer cases are white men who were included in the follow-up study and who developed lung cancer before October 1, 1988. Cases include: (a) decedents with primary cancer of the trachea, bronchi or lungs mentioned on the death certificate and (b) active employees diagnosed as having a primary lung cancer. We did not attempt to obtain copies of the lung cancer cases' medical records. Investigations which have compared death certificates with medical records (2) or autopsy findings (3,4) have determined that lung cancer is recorded on death certificates with high specificity and sensitivity.

The CNSN cases are white men who met the criteria for inclusion in the follow-up study and who developed a CNSN before October 1, 1988. CNSN cases include: (a) decedents whose death certificate mentioned a neoplasm of the brain, the spinal cord, the cranial and spinal meninges or the roots of the cranial and spinal nerves and (b) employees diagnosed with a CNSN while still working at the plant.

Control selection

For each lung cancer case we selected two controls from among cohort members who had the same year of birth as the case and who were not known to have died before the date of death (or diagnosis) of the case. Employment status as of the date of diagnosis was an additional matching factor for controls selected for living lung cancer cases. When more than two subjects were eligible to serve as controls for a given case, two were chosen at random. In order to apply density sampling theory (5), each subject was eligible to be selected as a control for all cases with whom he "matched." For the same reason, a case was eligible to be selected as a control for another case until his death or diagnosis.

We selected four controls for each CNSN case using the matching criteria described above for the controls for lung cancer cases. When more than four subjects were eligible for matching as controls, four were chosen at random.

Data collection

Work histories

Information on employment at the plant was available from records collected for the previous study. In addition to demographic data, these records contain a chronologic listing of all job titles and of department and building assignments.

We used these data to classify subjects according to six broad work areas, including three production areas (P&A, south dyes and north dyes), laboratories, maintenance and services. The production areas have been described previously (1). "Services" comprises all departments not classified as production areas, laboratories or maintenance: i.e., administration, waste treatment, energy operations, warehouse facilities, engineering and security. The south dyes, north dyes and P&A categories include only those subjects with production-related duties in the areas; managers and clerks for the three areas are assigned to the services category, and laboratory workers for the three areas are assigned to the laboratories category.

We also classified subjects according to individual production buildings. A given "building" category includes all production, maintenance and laboratory workers assigned to duties related to chemical processes occurring in that building.

We interviewed active and retired long-term employees to determine if the areas and buildings included in each grouping are similar in terms of duties and production processes. In addition, long-term employees reviewed lists of study subjects whose personnel records indicated employment in a specific work area or building, in order: (a) to confirm the personnel record data; (b) to specify the subarea within the building where each subject had worked (see below); (c) to list his duties; and (d) to estimate an ordinally ranked category of potential contact with asbestos, epichlorohydrin, raw materials, intermediates and end products in each subarea. The categories varied from 0 (no potential contact) to 10 (maximum potential contact). We computed "cumulative potential exposure" for each subject by multiplying each category of potential contact experienced by the subject by the number of years worked in that category and by summing the resulting values over each category. No industrial hygiene data were used in chemical exposure estimation.

For subjects ever employed in building 108 of the P&A area, we asked senior employees to specify the subarea of building 108 in which each subject worked. This was done to determine if these subjects worked in the north wing, where only epoxy resins were produced, or in other areas of building 108, where additives and other chemicals were manufactured.

For subjects ever employed in maintenance or laboratories, we asked senior employees to specify the production building, if any, to which each person had been assigned or to which his duties were related. However, most of the maintenance employees with duties outside the central shop worked throughout the plant, without assignment to a specific building.

We developed a detailed work history file. This contains data from the personnel records, as well as information provided by the long-term employees.

Chemical use and production data

The plant has used hundreds of raw materials and has manufactured a large number of products. To document the types and amount of chemicals present in the various work areas, we attempted to identify all chemicals used or produced, by year and production building.

We reviewed, cross-checked and abstracted data from all available documents related to production statistics, from the opening of the plant until 1979. These records include: (a) "Annual Tariff Reports," which are available for the north and south dyes areas from 1952 to 1958 and from 1962 to 1979 and which contain names, codes and amount of production of intermediates and end products; (b) "formulas," which list names, codes, processes and building of production of intermediates and end products for the north and south dyes areas from 1952 to 1979; (c) "goes-into-lists," which are available for P&A and for the north and south dyes areas and which contain names, codes and buildings of use of raw materials for the years 1963, 1967, 1970, 1973 and 1977; (d) annual sales reports, which are available for P&A from 1960 to 1979 and which contain end product names, codes, amount and subarea of production in P&A.

Questionnaires and plant medical records

We obtained information on potential confounding variables by interviewing study subjects or their next-of-kin, using a structured questionnaire. We asked respondents about the subjects' smoking habits; about non-Toms River plant jobs held for at least six months; about employment in any of 26 occupations; about occupational exposure to any of 18 agents; and about history of certain medical conditions, including neoplasms, epilepsy, head trauma and radiation treatment. We completed the interviews between November 1, 1988, and March 15, 1989. Two project staff members conducted in-person interviews of subjects (or next-of-kin) residing in the Toms River area and telephone interviews of respondents residing in other locations. When the respondent was unable to be interviewed in person or by telephone

(N = 13), he or she was asked to complete a self-administered questionnaire.

We also abstracted plant medical records, available for all employees active after 1968, to obtain information on smoking, on cancer occurrence and on any exposure to chemicals which was reported by a subject to the plant infirmary. When information on smoking was available from both personal interviews and plant medical records, we retained the greater value for years of smoking and number of cigarettes smoked per day for analysis.

Using variables measuring years of smoking, average number of cigarettes per day and number of pack-years, we classified subjects as "light" or "heavy" smokers. Heavy smokers are subjects meeting any of the following criteria: (a) smoked as of the date of death or interview, (b) smoked an average of at least 20 cigarettes per day for 30 or more years, (c) smoked an unknown number of cigarettes per day for at least 30 years, (d) smoked an average of at least 20 cigarettes per day for an unknown number of years. Light smokers are all other smokers, including those who had smoked only pipes and/or cigars. In most analyses, light smokers are combined with nonsmokers.

We also classified subjects according to high-risk employment before and after working at the Toms River plant. Jobs and industries entailing a high lung cancer risk are specified on the basis of data from a recent report by the New Jersey State Department of Health (6). These jobs and industries are listed in Appendix A.

Data analysis

The main objective of the data analysis was to evaluate the relation between lung cancer and CNSN and work areas, buildings and/or potential exposure to specific agents, while adjusting for confounding variables. Specific chemicals of interest include asbestos and epichlorohydrin.

The measure of association in this study is the OR, which provides an estimate of the ratio of the disease rate among exposed subjects to the disease rate among unexposed subjects. For analyses comparing the work histories of lung cancer and CNSN cases with their individually matched controls, we used conditional logistic regression procedures to estimate ORs and 95% CIs. ORs and CIs are not computed for exposure categories containing fewer than 5 subjects.

We performed several additional analyses including: (a) trend analyses, (b) analyses allowing for "induction time" and (c) analyses of space-time clusters of excesses. The trend analyses evaluated disease risk as a function of duration of employment in specific work areas or buildings or as a function of cumulative potential exposure. Analyses allowing for "induction time" (defined as the time period between the starting date of potential exposure or employment and the date of the lung cancer or CNSN case's death or diagnosis) were performed using 10 and 20 years as cutpoints.

ORs were computed with and without adjustment for possible confounding variables. Factors evaluated as possible confounders include cigarette smoking, employment in jobs or industries other than at the Toms River plant and, for CNSN analyses only, history of head trauma, epilepsy and radiation treatment. Cigarette smoking was the only one of these factors which proved to be an actual confounder in certain analyses. If adjustment for cigarette smoking appreciably modified the direction or strength of an association, it was kept in the analysis. When information on exposures or on cigarette smoking was missing we included in the regression model one term which allowed estimation of the OR for the missing data category versus the unexposed category and one term which allowed estimation of the OR for each category of known exposure versus the unexposed (7). Unless otherwise specified the tables display conditional ORs, unadjusted for cigarette smoking.

We performed analyses using various definitions of cigarette smoking. Results were similar regardless of the definition used. Therefore, we present only the results obtained using cigarette smoking classified as "light" or "heavy."

Two-sided 95% CIs of the ORs are displayed throughout the tables. Results are considered statistically significant when the CI does not include the null value of 1.0.

RESULTS

Lung cancer

Forty-seven of the 51 lung cancer cases are deceased, and 4 are active employees. Cases range in age at death (or diagnosis) from 40 to 80 years, with a mean age of 61 years. The lung cancer deaths (or diagnoses) occurred over a 24-year period, from 1964 to 1987, with a median year of 1981.

Lung cancer cases and controls have similar year of birth, year of hire and duration of employment distributions (table 1). The two groups differ markedly with respect to vital status: 70% of the controls were alive on October 1, 1988, compared to 8% of the cases.

Table 2 describes the results of data collection among lung cancer cases and controls. All subjects have a complete work history. Plant medical records are available for 67% of lung cancer cases and 68% of the controls. Interviews were completed with 35 (69%) cases and 75 (74%) controls. Nonrespondents include 9 (18%) cases and 18 (18%) controls who could not be located and 7 (14%) cases and 9 (9%) controls who were located but who refused to participate.

All lung cancer cases with known smoking status were smokers (table 3). Two smoked only pipes and/or cigars, and the rest smoked cigarettes. Sixty-seven (66%) of the controls were cigarette smokers, 6 had smoked only pipes and/or cigars, and 9 never smoked.

The risk of lung cancer increases with years of cigarette smoking (test for trend: p=0.007) and is increased 6- to 7-fold among subjects who smoked for 30 or more years compared to subjects who smoked for fewer than 20 years (table 3). There is a positive trend (p=0.004) for the relation between lung cancer and the average number of cigarettes smoked per day, and smoking 20 or more cigarettes per day is associated with about a 10-fold increase in risk, when compared to smoking fewer than 10 cigarettes per day. There also is a consistent trend of increasing ORs with increasing pack-years of smoking (p=0.01). Heavy smoking, compared to light smoking, is strongly associated with lung cancer [33 (65%) of cases versus 29 (28%) of controls "exposed"; OR = 5.9; 95% CI = 2.4-15). Subjects with unknown smoking status have ORs which tend to be intermediate between the null value of 1.0 and the OR for highest level of smoking.

The distributions of lung cancer cases and controls by non-Toms River plant occupational history are similar (table 4). The OR for employment in jobs or industries considered to be associated with a high risk of lung cancer is 0.9 (95% CI = 0.4-2.1). No particular job preceding or subsequent to employment at the plant is strongly associated with lung cancer.

Table 5 displays the number of cases and controls ever employed in the major work areas, along with ORs and 95% CIs. Employment in the south dyes area is associated with an elevated OR of 2.4 (95% CI = 1.1-5.2), based on 21 cases versus 24 controls employed in the area. Subjects in the P&A area (7 cases and 11 controls) have a slightly elevated OR of 1.3 (95% CI = 0.5-3.4), and maintenance workers (23 cases and 38 controls) have an OR of 1.4 (95% CI = 0.7-2.8). Subjects employed in the north dyes area (6 cases and 14 controls) and in laboratories (10 cases and 24 controls) each have an OR of 0.8.

Tables B1 through B5 (Appendix B) present the distribution of subjects by duration of employment and years since first employment (induction period) for each of the work areas included in table 5. No statistically significant trend with duration of employment is present for any of the areas.

The elevated OR for the south dyes area is restricted to subjects with 10 or more years since beginning work in the area (OR, adjusted for smoking = 4.6; 95% CI = 0.9-23). In contrast, no specific induction period is identified for the other work areas.

Subjects who worked in maintenance for 10 or more years (12 cases and 15 controls) have an OR, unadjusted for smoking, of 1.8 (95% CI = 0.8-4.4), when compared to subjects never employed in maintenance. This OR decreases, however, to 1.4 (95% CI = 0.5-3.8) when it is adjusted for smoking.

Table 6 presents lung cancer ORs by building. The only buildings with a notably elevated OR are building 103 (8 cases and 6 controls; OR = 3.3; 95% CI = 1.0-11) and building 52/3 (AQ production) (6 cases and 1 control; OR = 12; 95% CI = 1.4-99). Three cases, compared to no controls, worked in building 54/5 (epichlorohydrin production) (p = 0.07).

Each of the buildings mentioned above is in the south dyes area, and the positive results for these buildings are not independent. When analyses are restricted to subjects with "pure" employment in only one of the buildings, the OR is 2.3 (95% CI = 0.6-8.7; 5 cases and 5 controls) for building 103, and there are 3 cases and no control remaining in building 52/3 (p = 0.07). No case or control remains in the group of workers employed in building 54/5. All of the cases who worked in buildings 103, 52/3 or 54/5 were either heavy smokers or had unknown smoking status.

Tables B6 through B14 (Appendix B) display the distribution of cases and controls by duration of employment and years since starting work in each of the buildings included in table 6. There are no pronounced trends for any building.

Table 7 presents data on subjects by maintenance work in, versus outside, the central maintenance shop. Compared to subjects never employed in maintenance, maintenance workers ever assigned to duties outside the central shop, except yard and janitorial duties, have an OR, unadjusted for smoking, of 2.5 (95% CI = 1.0-6.4; 13 cases and 12 controls) and an adjusted OR of 2.0 (95% CI = 0.7-5.6). Maintenance workers who always worked in the central shop or who held yard or janitorial duties have an adjusted OR of 0.9 (95% CI = 0.4-2.1; 10 cases and 26 controls).

Table 8 displays the distribution of subjects by maintenance job title. The two most frequently held titles are pipefitter (13 subjects) and janitor (29 subjects). A higher proportion of cases (12%) than of controls (7%) had worked as a pipefitter, whereas a similar proportion of cases (20%) and of controls (19%) worked as a janitor. Compared to subjects never employed as pipefitters, employees who held this job title for 5 or more years have an OR of 3.3 (95% CI = 0.8-14), based on 5 cases and 3 controls (Appendix B, table B15). All of the 6 pipefitter cases, compared to 3 of the 7 pipefitter controls, started working in this job 10 or more years before lung cancer occurred. Examination of the distribution of cases and controls by duration of employment and induction period in other maintenance jobs (tables B16 and B17) does not identify any high risk subgroup.

For subjects having potential contact with asbestos (20 cases and 29 controls) the smoking adjusted OR is 1.5 (95% CI = 0.6-3.5) (table 9). Lung cancer risk does not appear to be a function of induction period or of duration of potential asbestos exposure. However, the data suggest a direct relation with cumulative potential exposure level (test for trend: p=0.2).

All subjects having potential contact with asbestos were maintenance workers. Therefore, we were not able to determine if asbestos has an effect on lung cancer risk which is independent of employment in maintenance. Similarly, we attempted to determine if the increased ORs among all maintenance workers combined and among non-central shop maintenance workers were attributable to asbestos exposure. For maintenance workers having potential contact with asbestos (20 cases and 29 controls), compared to nonmaintenance workers, the OR is 1.6 (95%

CI = 0.8-3.2). For maintenance workers with no potential contact with asbestos (3 cases and 9 controls) the OR is 0.7 (95% CI = 0.2-2.9). All non-central shop maintenance workers had potential contact with asbestos.

Twelve lung cancer cases and 18 of their controls had potential contact with epichlorohydrin (OR = 1.7; 95% CI = 0.7-4.1) (table 10). However, the increased OR is restricted to subjects with short duration (OR = 2.3; 95% CI = 0.8-6.7) and with low cumulative potential exposure (OR = 2.7; 95% CI = 0.9-8.4), whereas employees with at least 10 years of potential exposure (OR = 0.7; 95% CI = 0.1-4.1) and those with the higher cumulative potential exposure level (OR = 0.7; 95% CI = 0.2-3.4) have no evidence of an elevated risk of lung cancer.

In order to identify space-time clusters of lung cancer cases, we performed analyses by work area and calendar year, by building and calendar year and by material and calendar year. ORs are elevated for certain time periods in the south dyes area and in maintenance. In particular, 4 cases and 1 control had worked in building 104 from 1954 through 1956 (OR = 8.0; 95% CI = 0.8-394); 4 cases and 1 control had worked in building 103 in 1960 (OR = 8.0; 95% CI = 0.8-394); and 4 cases and 1 control had worked in building 52/3 in 1960 (OR = 8.0; 95% CI = 0.8-394). One of the cases had worked both in building 104 in 1954-56 and in building 52/3 in 1960. All of these cases are classified as heavy smokers, with the exception of one man who worked in building 103 and who had an unknown smoking status. All of the respective controls are light smokers. Among subjects who had worked as pipefitters from 1966 through 1969 the OR is 5.0 (95% CI = 0.8-53), based on 5 cases and 2 controls.

Plant medical records indicate that subjects had visited the plant infirmary because of exposure to 48 different chemicals. The only one of these which was experienced more frequently by cases than by controls is exposure to chlorine (table 11). Six cases compared to 3 controls sought treatment because of contact with this chemical. The OR, unadjusted for smoking, is 5.7 (95% CI = 1.1-30), and the adjusted OR is 27 (95% CI = 3.5-205). The observed association reflects primarily the data for light smokers, among whom 3 of 6 cases, versus 3 of 40 controls, were exposed to chlorine.

We also classified subjects as having potential "routine" or "possible" exposure to chlorine. Routinely exposed subjects include those who visited the infirmary because of chlorine exposure or who worked in building subareas with known routine use of chlorine. Possibly exposed subjects worked in the same building but not in the same subarea where chlorine was used routinely, were maintenance workers employed throughout the plant or were laboratory workers. When compared to employees who never worked in areas with chlorine use, the routinely exposed group (8 cases and 6 controls) has an OR, unadjusted for smoking, of 4.3 (95% CI = 1.3-15) and an adjusted OR of 8.9 (95% CI = 2.0-40). The possibly exposed group (27 cases and 45 controls) has ORs unadjusted and adjusted for smoking of 2.0 (95% CI = 0.9-4.5) and

1.4 (95% CI = 0.5-3.5), respectively.

CNSN

We identified a total of 11 CNSN cases, three of whom are alive. The cases range in age at death (or diagnosis) from 40 to 82 years, with a median age of 54. The CNSN deaths (or diagnoses) occurred from 1971 to 1986, with a median year of 1979. Seven of the cases had a malignant brain tumor (astrocytoma or glioblastoma), 2 had a meningioma, and 2 had other types of benign CNSN.

Table 12 compares the distribution of CNSN cases and controls by year of birth, vital status, year of hire and duration of employment. The median year of birth of both CNSN cases and controls is 1929. The differences among the two groups with respect to year of hire and duration of employment are not remarkable, except that the proportion hired between 1960 and 1964 is larger for cases than for controls. Also, 86% of the controls, compared to 27% of the CNSN cases, are alive.

Interviews were completed for 8 (73%) of the CNSN cases and for 37 (84%) of their controls (table 13). This difference is due to the fact that a respondent could not be located for 27% of cases compared to 14% of controls.

Information on smoking is available for 8 of the cases and for all of the controls. Only 1 case had never smoked, and 1 had smoked only pipes and/or cigars. The ORs for years of cigarette smoking, average number of cigarettes per day and number of pack-

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years range between 0.6 and 1.5 and do not approach statistical significance. For example, the OR for heavy smoking versus light smoking is 1.2 (95% CI = 0.2-6.6).

Four CNSN cases and 4 controls worked before or subsequent to their Toms River plant employment in jobs which have been linked to an excess of CNSN (8,9). The OR for these jobs is 1.8 (95% CI = 0.4-8.7).

As shown in table 14, ORs for CNSN are elevated for production workers in the P&A area (3 cases and 4 controls; OR = 4.2; 95% CI = 0.7-26) and in the north dyes area (5 cases and 10 controls; OR = 3.6; 95% CI = 0.7-20). South dyes area employees (3 cases and 9 controls) have an OR of 1.5 (95% CI = 0.3-7.2), and laboratory workers (4 cases and 15 controls) have an OR of 1.1 (95% CI = 0.3-4.1).

Tables C1 through C5 (Appendix C) display the distribution of cases and controls by duration of employment and years since first employment in each of the work areas listed in table 14. All of the cases and controls in P&A have an interval from first employment of at least 10 years (table C1). All 3 of the cases, versus 4 of the 9 controls, in the south dyes area occurred in the subgroup with 20 or more years since first hire and with at least 5 years duration of employment (table C2). Four of the 5 cases and 9 of the 10 controls in the north dyes area have an interval from first employment of 10 or more years (table C3). The ORs for these subgroups are imprecise, with 95% CIs which include the null value of 1.0.

Table 15 displays data on CNSN cases and controls by building, including two subareas of building 108 (the north wing and "other" areas). Statistically significantly higher proportions of cases than of controls have a history of employment in the north wing of building 108 (3 cases and 1 control; p = 0.03) and in building 104 (3 cases and 0 controls; p = 0.02). The moderately elevated OR found among north dyes area employees is not restricted to any particular building. These results indicate that the elevated risks in the south dyes and P&A areas (table 14) are confined, respectively, to building 104 and to the north wing of building 108.

Tables C6 through C15 (Appendix C) provide data on cases and controls by duration of employment and years since starting work in specific buildings. All of the 3 CNSN cases who worked in building 104 have an interval from onset of employment of 20 or more years (table C10). Two of the cases worked in building 104 for at least 5 years, whereas the third case worked there for less than a year. There are no other trends with duration of employment or induction period.

Further analysis by building, subarea and calendar year demonstrate that the 3 CNSN cases who worked in the north wing of building 108 had duties related to that subarea in 1963 and 1964, versus no control. One case worked there from 1959 through 1973, 1 from 1961 through 1976, and 1 in 1963 and 1964. The 3 CNSN cases employed in building 104 worked there, respectively, from 1953 through 1959, from 1959 through 1965 and from 1964 to 1965.

Most of the increase in the north dyes area is confined to the years 1960 through 1967.

Four cases versus 7 controls had potential contact with epichlorohydrin (OR = 4.2; 95% CI = 0.7-26) (table 16). The results displayed in table 16 also suggest a direct association with duration of exposure (test for trend: p=0.11). In addition, the OR increases with cumulative potential exposure and reaches a value of 9.3 (95% CI = 0.8-109) for workers with a level of 50 or more cumulative exposure units, compared to workers never exposed. The p-value for the test for trend is 0.08.

Evaluation of exposures to chemicals reported to the plant infirmary shows that only epichlorohydrin is associated with CNSN, based on 3 cases and 1 control with such exposure (p = 0.02). Information related to medical record reports of exposure is missing for about 25% of the cases and the controls.

To determine if certain histologic types of CNSN are associated with work areas or possible chemical exposures, we evaluated malignant brain tumors, meningiomas and other benign CNSN separately. All 3 of the CNSN cases employed in building 104 had malignant tumors, whereas no control worked in that building. Four of the 5 CNSN cases employed in the north dyes area had malignant tumors (OR = 6.0; 95% CI = 0.6-59). One of the malignant brain tumor cases had worked both in building 104 and in the north dyes area. Therefore, 6 of the total of 7 cases with malignant brain tumors worked in building 104 and/or in the north dyes area. The seventh case worked in a laboratory of the south dyes area.

Both of the meningioma cases versus 3 of their 8 controls had potential contact with epichlorohydrin. Also, both cases versus 2 controls had more than 10 years of exposure and had a cumulative potential exposure level in the highest category. The same two meningioma cases had been seen at the plant infirmary because of exposure to epichlorohydrin. No specific pattern of exposure is evident for the remaining two benign CNSN cases.

Table 17 summarizes the results described above. Cases' and controls' distribution by employment in the north wing of building 108 and in buildings 104, 305/6 and 307 and their distribution by routine and acute exposure to epichlorohydrin are displayed.

DISCUSSION

The major methodologic strengths of this study derive from the subject selection procedures and from the objectivity of available data on work history and on certain potential confounders. First, we included all known lung cancer and CNSN cases, and we selected a series of controls randomly from among cohort members who were the same age as cases and who were under observation but disease-free at the time of cases' diagnosis (or death). These procedures for choosing subjects should minimize selection bias and confounding by age and calendar time. Second, we obtained information on Toms River plant work history and on acute exposures experienced by the subject at the plant from personnel records and from plant medical records. The fact that these records were established before disease occurrence reduces the possibility of information bias. Medical records were unavailable for about 30% of the study subjects. However, the proportion of subjects with missing medical data was similar for cases and controls. Therefore, it is unlikely that the missing information could have biased the study results. Third, we attempted to control for confounding by cigarette smoking, the major determinant of lung cancer. Although this effort may not have been completely successful, as discussed later, the inclusion of data on subjects' smoking habits strengthens inferences which can be made about the results.

The study also has several limitations which should be considered. We were not able to interview all study subjects or their next-of-kin, and we completed interviews for a slightly higher proportion of controls than cases. As a result, we do not have any smoking information for about 20% of cases and controls, and more cases than controls have smoking information based on medical records (25% versus 17%). Furthermore, interviews were conducted with next-of-kin for about 90% of cases and 30% of controls. For subjects who had both interviews and medical records, information on smoking was similar for the two sources. Also, analyses which stratified for the type of person interviewed produced results similar to those already presented. However, because smoking is a strong determinant of lung cancer and is the most important potential confounder in this study, it is possible that missing data on smoking has resulted in incomplete control of confounding by this factor.

Another limitation relates to study size, which was rather small overall, particularly for CNSN. Precision was decreased further in analyses which required control for smoking and for missing data, and we evaluated many hypotheses. Therefore, it is likely that some of the positive results are due to chance.

The goal of identifying independent associations remained an unsolved problem. Production workers tended to have been employed in several different areas and buildings at the plant and, therefore, did not have "pure" exposures. It was not possible to identify specific chemicals responsible for increased risks found for certain work areas, because work in each area entailed potential exposure to many substances.

Finally, our estimates of individual subjects' exposure to specific chemicals, such as asbestos and epichlorhydrin, probably are inaccurate because they are not based on actual exposure measurements. There is no reason, however, to suspect any systematic bias in the assignment of subjects to various chemical exposure categories. Random misclassification would lead to underestimation of effects and could not account for the positive associations found in this study. These limitations and other issues are discussed further, in the context of specific results for lung cancer and CNSN.

Lung cancer

The previous RFS of subjects employed at the Toms River plant found a larger than expected number of lung cancer deaths among subjects employed in maintenance for at least 10 years. The explanation for the observed increase is unclear, but possible reasons were thought to include confounding by cigarette smoking or exposure to asbestos, which may have been sustained in maintenance jobs (10).

The case-control study also identifies elevated ORs for some subgroups of maintenance workers. Specifically, men who worked in maintenance for at least 10 years have an 80% increase in the risk of lung cancer. However, this is reduced to a 40% increase after controlling for cigarette smoking. In exploring further the relation with maintenance work, we noted that the increased risk is restricted to subjects who had potential contact with asbestos and that pipefitters have an elevated OR for lung cancer. All subjects in the latter subgroup had potential contact with asbestos. In the aggregate, these results suggest that the increased risk of lung cancer among maintenance workers at the plant is attributable in part to confounding by cigarette smoking and in part to occupational exposure to asbestos or other unidentified agents correlated with exposure to asbestos.

Lung cancer has been found in some studies to be associated with exposure to welding fumes (6,11,12). Anecdotal reports of high levels of welding fumes in the central maintenance shop at the plant prompted us to evaluate the relation between lung cancer and employment in that area. We found no such association. The overall increased risk of lung cancer among maintenance workers was restricted entirely to men who had worked outside the central shop, all of whom had potential contact with asbestos.

We identified a 2.5-fold increased risk of lung cancer among subjects employed in the south dyes area. The increase is concentrated among subjects employed in building 103, 52/3 (AQ production) and 54/5 (epichlorohydrin production) in certain years; it is not confounded by smoking; and it does not appear to be attributable to epichlorohydrin exposure, since we found no suggestion of a causal relationship between lung cancer and this chemical. Rather, it is more likely that the increased risk of lung cancer in the south dyes area is due to chance or, if causal, to exposures related to the production of AQ intermediates and dyes during the late 1950s and early 1960s. There are no previous reports of a positive association between lung cancer and AQ, AQ intermediates and AQ dyes production. An epidemiologic study of 1,975 workers at an AQ dyestuffs manufacturing plant in Scotland found a respiratory cancer SMR of 97, based on 64 observed and 66 expected deaths from this cause during the follow-up period of 1956 to mid 1980 (13). Because of the lack of supporting evidence from other epidemiologic investigations, the increased OR seen in the present study should not be interpreted as a causal association.

It is possible that the positive association observed for workers in the epichlorohydrin production building, if not due to chance, is related to exposure to raw materials used there (i.e., chlorine and allyl chloride) or to exposures encountered in other buildings of the south dyes area. Table D1 (Appendix D) lists the end products manufactured in buildings 102, 103 and 104 before 1961. Building 52/3 produced AQ from the oxidation of anthracene with vanadium pentoxide, starting in 1957 and continuing through 1980. Building 54/5 produced epichlorohydrin from 1961 through 1965, using a process consisting of hypochlorination of allyl chloride, neutralization with lime and dehydrochlorination of dichlorohydrin into epichlorohydrin.

The lung cancer OR for reported exposure to chlorine was markedly elevated. Four of the six cases with this exposure worked in the south dyes area (two in building 102, one in building 104 and one in building 54/5 (epichlorohydrin production)). The other two were maintenance workers (one electrician and one machinist). Two of the three exposed controls worked in building 104, and one worked in a warehouse. All but one of the exposed cases had the following characteristics: (a) they started working in the area (duty, for maintenance workers) where the acute exposures took place before 1965, (b) they worked there for at least 5 years and (c) the time period from starting employment to cancer occurrence was at least 10 years.

Chlorine was used at the plant in epichlorohydrin production between 1961 and 1965 and in AQ intermediates production in buildings 102 and 104 from 1952 through 1983. Small quantities of chlorine also were used in the north dyes area between 1963 and 1970 and in laboratories, but none of the study subjects was known to have been acutely exposed to chlorine except in the south dyes area. Table D2 lists the AQ products which were manufactured using chlorine as a raw material in 1963, 1967 and 1970, respectively. Most of these products also are listed in table D1 among the products possibly related to the excesses found in the south dyes area.

The observed association between lung cancer and chlorine is based on small numbers, and it may be due to chance or to confounding by other unidentified exposures correlated with chlorine use. Several studies have reported that acute exposure to chlorine produces short term lung tissue damage (14-17). Follow up of subjects involved in war-time use of chlorine, as well as of persons exposed in transportation and industrial accidents, has demonstrated, however, that pulmonary function is gradually restored after acute exposure. There are no previous reports of a positive association between acute or chronic chlorine exposure and cancer in humans. A recent study of lung cancer among chemical workers showed that the frequency of exposure to chlorine was almost identical for cases and controls (18). We are not aware of any published investigaton of the carcinogenicity of chlorine in laboratory animals. A toxicology study has shown that rats exposed to low doses of chlorine for six weeks had moderate inflammatory reactions around the respiratory bronchioles and alveolar ducts and hyperplasia and hypertrophy of epithelial cells of the respiratory bronchioles, alveolar ducts and alveoli (19). In a similar study, monkeys were less sensitive than rats to chlorine toxicity (20).

CNSN

The RFS of Toms River plant employees reported an association between CNSN and work in the north dyes area. The present study also finds this result and suggests that the increased risk is restricted to malignant brain tumors.

The north dyes area produced azo intermediates and dyes. Building 307 prepared intermediates for the diazotization reactions, coupling agents and some nonazo dyes based on copper phthalocyanine. Building 305/6 synthesized azo dyes by means of diazotization and coupling reactions, phosgenations, nitrosations and alkylations. Building 301 standardized azo dyes by mixing, milling and drying.

Because all malignant brain tumor cases among north dyes employees worked in the area during the 1960s, we examined the raw materials, intermediates and end products which were used and produced in the different buildings during that period of time. For brevity, we display in tables E1 to E3 (Appendix E) the intermediates and end products which were produced in the north dyes area in 1963. It is not possible to determine which among the hundreds of chemicals might be responsible for the excess of malignant brain tumors, if the excess is, in fact, due to an occupational exposure. A total of 94 chemicals were used in the north dyes area and in no other areas in 1963 (table E4).

It has been reported that systemic administration of azo, azoxy and hydrazo compounds induces nervous system tumors among experimental animals (21). This observation supports the association seen in the present study. It also has been suggested that N-nitrosamines cause CNSN in man, since these compounds cause CNSN and other types of cancer in experimental animals (22). Low levels of N-nitrosamines have been found in an azo production area studied at another plant (23). However, the presence of N-nitrosamines in the north (azo) dyes area at the Toms River Plant has not been demonstrated.

Reasons for the apparent association between malignant brain tumors and work in the north dyes area, other than the presence of a causal exposure, must be considered. Chance remains a possible explanation, because this result is based on small numbers.

We also found that more malignant brain tumor cases than controls had been employed as production workers in building 104 in the late 1950s and early 1960s. Again, this result is based on small numbers (3 exposed cases and no exposed controls). Also, all of the cases employed in building 104 had worked in several other areas at the plant. Therefore, it is difficult to determine if the results for this building and other areas are independent.

Building 104 manufactured AQ intermediates, including AQ sulfonates and amino-AQs, produced from AQ sulfonates and ammonia, with arsenic acid or m-nitrobenzene sulfonic acid as oxidants. Tables E5 and E6 display, respectively, the raw materials and the intermediates used and produced in building 104 in 1963. Thirty-two raw materials were used in building 104 and in no other area in 1963 (table E7).

In summary, six of the seven malignant brain tumors occurred among workers who were employed in the north dyes area or in building 104. A list of 19 raw materials used both in north dyes and in building 104 and in no other area in 1963 is displayed in table E8. Table E9 lists products which were manufactured both in building 104 and in the north dyes area.

We also identified an elevated OR for CNSN among employees who were assigned to duties related to the north wing of building 108. However, we did not find a positive trend with duration of employment. The overall excess is based on three cases who had worked in that subarea at least in 1963 and 1964. Two of the exposed cases had a malignant brain tumor, and one had a meningioma. The malignant brain tumor cases also had worked in other areas: in particular, one had worked in building 104, and one in the north dyes area and in other production and laboratory buildings. The meningioma case was a laboratory worker assigned to duties related to the north wing of building 108. He also had worked in one other unspecified laboratory in the south dyes area.

Finally, we found a relation between CNSN and cumulative potential exposure to epichlorohydrin, based on 4 CNSN cases with potential exposure to this chemical in the P&A area and in epichlorohydrin production. Analysis of different histologic types of CNSN showed that meningioma, in particular, was associated with long duration and high cumulative value of routine exposure to epichlorohydrin and, also, with medical record reports of epichlorohydrin exposure. However, the two meningioma cases were exposed to many other chemicals in addition to epichlorohydrin, related to the production of epoxy resins, additives, brighteners and other chemicals. Therefore, we cannot rule out the possibility that epichlorohydrin is only a marker of an unknown duty or chemical process in the P&A area.

The two meningioma cases worked in P&A from 1967 to 1979 and from 1961 to 1976, respectively. Table E10 lists the raw materials used in building 108 of P&A in 1967; table E11 lists the end products manufactured by P&A in the same year.

We are not aware of any other reports of an excess of meningioma or other GNSNs among workers exposed to epichlorohydrin. The evidence on the carcinogenicity of epichlorohydrin in humans is inconsistent and is limited to lung cancer (24,25). However, epichlorohydrin is a carcinogen in experimental animals (26).

In the present study, none of the ORs for epichlorohydrin achieved statistical significance, with the exception of the result for acute exposure. Therefore, chance remains a plausible explanation of the observed association.

Concluding remarks

This study demonstrates that smoking is the major cause of lung cancer among Toms River Plant employees. However, exposure to asbestos and to chlorine and employment in the south dyes area also are associated with this cancer, after adjustment for smoking.

The study also identifies several elevated ORs for CNSN in analyses evaluating work areas and chemical exposures. The analyses are based on small numbers of subjects, and the results are, therefore, quite imprecise. Moreover, there are no other epidemiologic or toxicologic data which would support a causal interpretation of the observed associations.

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Table 1

General characteristics of lung cancer cases and controls

	No. of subjects	
	Cases	Controls
Total	51 (100%)*	102 (100%)
Year of birth:		
<1910	15 (29)	31 (30)
1910-1919	14 (28)	28 (28)
1920-1929	16 (31)	31 (30)
1930+	6 (12)	12 (12)
Vital status:		
Alive	4 (8)	71 (70)
Deceased	47 (92)	31 (30)
Year of hire:		
<1960	26 (51)	57 (56)
1960-1964	14 (27)	30 (29)
1965+	11 (22)	15 (15)
Duration of employment (years):		
<10	21 (41)	45 (44)
10-19	17 (33)	29 (28)
20+	13 (26)	28 (28)

* Numbers in parentheses are per cents of total subjects.

Table 2

Records available for lung cancer cases and controls

	No. of subjects			
	Cases		Controls	
Total	51	(100%)	102	(100%)
Work history	51	(100)	102	(100)
Medical record	34	(67)	69	(68)
Interview	35	(69)	75	(74)

Table 3

Smoking history of lung cancer cases and controls

	No. of subjects: Cases	No. of subjects: Controls	OR*	95% CI
Total	51 (100%)	102 (100%)		
Smoking status:				
Never smoked	0 (0)	9 (9)	1.0	
Cigar and/or pipe only	2 (4)	6 (6)	ND§	
Cigarettes	41 (80)	67 (66)	∞	0.9 - ∞
Unknown	8 (16)	20 (20)	∞	0.1 - ∞
Years of cigarette smoking:				
<20	3 (6)	27 (26)	1.0	
20-29	2 (4)	13 (13)	1.0	0.1 - 7.1
30-39	13 (26)	13 (13)	6.1	1.6 - 23
40+	18 (35)	23 (23)	7.0	1.7 - 29
Unknown	15 (29)	26 (25)	4.7	1.2 - 18
Average no. of cigarettes/day:				
<10	2 (4)	26 (25)	1.0	
10-19	5 (10)	11 (11)	5.2	0.8 - 32
20-29	16 (31)	18 (18)	10	2.1 - 50
30+	19 (37)	23 (23)	9.1	1.9 - 42
Unknown	9 (18)	24 (23)	3.8	0.8 - 19
Pack years:				
<10	2 (4)	27 (26)	1.0	
10-29	3 (6)	13 (13)	3.0	0.4 - 20
30-59	19 (37)	20 (20)	9.3	2.0 - 44
60+	11 (22)	16 (16)	8.2	1.6 - 42
Unknown	16 (31)	26 (25)	6.8	1.5 - 32
Level of smoking:				
Light	10 (20)	53 (52)	1.0	
Heavy	33 (65)	29 (28)	5.9	2.4 - 15
Unknown	8 (16)	20 (20)	2.2	0.7 - 6.8

* Conditional odds ratio.
§ Not determined.

Table 4

Distribution of lung cancer cases and controls by occupational history other than at the Toms River plant

	No. of subjects			
	Cases	Controls	OR	95% CI
Total	51 (100%)	102 (100%)		
Job or industry at high risk for lung cancer:*				
No	21 (41)	44 (43)	1.0	
Yes	14 (28)	31 (30)	0.9	0.4 - 2.1
Unknown	16 (31)	27 (27)	1.2	0.6 - 2.6

* Jobs and industries at high risk for lung cancer were classified according to a recent report from the New Jersey State Department of Health (reference no. 6).

Table 5

Distribution of lung cancer cases and controls by work area

	No. of subjects			
	Cases	Controls	OR	95% CI
Total	51 (100%)	102 (100%)		
South dyes	21 (41)	24 (24)	2.4	1.1-5.2
Plastics & additives	7 (14)	11 (11)	1.3	0.5-3.4
North dyes	6 (12)	14 (14)	0.8	0.3-2.3
Laboratories	10 (20)	24 (24)	0.8	0.4-1.8
Maintenance	23 (45)	38 (37)	1.4	0.7-2.8

Table 6

Distribution of lung cancer cases and controls by building

		No. of subjects*					
		Cases		Controls		OR	95% CI
Total		51	(100%)	102	(100%)		
Building (work area)¶							
102	(SDA)	8	(16)	14	(14)	1.2	0.5- 2.9
103	(SDA)	8	(16)	6	(6)	3.3	1.0- 11
104	(SDA)	8	(16)	10	(10)	1.8	0.6- 5.1
52/3 (AQ)	(SDA)	6	(12)	1	(1)	12	1.4- 99
54/5 (EPI)	(SDA)	3	(6)	0	(0)		
108	(P&A)	11	(22)	19	(19)	1.2	0.5- 2.6
305/6	(NDA)	7	(14)	9	(9)	1.6	0.6- 4.5
307	(NDA)	7	(14)	7	(7)	2.0	0.7- 5.7
301	(NDA)	0	(0)	2	(2)		

* The subjects in each building include production, maintenance and laboratory workers assigned to duties related to that building.

¶ P&A = plastics and additives; SDA = south dyes area; NDA = north dyes area.

Table 7

Distribution of lung cancer cases and controls by maintenance work in versus outside the control maintenance shop

	No. of subjects					
	Cases		Controls		OR*	95% CI
Total	51	(100%)	102	(100%)		
Maintenance central shop	10	(20)	26	(25)	0.9	0.4 - 2.1
Outside central shop	13	(25)	12	(12)	2.0	0.7 - 5.6

* Conditional odds ratio adjusted for two levels of smoking (heavy vs. light). Nonmaintenance workers (28 cases/64 controls) are the reference group.

Table 8

Distribution of lung cancer cases and controls by maintenance job title

	No. of subjects			
	Cases		Controls	
Total subjects	51	(100%)	102	(100%)
Total in maintenance	23	(45)	38	(37)
Maintenance job title:				
Pipefitter	6	(12)	7	(7)
Boilermaker	0	(0)	1	(1)
Electrician	3	(6)	0	(0)
Machinist	3	(6)	2	(2)
Janitor	10	(20)	19	(19)
Instrument mechanic	0	(0)	1	(1)
Painter	2	(4)	1	(1)
Service mechanic	1	(2)	1	(1)
Maintenance engineer	0	(0)	1	(1)
Maintenance helper	1	(1)	0	(0)
Mason	0	(0)	1	(1)

* Unconditional odds ratio. Nonmaintenance workers (28 cases/64 controls) are the reference group.

Table 9

Distribution of lung cancer cases and controls by patterns of potential exposure to asbestos

	No. of subjects					
	Cases		Controls		OR*	95% CI
Total	51	(100%)	102	(100%)		
Potential exposure:						
No	31	(61)	73	(72)	1.0	
Yes	20	(39)	29	(28)	1.5	0.6-3.5
Years since first potential exposure:						
Never exposed	31	(61)	73	(72)	1.0	
<10	3	(6)	7	(7)	1.8	0.4-8.8
10-19	9	(18)	8	(8)	1.6	0.5-5.1
20+	8	(16)	14	(14)	1.4	0.5-4.1
Duration of potential exposure (yrs):						
Never exposed	31	(61)	73	(72)	1.0	
<5	9	(18)	14	(14)	1.6	0.6-4.6
5+	11	(22)	15	(15)	1.4	0.5-4.1
Cumulative potential exposure units:						
Never exposed	31	(61)	73	(72)	1.0	
<5	4	(8)	10	(10)	1.0	0.3-3.7
5-29	8	(16)	11	(11)	1.5	0.4-5.4
30+	8	(16)	8	(8)	2.3	0.6-8.2

* Conditional odds ratio adjusted for two levels of smoking (heavy vs. light or none).

Table 10

Distribution of lung cancer cases and controls by patterns of potential exposure to epichlorohydrin

	No. of subjects			
	Cases	Controls	OR*	95% CI
Total	51 (100%)	102 (100%)		
Potential exposure:				
No	39 (76)	84 (82)	1.0	
Yes	12 (24)	18 (18)	1.7	0.7-4.1
Duration of potential exposure (yrs):				
Never exposed	39 (76)	84 (82)	1.0	
<10	9 (18)	11 (11)	2.3	0.8-6.7
10+	3 (6)	7 (7)	0.7	0.1-4.1
Cumulative potential exposure units:				
Never exposed	39 (76)	84 (82)	1.0	
<50	8 (16)	9 (9)	2.7	0.9-8.4
50+	4 (8)	9 (9)	0.7	0.2-3.4

* Conditional odds ratio adjusted for two levels of smoking (heavy vs. light or none).

Table 11

Distribution of lung cancer cases and controls by reported exposure to chlorine

	No. of subjects			
	Cases	Controls	OR*	95% CI
Total	51 (100%)	102 (100%)		
Reported exposure to chlorine:				
No	28 (55)	66 (65)	1.0	
Yes	6 (12)	3 (3)	27	3.5-205
Unknown	17 (33)	33 (32)	1.7	0.7-4.4

* Conditional odds ratio adjusted for two levels of smoking (heavy vs. light or none).

*

Table 12

General characteristics of CNSN cases and controls

	No. of subjects	
	Cases	Controls
Total	11 (100%)	44 (100%)
Year of birth:		
<1910	1 (9)	4 (9)
1910-1919	2 (18)	8 (18)
1920-1929	3 (27)	12 (27)
1930+	5 (46)	20 (46)
Vital status:		
Alive	3 (27)	38 (86)
Deceased	8 (73)	6 (14)
Year of hire:		
<1960	4 (36)	19 (43)
1960-1964	5 (46)	11 (25)
1965+	2 (18)	14 (32)
Duration of employment (years):		
<10	4 (36)	13 (30)
10-19	4 (36)	20 (45)
20+	3 (27)	11 (25)

Table 13

Records available for CNSN cases and controls

	No. of subjects	
	Cases	Controls
Total	11 (100%)	44 (100%)
Work history	11 (100)	44 (100)
Medical history	8 (73)	33 (75)
Interview	8 (73)	37 (84)

Table 14

Distribution of CNSN cases and controls by work area

	No. of subjects					
	Cases		Controls		OR	95% CI
Total	11	(100%)	44	(100)		
Plastics & additives	3	(27)	4	(9)	4.2	0.7-26
South dyes	3	(27)	9	(20)	1.5	0.3-7.2
North dyes	5	(45)	10	(23)	3.6	0.7-20
Laboratories	4	(36)	15	(34)	1.1	0.3-4.1
Maintenance	4	(36)	16	(36)	1.0	0.2-3.8

Table 15

Distribution of CNSN cases and controls by building*

	No. of subjects					
	Cases		Controls		OR	95% CI
Total	11`	(100%)	44	(100)		
Building:						
108-North wing	3	(27)	1	(2)		
108-Other than north wing	1	(9)	6	(14)	0.6	0.1-6.4
102	1	(9)	5	(11)	0.8	0.1-7.1
103	0	(0)	5	(11)	0.0	0.0-4.4
104	3	(27)	0	(0)		
52/3	1	(9)	0	(0)		
54/5	1	(9)	0	(0)		
305/6	4	(36)	7	(16)	2.8	0.7-12
307	2	(18)	5	(11)	1.9	0.3-12
301	1	(9)	2	(5)		

* The subjects in each building include production, maintenance and laboratory workers assigned to duties related to that building.

Table 16

Distribution of CNSN cases and controls by patterns of potential routine exposure to epichlorohydrin

	No. of subjects					
	Cases		Controls		OR	95% CI
Total	11	(100%)	44	(100)		
Routine exposure:						
No	7	(64)	37	(84)	1.0	
Yes	4	(36)	7	(16)	4.2	0.7-26
Duration of exposure (yrs):						
0	7	(64)	37	(84)	1.0	
<10	1	(9)	3	(7)		
10+	3	(27)	4	(9)	4.5	0.7-29
Cumulative exposure units:						
0	7	(64)	37	(84)	1.0	
<50	1	(9)	4	(9)	2.0	0.2-23
50+	3	(27)	3	(7)	9.3	0.8-109

Table 17

Distribution of CNSN cases and controls by employment in certain areas and exposure to epichlorohydrin (EPI)

Matching group	Study subject no.	North wing building 108	Building 104	North dyes area	Routine exposure to EPI	Acute exposure to EPI
Cases:						
11	66	-	-	+	+	+
19	146	+	+	+	+	-
23	59	-	+	-	-	?
26	23	-	-	+	-	-
34	107	-	-	+	-	?
35	77	-	-	-	-	-
36	31	-	-	-	-	-
41	164	+	-	-	+	+
45	161	+	+	-	+	+
53	183	-	-	+	-	-
62	187	-	-	-	-	?
Controls:						
11	30	-	-	-	+	-
11	64	-	-	-	-	-
11	89	-	-	+	+	?
11	124	-	-	-	-	-
19	2	-	-	-	+	?
19	11	-	-	-	-	-
19	149	-	-	-	+	-
19	162	-	-	-	-	?
23	26	-	-	-	-	?
23	78	-	-	-	-	?
23	171	-	-	-	-	?
23	189	-	-	-	-	?

(cont.)

Matching group	Study subject no.	North wing building 108	Building 104	North dyes area	Routine exposure to EPI	Acute exposure to EPI
Controls (cont.):						
26	34	-	-	-	-	-
26	41	-	-	-	-	-
26	104	-	-	-	-	?
26	179	-	-	+	-	-
34	14	-	-	+	-	-
34	16	-	-	+	-	-
34	39	-	-	-	-	+
34	185	-	-	-	+	-
35	8	-	-	-	-	-
35	32	-	-	-	-	-
35	106	-	-	-	-	-
35	140	-	-	-	+	-
36	20	-	-	-	-	-
36	24	-	-	-	-	-
36	71	-	-	-	-	-
36	85	-	-	-	-	-
41	15	+	-	-	+	-
41	19	-	-	+	-	-
41	48	-	-	+	-	-
41	62	-	-	-	-	-
45	37	-	-	-	-	-
45	109	-	-	-	-	-
45	150	-	-	-	-	-
45	178	-	-	-	-	-
53	63	-	-	+	-	?
53	114	-	-	-	-	?
53	144	-	-	-	-	-
53	190	-	-	-	-	-
62	43	-	-	+	-	?
62	73	-	-	+	-	-
62	134	-	-	+	-	-
62	139	-	-	-	-	-

APPENDIX A

List of jobs and industries associated with "high-risk" of lung cancer among New Jersey white men

Appendix A

List of jobs associated with "high-risk" of lung cancer among New Jersey white men (6)

Asbestos and insulator workers
Brickmasons, stonemasons, tilesetters
Plasterers, lathers
Boilermakers
Tinsmiths, sheetmetal workers
Blacksmiths
Metal molders
Roofers, slaters
Stationary engineers, stationary firemen
Automobile mechanics
Taxicab drivers, chauffeurs
Conductors, motormen
Printing workers
Barbers, hairdressers
Janitors, cleaners

List of industries associated with "high-risk" of lung cancer among New Jersey white men (6)

Shipbuilding workers
Nonmetallic mining & quarrying workers
Cement, structural clay & miscellaneous nonmetallic mineral product workers
Petroleum workers
Rubber workers
Leather, tanning & finishing workers
Shoe repair shop workers, shoemakers, bootblacks
Printing industry workers
Furniture and fixture workers
Barber and beauty shops workers
Laundry & dry cleaning workers
Trucking service, warehousing & storage workers
Street railway & bus line workers

Appendix B

Distribution of lung cancer cases and controls by duration of employment and years since first employment in work areas at the TRP

Table B1

Distribution of lung cancer cases and controls by duration of employment and years since first employment in the south dyes area

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	30	-	-	-	-
	Controls	78	-	-	-	-
<10	Cases	-	1	0	0	1
	Controls	-	0	1	2	3
10-19	Cases	-	1	1	4	6
	Controls	-	0	2	3	5
20+	Cases	-	3	3	8	14
	Controls	-	0	3	13	16
Ever (>0)	Cases	-	5	4	12	21
	Controls	-	0	6	18	24

Table B2

Distribution of lung cancer cases and controls by duration of employment and years since first employment in plastics and additives

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	44	-	-	-	-
	Controls	91	-	-	-	-
<10	Cases	-	2	0	1	3
	Controls	-	1	0	1	2
10-19	Cases	-	0	0	1	1
	Controls	-	0	1	1	2
20+	Cases	-	0	2	1	3
	Controls	-	0	2	5	7
Ever (>0)	Cases	-	2	2	3	7
	Controls	-	1	3	7	11

Table B3

Distribution of lung cancer cases and controls by duration of employment and years since first employment in the north dyes area

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	45	-	-	-	-
	Controls	88	-	-	-	-
<10	Cases	-	0	1	0	1
	Controls	-	1	1	2	4
10-19	Cases	-	2	1	0	3
	Controls	-	0	0	5	5
20+	Cases	-	0	1	1	2
	Controls	-	0	1	4	5
Ever (>0)	Cases	-	2	3	1	6
	Controls	-	1	2	11	14

Table B4

Distribution of lung cancer cases and controls by duration of employment and years since first employment in laboratories

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	41	-	-	-	-
	Controls	78	-	-	-	-
<10	Cases	-	1	1	0	2
	Controls	-	1	2	0	3
10-19	Cases	-	0	1	3	4
	Controls	-	4	2	4	10
20+	Cases	-	1	0	3	4
	Controls	-	0	4	7	11
Ever (>0)	Cases	-	2	2	6	10
	Controls	-	5	8	11	24

Table B5

Distribution of lung cancer cases and controls by duration of employment and years since first employment in maintenance

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	28	-	-	-	-
	Controls	64	-	-	-	-
<10	Cases	-	0	2	1	3
	Controls	-	2	4	2	8
10-19	Cases	-	0	2	7	9
	Controls	-	2	1	7	10
20+	Cases	-	1	3	7	11
	Controls	-	7	3	10	20
Ever (>0)	Cases	-	1	7	15	23
	Controls	-	11	8	19	38

Table B6

Distribution of lung cancer cases and controls by duration of employment and years since first employment in building 108

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	44	-	-	-	-
	Controls	83	-	-	-	-
<10	Cases	-	2	1	1	4
	Controls	-	1	0	2	3
10-19	Cases	-	1	0	3	4
	Controls	-	1	1	4	6
20+	Cases	-	0	2	1	3
	Controls	-	0	2	8	10
Ever (>0)	Cases	-	3	3	5	11
	Controls	-	2	3	14	19

F 04

Table B7

Distribution of lung cancer cases and controls by duration of employment and years since first employment in building 102

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	43	-	-	-	-
	Controls	88	-	-	-	-
<10	Cases	-	1	0	0	1
	Controls	-	0	3	1	4
10-19	Cases	-	0	0	0	0
	Controls	-	0	1	2	3
20+	Cases	-	2	1	4	7
	Controls	-	0	1	6	7
Ever (>0)	Cases	-	3	1	4	8
	Controls	-	0	5	9	14

Table B8

Distribution of lung cancer cases and controls by duration of employment and years since first employment in building 103

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	43	-	-	-	-
	Controls	96	-	-	-	-
<10	Cases	-	1	0	0	1
	Controls	-	1	0	0	1
10-19	Cases	-	3	0	1	4
	Controls	-	0	1	1	2
20+	Cases	-	0	1	2	3
	Controls	-	1	1	1	3
Ever (>0)	Cases	-	5	1	2	8
	Controls	-	1	2	3	6

F 06

Table B9

Distribution of lung cancer cases and controls by duration of employment and years since first employment in building 104

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
C	Cases	43	-	-	-	-
	Controls	92	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	1	1
10-19	Cases	-	1	2	1	4
	Controls	-	0	0	1	1
20+	Cases	-	0	1	3	4
	Controls	-	1	2	5	8
Ever (>0)	Cases	-	1	3	4	8
	Controls	-	1	2	7	10

Table B10

Distribution of lung cancer cases and controls by duration of employment and years since first employment in building 52/3 (AQ)

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	45	-	-	-	-
	Controls	101	-	-	-	-
<10	Cases	-	0	1	0	1
	Controls	-	0	0	0	0
10-19	Cases	-	2	0	1	3
	Controls	-	0	0	0	0
20+	Cases	-	0	1	1	2
	Controls	-	1	0	0	1
Ever (>0)	Cases	-	2	2	2	6
	Controls	-	1	0	0	1

Table B11

Distribution of lung cancer cases and controls by duration of employment and years since first employment in building 54/5 (EPI)

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	48	-	-	-	-
	Controls	102	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
10-19	Cases	-	1	1	0	2
	Controls	-	0	0	0	0
20+	Cases	-	0	1	0	1
	Controls	-	0	0	0	0
Ever (>0)	Cases	-	1	2	0	3
	Controls	-	0	0	0	0

Table B12

Distribution of lung cancer cases and controls by duration of employment and years since first employment in building 305/6

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	44	-	-	-	-
	Controls	93	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	1	1	0	2
10-19	Cases	-	0	2	2	4
	Controls	-	1	0	4	5
20+	Cases	-	0	1	2	3
	Controls	-	0	0	2	2
Ever (>0)	Cases	-	0	3	4	7
	Controls	-	2	1	6	9

F 10

Table B13

Distribution of lung cancer cases and controls by duration of employment and years since first employment in building 307

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	44	-	-	-	-
	Controls	95	-	-	-	-
<10	Cases	-	0	1	0	1
	Controls	-	0	0	2	2
10-19	Cases	-	2	1	2	5
	Controls	-	0	0	3	3
20+	Cases	-	0	0	1	1
	Controls	-	0	0	2	2
Ever (>0)	Cases	-	2	2	3	7
	Controls	-	0	0	7	7

Table B14

Distribution of lung cancer cases and controls by duration of employment and years since first employment in building 301

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	51	-	-	-	-
	Controls	100	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
10-19	Cases	-	0	0	0	0
	Controls	-	0	0	1	1
20+	Cases	-	0	0	0	0
	Controls	-	0	1	0	1
Ever (>0)	Cases	-	0	0	0	0
	Controls	-	0	1	1	2

Table B15

Distribution of lung cancer cases and controls by duration of employment and years since first employment as pipefitters

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	45	-		-	-
	Controls	95	-		-	-
<10	Cases	-	0		0	0
	Controls	-	4		0	4
10-19	Cases	-	0		2	2
	Controls	-	0		2	2
20+	Cases	-	1		3	4
	Controls	-	0		1	1
Ever (>0)	Cases	-	1		5	6
	Controls	-	4		3	7

Table B16

Distribution of lung cancer cases and controls by duration of employment and years since first employment as electricians, machinists, painters, service mechanics or maintenance helpers

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	43	-		-	-
	Controls	98	-		-	-
<10	Cases	-	1		1	2
	Controls	-	1		0	1
10-19	Cases	-	1		2	3
	Controls	-	0		1	1
20+	Cases	-	2		1	3
	Controls	-	1		1	2
Ever (>0)	Cases	-	4		4	8
	Controls	-	2		2	4

Table B17

Distribution of lung cancer cases and controls by duration of employment and years since first employment in other maintenance jobs§

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	42	-		-	-
	Controls	75	-		-	-
<10	Cases	-	1		0	1
	Controls	-	1		2	3
10-19	Cases	-	1		3	4
	Controls	-	3		4	7
20+	Cases	-	1		3	4
	Controls	-	9		8	17
Ever (>0)	Cases	-	3		6	9
	Controls	-	13		14	27

§ Boilermakers, janitors, instrument mechanics, welder, crane operators, and maintenance foremen.

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Appendix C

Distribution of CNSN cases and controls by duration of employment and years since first employment in work areas at the TRP

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Table C1

Distribution of CNSN cases and controls by duration of employment and years since first employment in plastics and additives

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	8	-	-	-	-
	Controls	40	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
10-19	Cases	-	0	0	2	2
	Controls	-	1	0	1	2
20+	Cases	-	1	0	0	1
	Controls	-	1	0	1	2
Ever (>0)	Cases	-	1	0	2	3
	Controls	-	2	0	2	4

Table C2

Distribution of CNSN cases and controls by duration of employment and years since first employment in the south dyes area

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	8	-	-	-	-
	Controls	35	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	1	1	2
10-19	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
20+	Cases	-	0	0	3	3
	Controls	-	1	2	4	7
Ever (>0)	Cases	-	0	0	3	3
	Controls	-	1	3	5	9

Table C3

Distribution of CNSN cases and controls by duration of employment and years since first employment in the north dyes area

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	6	-	-	-	-
	Controls	34	-	-	-	-
<10	Cases	-	0	1	0	1
	Controls	-	0	0	1	1
10-19	Cases	-	0	1	2	3
	Controls	-	1	1	5	7
20+	Cases	-	0	1	0	1
	Controls	-	0	0	2	2
Ever (>0)	Cases	-	0	3	2	5
	Controls	-	1	1	8	10

Table C4

Distribution of CNSN cases and controls by duration of employment and years since first employment in laboratories

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	7	-	-	-	-
	Controls	29	-	-	-	-
<10	Cases	-	0	0	1	1
	Controls	-	0	3	0	3
10-19	Cases	-	0	2	0	2
	Controls	-	1	1	2	4
20+	Cases	-	0	0	1	1
	Controls	-	0	1	7	8
Ever (>0)	Cases	-	0	2	2	4
	Controls	-	2	4	9	15

Table C5

Distribution of CNSN cases and controls
by duration of employment and years since
first employment in maintenance

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	7	-	-	-	-
	Controls	28	-	-	-	-
<10	Cases	-	0	1	0	1
	Controls	-	3	1	0	4
10-19	Cases	-	0	0	1	1
	Controls	-	0	0	5	5
20+	Cases	-	0	1	1	2
	Controls	-	0	1	6	7
Ever (>0)	Cases	-	1	1	2	4
	Controls	-	4	1	11	16

Table C6

Distribution of CNSN cases and controls
by duration of employment and years since first
employment in the north wing of building 108

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	8	-	-	-	-
	Controls	43	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
10-19	Cases	-	0	0	1	1
	Controls	-	0	0	0	0
20+	Cases	-	1	0	1	2
	Controls	-	1	0	0	1
Ever (>0)	Cases	-	1	0	2	3
	Controls	-	1	0	0	1

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Table C7

Distribution of CNSN cases and controls by duration of employment and years since first employment in "other" areas of building 1082

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	10	-	-	-	-
	Controls	39	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
10-19	Cases	-	0	0	1	1
	Controls	-	1	0	2	3
20+	Cases	-	0	0	0	0
	Controls	-	0	0	2	2
Ever (>0)	Cases	-	0	0	1	1
	Controls	-	1	0	4	5

Table C8

Distribution of CNSN cases and controls by duration of employment and years since first employment in building 102

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	10	-	-	-	-
	Controls	39	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	1	0	0	1
10-19	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
20+	Cases	-	0	1	0	1
	Controls	-	0	1	3	4
Ever (>0)	Cases	-	0	1	0	1
	Controls	-	1	1	3	5

Table C9

Distribution of CNSN cases and controls by duration of employment and years since first employment in building 103

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	11	-	-	-	-
	Controls	39	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	1	1	2
10-19	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
20+	Cases	-	0	0	0	0
	Controls	-	1	1	1	3
Ever (>0)	Cases	-	0	0	0	0
	Controls	-	1	2	2	5

Table C10

Distribution of CNSN cases and controls by duration of employment and years since first employment in building 104

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	8	-	-	-	-
	Controls	44	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
10-19	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
20+	Cases	-	1	0	2	3
	Controls	-	0	0	0	0
Ever (>0)	Cases	-	1	0	2	3
	Controls	-	0	0	0	0

Table C11

Distribution of CNSN cases and controls by duration of employment and years since first employment in building 52/3 (AQ)

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	10	-	-	-	-
	Controls	44	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
10-19	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
20+	Cases	-	0	1	0	1
	Controls	-	0	0	0	0
Ever (>0)	Cases	-	0	1	0	1
	Controls	-	0	0	0	0

Table C12

Distribution of CNSN cases and controls by duration of employment and years since first employment in building 54/5 (EPI)

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	10	-	-	-	-
	Controls	44	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
10-19	Cases	-	1	0	0	1
	Controls	-	0	0	0	0
20+	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
Ever (>0)	Cases	-	1	0	0	1
	Controls	-	0	0	0	0

Table C13

Distribution of CNSN cases and controls by duration of employment and years since first employment in building 305/6

Years since first employment		Duration of employment (years) 0	<1	1-4	5+	Ever (>0)
0	Cases	7	-	-	-	-
	Controls	37	-	-	-	-
<10	Cases	-	0	1	0	1
	Controls	-	0	0	1	1
10-19	Cases	-	0	2	0	2
	Controls	-	1	0	3	4
20+	Cases	-	0	1	0	1
	Controls	-	0	1	1	2
Ever (>0)	Cases	-	0	4	0	4
	Controls	-	1	1	5	7

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Table C14

Distribution of CNSN cases and controls by duration of employment and years since first employment in building 307

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	9	-	-	-	-
	Controls	39	-	-	-	-
<10	Cases	-	0	1	0	1
	Controls	-	0	0	0	0
10-19	Cases	-	0	0	1	1
	Controls	-	0	0	3	3
20+	Cases	-	0	0	0	0
	Controls	-	0	1	1	2
Ever (>0)	Cases	-	0	1	1	2
	Controls	-	0	1	4	5

Table C15

Distribution of CNSN cases and controls by duration of employment and years since first employment in building 301

Years since first employment		Duration of employment (years)				
		0	<1	1-4	5+	Ever (>0)
0	Cases	10	-	-	-	-
	Controls	42	-	-	-	-
<10	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
10-19	Cases	-	0	0	1	1
	Controls	-	0	1	1	2
20+	Cases	-	0	0	0	0
	Controls	-	0	0	0	0
Ever (>0)	Cases	-	0	0	1	1
	Controls	-	0	1	1	2

APPENDIX D

List of chemicals present in work areas associated with an increased risk of lung cancer

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APPENDIX E

List of chemicals present in work areas associated with an increased risk of CNSN

Table E1

List of products manufactured in building 305/6 in 1963

	NAME	CODE
1	IRGALAN YELLOW GL	99000
2	ACID BLACK BRO	100101
3	ACID BLUE NGB	100200
4	ACID ORANGE NR	100900
5	ACID ORANGE 2R	101000
6	ACID RED 3NB	101100
7	ALIZARINE BLUE 2A	101600
8	AZO EOSINE G	102700
9	AZO RHODINE 6B	102800
10	AZO RHODINE 2G	102900
11	AZO RUBINDLE 3GP	103000
12	CIBALAN YELLOW 3GL	103700
13	CIBALAN BROWN BL	103800
14	CIBALAN GREY BL	104000
15	CIBALAN YELLOW FGL	104100
16	CROCEIN SCARLET FL	104500
17	CROCEIN SCARLET MOO	104600
18	ACID RED B	105200
19	ACID ORANGE 2G	105300
20	ACID YELLOW C 173	105500
21	ACID YELLOW 2GP	105700
22	JASMINE G	105900
23	IRGALAN BROWN 2RL	106200
24	IRGALAN GREY BL	106300
25	IRGALAN ORANGE RL	106400
26	MAUVE	106900
27	METANIL YELLOW	107000
28	ACID GREEN V	107100
29	ACID BLUE BLACK B	107200
30	NEOLAN BLACK WA	107900
31	NEOLAN BLACK WAL	108000
32	NEOLAN BLACK WAO	108100
33	NEOLAN BLUE 2G	108200
34	NEOLAN BORDEAUX RM	108600
35	NEOLAN GREEN D	108700
36	NEOLAN ORANGE G	109000
37	NEOLAN ORANGE GRE	109100
38	NEOLAN RED BRE	109700
39	NEOLAN RED GREC	109800
40	NEOLAN YELLOW BE	110200
41	NEOLAN YELLOW GR	110400
42	NEROL 2B	110600
43	NEROL 4B	110700
44	NEUTRAL BROWN R	110800
45	NEW COCCINE	110900
46	ORANGE Y	111100
47	POLAR ORANGE R	111400
48	POLAR RED B	111500

49	POLAR RED 3B	111600
50	POLAR RED G	111700
51	POLAR RED R	111800
52	POLAR RED RS	111900
53	POLAR YELLOW 2G	112000
54	POLAR YELLOW 5G	112100
55	POLAR YELLOW R	112200
56	RESORCINE BROWN B	112300
57	RESORCINE BROWN R	112400
58	ROCCELINE 2S	112700
59	SILK RED B	113100
60	TARTRAZINE	113800
61	VICTORIA VIOLET 4BS	114100
62	LANASYN BROWN RL	115000
63	TORACYL OLIVE G	116100
64	NEOLAN BLACK WAN	116500
65	ACID ORANGE SLF	117100
66	IRGALAN DARK GREEN 2BL GRANULE	117342
67	ORANGE Y BRD	117406
68	ACID YELLOW FLW	117500
69	IRGALAN YELLOW 2GL	117800
70	ART SILK BLACK G	200100
71	BENZO YELLOW RL	200300
72	BENZO ORANGE R	200400
73	BENZO PURPURINE 4BMP	200500
74	BENZO PURPURINE 4BS	200600
75	CHLORAMINE GREEN B	201000
76	CHLOR BLUE 4GL	201400
77	CHLOR BROWN BRLL	201700
78	CHLOR GREEN BLL	201900
79	CHLOR GREEN 5GLL	202000
80	CHLOR ORANGE TGLL	202200
81	CHLOR RED 5BL	202500
82	CHLOR RED 6BLL	202600
83	CHLOR TURQUOISE VLL	202700
84	CHLOR VIOLET 2 RLL	202900
85	CHLOR YELLOW 5GL	203000
86	CHLOR YELLOW 2GLL	203300
87	CIBACRON BLACK BG	204601
88	DIAZO BLUE B	204700
89	DIAZO RED 2B	205100
90	DIAZO SCARLET RPC	205300
91	CONGO RED	205600
92	DIAZO BLUE BR	205800
93	DIAZO BLUE 2RW	206000
94	DIPHENYL BLUE GREEN BL	206400
95	DIRECT BLACK E	206700
96	DIRECT BLACK ECW	206800
97	DIRECT BLUE 2B	207800
98	DIRECT BLUE 3B	207900
99	DIRECT BORDEAUX 6B	208000
100	DIRECT VIOLET B	208100
101	DIRECT YELLOW C	208200
102	DIRECT BROWN CT	208400

103	DIRECT BORWN	MR	208700
104	DIRECT BROWN	RG	209000
105	DIRECT BROWN	T	209100
106	DIRECT GREEN	D	209600
107	DIRECT BLUE	FF	210600
108	DIRECT ORNAGE	4G	210700
109	DIRECT ORANGE	2R	211200
110	DIRECT ORANGE	SE	211300
111	DIRECT ORANGE	SW	211400
112	DIRECT RED	8BL	211500
113	DIRECT RED	F	211700
114	DIRECT SCARLET	4BA	211800
115	DIRECT SCARLET	8BA	211900
116	DIRECT SCARLET	4BN	212000
117	DIRECT SCARLET	SE	212300
118	DIRECT YELLOW	AG	212400
119	DIRECT YELLOW	EFC	212500
120	DIRECT YELLOW	G	212600
121	DIRECT YELLOW	3GP	212800
122	DIRECT YELLOW	6GP	212900
123	DIRECT GARNET	2RB	213300
124	DIRECT GREEN	BB	213400
125	DIRECT GREEB	BY	213600
126	LUMISOL BLUE	BL	213900
127	LUMISOL BLUE	L	214400
128	LUMISOL BLUE	RL	214500
129	LUMISOL BLUE	VG	214600
130	DIRECT BLUE	5B	215300
131	DIRECT BLUE	6B	215900
132	FORMAL BLACK	G	216500
133	PAPER ORANGE	R	217300
134	PAPER YELLOW	CD	217400
135	DIAZO ORANGE	R	217800
136	DIRECT BROWN	BP	218200
137	ZAMBESI BLACK	BG	218900
138	ZAMBESI BLACK	BHR	219100
139	ZAMBESI BLACK	N	219300
140	PAPER YELLOW	G	220800
141	CIBACRON BRILLIAN BLUE	BR	221601
142	CIBACRON BRILLIANT YELLOW	3G	221701
143	CIBACRON BRILIANT ORANGE	GP	222701
144	PAPER YELLOW	AA	222900
145	PAPER YELLOW	DM	223000
146	DIRECT BLACK	BN	223200
147	CIBACRON BROWN	3GR	221801
148	PAPER BLUE	VG	223300
149	PAPER BROWN	M	223400
150	PAPER YELLOW	3R	223500
151	CHROME BROWN	O	300400
152	CHROME BLACK	FW	300600
153	CHROME ORANGE	FR	300800
154	CHROME YELLOW	G	301400
155	CHROME BROWN	AEB	301900
156	CHROME BLACK	TN	302300

157	CHROME BLUE BLACK R SOL	302500
158	CHROME BLUE BLACK RZN	302800
159	CHROME BROWN R	303000
160	CHROME FLAVINE A	303200
161	CHROME BROWN RLL	303600
162	CHROME CYANINE BLL	303700
163	CHROME ORANGE ML	303800
164	CHROME YELLOW ME	304000
165	CHROME BLACK TO	304100
166	BISMARK BROWN G	500100
167	BISMARK BROWN R	500200
168	CHRYSOIDINE G	500300
169	1 ACETAMINO 2 METHOXYNAPHT DRY	M00249
170	ALBATEX PO FILTER CAKE	M01760
171	4 AMINOAZOSALICYLIC CAKE	M03300
172	AMINO J ACID CAKE	M04250
173	12 AMINONAPHTHOL 14 SA CAKE	M05650
174	BENZENE SULFO H CAKE	M16780
175	BENZO YELLOW BL INT CAKE	M18280
176	ACETATE DIAZO BLACK GN INT CAK	N00494
177	ACETATE SCARLET B INT CAKE	N00554
178	ACETATE YELLOW CW INT CAKE	N00565
179	ACETATE YELLOW G INT CAKE	N00567
180	1 CARBOMAX 7 AMINOAPHTHOL DRY	M24369
181	CHLOR YELLOW 5 GL INT CAKE	M25542
182	2 CHLOR 5 AMINOBENZOIC CAKE	M25610
183	CHLORAMINE RED 3B INT CAKE	M25620
184	CHLOR GREEN BLL INT CAKE	M26515
185	M CHLORO PMP CAKE	M26680
186	CHROMESALAM SOLUTION	M27770
187	CHRYSOPH INT CAKE	M28200
188	CIBACRON BRILL BLUE BR PINT CA	M28250
189	DIRECT ORANGE 4G INT CAKE	M38260
190	J ACID UREA CAKE	M50120
191	LAN BROWN INT	M51440
192	NITROAMINOSTILBENE DISA CAKE	M60400
193	ORANGE 3LWF TRIAZOLE CAKE	M66900
194	PAPER YELLOW 3R INT CAKE	M68661
195	RG BASE	M75075
196	YELLOW EFC TRIAZOLE	M07800

Table E2

List of products manufactured in building 307 in 1963

1	ALIZARINE BLUE 4GL	
2	CHLOR YELLOW FF	102200
3	DIRECT ORANGE 3LWF	209200
4	DIRECT ORNAGE NAR	210900
5	A ACETAMINO 7 NAPHTOL CAKE	211000
6	ALPHA SALT CAKE	M00285
7	ALPHA SUFONATION	M01902
8	1 AMINOAZOBENZENE M SA CAKE	M01920
9	4 AMINOAZOBENZENE P SA CAKE	M03165
10	2 AMINOBENZOIC 5 SULFAMIDE CAK	M03168
11	AMINO G SALT CAKE	M03510
12	17 AMINONAPHTHOL BASE CAKE	M04200
13	2AMINOPHENOL 4MEHTYLSULFONE CA	M05550
14	2AMINOPHENOL M SULFAMIDE CAKE	M06580
15	2AMINOPHENOL 4SULFOMETHYLAMIDE	M06590
16	2 AMINOPHENOL 4 SA CAKE	M06640
17	ANILINE OMEGA CAKE	M06660
18	O ANISIDINE OMEGA CAKE	M07920
19	2 AMINO 4 CRESOL DRY	M08530
20	BROENNER ACID CAKE	L04053
21	BROMAMINE ACID 100 CAKE	M22380
22	CASSELLA ACID CAKE	M22400
23	CHLOR YELLOW 2 GLL INT CAKE	M24496
24	1CHLOROBENZENE 4METHYSULFONE D	M25544
25	CHLOROBENZENE 4SULFINIC CAKE V	M26450
26	OCHLOROBENZOIC 5SULFAMID CAKE	M26455
27	CHROME YELLOW ME INT CAKE	M26475
28	CLEVES ACID 16 CR CAKE	M27830
29	CLEVES ACID 17 PURE CAKE	M28950
30	CLEVES 18 FRACTION CAKE/17	M28957
31	DASD SOLUTION	M28966
32	25DICHLOR DIAZOBENZENE 4SA CAK	M32503
33	25 DICHLOROSULFO PMP CAKE	M35575
34	2,6 DICHLOR PNA	M35620
35	DINITROBENZENE 1 SA CAKE	M35626
36	FORMAL BLACK G INT CAKE	M37585
37	G SALT CAKE	M43590
38	GAMMA ACID CAKE	M44030
39	J ACID CAKE	M44050
40	METANILIC ACID CAKE	M50100
41	MPD SA CAKE	M53740
42	MTD SOLUTION	M56020
43	18 NAPHTHSULTON DRY	M56312
44	NITRO DIAZO ACID CAKE	M59000
45	NITROTOL NEROL ACID CAKE	M61900
46	2 NITROTRICHLORPHENOL CAKE	M63450
47	ONCB 4 METHYLSULFONE CAKE	M64000
48	ONCB 4 SULFOMETHAMID CAKE	M66521
49	ONCBS CAKE	M66555
50	ONT SA CAKE	M66565
		M66605

51	PAA CAKE	M68520
52	PHENYL J CAKE	M69770
53	PNAA CAKE	M71900
54	PNCBS CAKE	M71907
55	PNSA CAKE	M71920
56	PNTDS FREE ACID	M71933
57	R SALT PURE CAKE	M75253
58	R SALT CR CAKE	M75250
59	SCHAEFFER SALT PURE CAKE	M77305
60	P SULFO PMP CAKE	M80860
61	P TOLUIDINE NEROL CAKE	M83400
62	M TOLUIDINE ONEGA CAKE	M83450
63	TURQUOISE VLL INT CAKE	M84870

Table E3

List of products manufactured in building 301 in 1963

	NAME	CODE
1	DIRECT BLACK GX	207200
2	DIRECT BLACK GXR	207300
3	DIRECT BLACK W	207500
4	FORON YELLOW BROWN S 2RFL/GRAN	404343
5	AC/DISPERSE SCARLET 2GH	404740

Table E4

List of raw materials used in the north dyes area and in no other area in 1963

1	1 M ACETAMBENZOYLAM 7 NAPHTHOL PURCH	
2	ACETOACETANILIDE	K00173
3	4 AMINOAZOBENZENE HYDROCHLORIDE	K00725
4	P AMINOPHENOL TECH	K03153
5	2 AMINOTOLUENE 5 SA GRD	K06552
6	AMMONIUM SULFAMATE	K06801
7	3 ANILINE SULFANLIDE 100 PURCH	J07088
8	O ANISIDINE TECH	K08049
9	BENZENESULFOCHLORIDE	K08450
10	BENZIDINE HCL CAKE	K16786
11	BENZIDINE MONOACID CAKE	K16950
12	1 BENZOYLAMINO 7 NAPHTHOL PURCH	K16981
13	CARBON DIOXIDE LIQUID	K18318
14	CERELOSE	J24412
15	CHICAGO ACID PURCH GRD	K24895
16	3 CHLOR 2 AMINOTOLUENE	K25102
17	M CHLOROANILINE	K25630
18	P CHLOROANILINE	K26370
19	O CHLOROBENZOIC ACID TECH	K26372
20	2 CHLOR 4 NITRANILINE	K26470
21	O CHLORONITROBENZENE	K26520
22	CHROME FLUORIDE 100	K26550
23	CHROME SULFATE BASIC 100	J27700
24	CHROMIUM ACETATE	J27780
25	CITRIC ACID	J27860
26	COBALT SULFATE MONOHYDR 100	K28750
27	P CRESOL	J29230
28	DEHYDROTHIO P TOLUIDINE	K29953
29	O DIANISIDINE DIHYDRO CHLORIDE CAKE	K34000
30	25 DICHLORANILINE	K34871
31	DIETHYLANILINE	K35465
32	DIHYDRAZINE SULFATE	K36070
33	25 DIMETHOXYANILINE	J36200
34	24 DINITROANILINE	K36400
35	24 DINITROTOLUENE	K37550
36	DIOXANE	K37770
37	24 DIOXYQUINOLINE	K37870
38	DISODIUM PHOSPHATE	K37885
39	O ETHYLANILINE	J38370
40	ETHYL SOD OXALACETATE	K42600
41	FERRIC SULFATE	K42780
42	FERROUS SULFATE	J43115
43	GLYCINE TECH	J43130
44	H ACID	K44770
45	HEXAMETAPHOSPHATE	K45020
46	HYDROFLUORIC ACID	J45510
47	IGEPON T 77	J46630
48	IRON GRD 60 M REG	K47420
49	ISOPROPYLAMINE	J47862
		K48600

50	LIMESTONE PULV CACO3	J52000
51	24 LUTIDINE	K52350
52	MAGNESIA	J53220
53	MANGANESE SULFATE	J53390
54	METHOXY CLEVES PURCH 100 GRD	K53853
55	METHYLCHLOROFORMATE	K54200
56	N METHYL J ACID	K54396
57	MNPT	K55100
58	MTD CRYST PURCH	K56303
59	NAPHTHOL ALPHA TECH	K58700
60	NAPHTHOL BETA FLAKES	K58730
61	N AND W ACID PURCH	K59100
62	NAPHTHIONIC SODA SALT URCH DRY	K59204
63	M NITRO ANILINE PURCH	K60095
64	NITRIC ACID 67	J60210
65	M NITROBENZOYL CHLORIDE	K61140
66	P NITROBENZOYL CHLORIDE	K61200
67	ONT	K66600
68	ORTHANILIC ACID	K67000
69	ORZAN P	K67185
70	P PHENYLENEDIAMINE	K69650
71	PHENYL PERI GRD PURCH	K69802
72	PHOSGENE CYL	K70000
73	PLURONIC ACID F 68	K71700
74	PMP 100 PURCH	K71849
75	PNT	K71930
76	PUMICE	J72785
77	RESORCINOL	K74650
78	RR ACID CAKE	K75200
79	S ACID CAKE PURCH	K76101
80	SALT BULK	J76151
81	SODA ASH BULK	J77701
82	SODIUM CYANATE	J78040
83	SODIUM FLUORIDE	J78080
84	SODIUM FORMATE	K78120
85	SODIUM MONOPHOSPHATE	J78180
86	SODIUM NITRITE LIQUOK 100	J78226
87	SODIUM PICRAMATE TECH	K78280
88	SULFANILIC ACID	K80330
89	O TOLIDINE HCL CAKE	K83050
90	M TOLIDINE HCL CAKE	K83060
91	O TOLUIDINE TECH	K83325
92	TWEEN 40	K85700
93	XYLIDINES MIXED	K97520
94	ZINC CHLORIDE ANHYD	J99402

Table E5

List of raw materials used in building 104 in 1963

1	ALUMINUM POWDER	
2	AMMONIA LIQUOR 100BA REAGENT	J02010
3	AMMONIA LIQUOR 100	J07048
4	AMMONIA ANHYD CYL	J07050
5	AMMONIUM CHLORIDE	J07053
6	AMMONIUM META VANADATE	J07060
7	AMMONIUM SULFATE	J07070
8	ANTHRANILIC TECH	J0709[illegible]
9	ANTIFOAM A DC	K0970
10	ARSENIC ACID	K09800
11	BARIUM CHLORIDE POWDER	J15250
12	BARIUM SULFATE	J16250
13	BENZALDEHYDE	J16270
14	BENZOIC	K16600
15	BICARBONATE	K17070
16	BICHROMATE	J18900
17	BISULFITE	J18920
18	BORIC ACID GRANULAR TECH	J18950
19	BROMINE	J20650
20	CALGON	J22480
21	CAUSTIC POTASH FLAKES	J24300
22	CAUSTIC SODA GRD	J24540
23	CAUSTIC SODA LIQUOR 50	J24549
24	CHLORINE CYL SMALL	J24551
25	CHLOROACETIC MIXED	J26105
26	CHLOROBENZENE	K26280
27	P CHLORONITROBENZENE	K26420
28	P CHLOROPHENOL	K26553
29	CHLOROSULFONIC	K26650
30	COPPER CHEMICAL SA	J26700
31	COPPER SULFATE CRYSTAL	J29352
32	CUPRIC OXIDE	J29501
33	CUPROUS CHLORIDE	J30465
34	DEXTRIN	J30521
35	DEXTROSE	K34350
36	DICALITE	K34360
37	O DICHLORBENZENE TECH	J35410
38	14 DIMESIDINO AQ GRD	K35530
39	DIMETHYLANILINE	K36382
40	DINA ACID DRY BASLE	K37290
41	DIOXAMIC ACID M GRD	K37507
42	DOWICIDE 2	K37859
43	DUPONOL WA DRY	K40026
44	DUPONOL WA PASTE	K40900
45	ETHYLBENZYLANILINE	K40901
46	FERRIC CHLORIDE HYDRATE	K24630
47	FLAVANTHRONE CR DRY BASLE	J43104
48	FORMALDEHYDE	K43410
49	GLYCERINE	K43600
50	HYDROQUINONE	K44760
		K46800

51	HYDROSULFITE	
52	HYPO 100	J46820
53	IODINE	J46950
54	IRON BORINGS C	J47800
55	IRON BORINGS F	J47850
56.	ISOBUTANOL	J47855
57	LIME HYDRATE 87	K48500
58	MAGNESIUM CHLORIDE	J51950
59	MAGNESIUM SULFATE	J53200
60	MANGANESE CHLORIDE	J53250
61	MERCURY	J53325
62	METHANOL 100	J53640
63	MIXED ACID 50 50 PURCH	K53780
64	MONOETHANOLAMINE	J55062
65	MURIATIC ACID	K55500
66	NACCONAL NR	J56500
67	NAPHTHALENE FLAKE	K58100
68	NAPHTHYLAMINE ALPHA TECH	K58200
69	NEKAL BX 78	K59400
70	NITRIC ACID 98	K59826
71	NITROBENZENE	J60200
72	NITROGEN CYLINDERS	K60950
73	NUCHAR	J62200
74	OCTYL ALCOHOL	J65500
75	OLEUM 25	K66200
76	OLEUM 65	J66510
77	OXALIC	J66515
78	PHOSPHOTEX	K67200
79	PHTHALIC	J70250
80	PINE OIL	K70400
81	POTASSIUM CHLORIDE	K71300
82	POTASSIUM PERMANGANATE	J72360
83	POTASSIUM SULFATE IND	J72400
84	PYRIDINE 30A	J72458
85	REVATOL DRY PURCH	K73020
86	SALT BAG	K75002
87	SANDOZOL N	J76150
88	SODA ASH BAG	K76210
89	SODIUM ACETATE ANHYD	J77700
90	SODIUM CHLORATE	K77850
91	SODIUM NITRATE	J78020
92	SODIUM SULFATE	J78200
93	SODIUK SULFITE ANHYD	J78500
94	STAYBELITE RESIN	J78630
95	SUGAR	K79500
96	SULFHYDRATE	K79850
97	SULFIDE FLAKES	J80450
98	SULFUR FLOWERS	J80471
99	SULFUR FLOWERS ANCHOR	J81200
100	SULFURIC 78	J81201
101	SULFURIC 96	J81400
102	SULFURYL CHLORIDE	J81410
103	TAMOL X	J81500
104	TERGITOL 08	K82105
		K82260

105	TOBIAS ACID	K83000
106	P TOLUENESULFAMID	K83190
107	TWITCHELL OIL	K85750
108	ULTRAWET DS	K86200

Table E6

List of products manufactured in building 104 in 1963

	NAME	CODE
1	ACID GREEN	100400
2	ACID VIOLET 6B	101300
3	ALIZARINE BLUE BLACK B	101400
4	ALIZARINE GREEN GNN	101500
5	ALIZARINE BLUE BL	103100
6	ACRIDYLIC DRY	M00900
7	1 AMINO AQ DRY	M02902
8	2 AMINO AQ DRY	M02925
9	1 AMINO AQ 58 SULFONATE DRY	M03050
10	15 AMINOCHLOR AQ DRY	M04000
11	15 AQ DIACID CAKE	M11600
12	18 AQ DISULFONATE CAKE	M11620
13	1518 AQ DISULFONATE CAKE	M11625
14	26 AQ DISULFONATE CAKE	M11640
15	1 AQ SULFONATE CAKE	M11700
16	BENZAN PURES 100 DRY	M16650
17	15 AQ DISULFONATE CAKE	L11602
18	1 CHLOR AQ DRY	M25700
19	CHLORMETHYL AQ DRY	M26230
20	15 CHLORNITRO AQ CAKE	M26250
21	CHLORMETHYL AQ DRY	M26273
22	CHLOROBENZAN DRY	M26400
23	15DIAMINO AQ CR 100 DRY	L34743
24	15 DIAMINO AQ REC 100 DRY	L34746
25	1518 DIAMINO AQ DRY	M34750
26	26 DIAMINO AQ DRY	M34760
27	DIAMINODIANTHRIMIDE DRY	M34780
28	DIBAROMBENZANE DRY	M35250
29	15 DICHLOR AQ DRY	M35435
30	18 DICHLOR AQ DRY	M35488
31	15 18 DINITRO AQ CAKE	M37560
32	15/18 DINITRO AQ CR DRY	M37564
33	DINITRODIANTHRIMIDE CAKE	M37640
34	DINITRODIOXAMIC CAKE	M37660
35	1458 DINITRODIOXY AQ CAKE	M37675
36	DNC B SA CAKE	M38900
37	EBA SA CAKE	M42030
38	LEUCAMINE DRY	M51800
39	1 NITRO AQ 5 ACID CAKE	M60800
40	1 NITRO AQ 58 SULFONATE CAKE	M60860
41	NITRO CASSELLA CAKE	M61350
42	2 NITRO 4 CHLORPHENOL GSA CAKE	M61620
43	QUINIZARIN CAKE	M73700
44	1518 SAPPHIROL CAKE	L76650
45	15 SAPPHIROL BASE CAKE	L76653
46	SULFOBROMAMINIC CAKE	M80490
47	TETRA ACID INT CAKE	L82306
48	VAT BLACK 2B CAKE	P87420

49	VAT BLACK 2 BD CAKE
50	VAT BLACK DPN CAKE
51	VAT BLUE GF CAKE
52	VAT BLUE GF BASE SF DRY
53	VAT BLUE BS DRY
54	VAT BRILL BLUE R DRY
55	VAT BROWN GR BASE SF DRY
56	VAT DARK BLUE MBA CAKE
57	VAT GOLD ORANGE 2R CAKE
58	VAT OLIVE 2R CAKE ST

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Table E7

List of raw materials used in building 104 and in no other area in 1963

1	ALUMINUM POWDER	J02010
2	AMMONIA LIQUOR 100BA REAGENT	J07048
3	AMMONIA ANHYD CYL	J07053
4	ANTIFOAM A DC	K09800
5	ARSENIC ACID	J15250
6	BARIUM CHLORIDE POWDER	J16250
7	BENZALDEHYDE	K16600
8	BENZOIC	K17070
9	CHLOROACETIC MIXED	K26280
10	P CHLOROPHENOL	K26650
11	CUPRIC OXIDE	J30465
12	DEXTROSE	K34360
13	14 DIMESIDINO AQ GRD	K36382
14	DIMETHYLANILINE	K37290
15	DINA ACID DRY BASLE	K37507
16	DIOXAMIC ACID M GRD	K37859
17	DUPONOL WA PASTE	K40901
18	ETHYLBENZYLANILINE	K42630
19	FERRIC CHLORIDE HYDRATE	J43104
20	FLAVANTHRONE CR DRY BASLE	K43410
21	IODINE	K47800
22	ISOBUTANOL	K48500
23	MANGANESE CHLORIDE	J53325
24	MERCURY	J53640
25	NITRIC ACID 98	J60200
26	PYRIDINE 30A	K73020
27	SODIUM NITRATE	J78200
28	STAYBELITE RESIN	K79500
29	SULFUR FLOWERS ANCHOR	J81201
30	TERGITOL 08	K82260
31	TOBIAS ACID	K83000
32	P TOLUENESULFAMID	K83190

Table E8

List of raw materials used both in building 104 and the north dyes area and in no other area in 1963

1	ANTHRANILIC TECH	K09700
2	P CHLORONITROBENZENE	K26553
3	COPPER SULFATE CRYSTAL	J29501
4	DOWICIDE 2	K40026
5	IRON BORINGS C	J47850
6	MAGNESIUM CHLORIDE	J53200
7	MAGNESIUM SULFATE	J53250
8	MIXED ACID 50 50 PURCH	J55062
9	NACCONAL NR	K58100
10	NAPHTHALENE FLAKE	K58200
11	NAPHTHYLAMINE ALPHA TECH	K59400
12	NITROGEN CYLINDERS	J62200
13	OLEUM 65	J66515
14	POTASSIUM CHLORIDE	J72360
15	POTASSIUM PERMANGANATE	J72400
16	POTASSIUM SULFATE IND	J72458
17	SANDOZOL N	K76210
18	SODIUM SULFITE ANHYD	J78630
19	SULFURIC 78	J81400

Table E9

List of products manufactured both in building 104 and the noth dyes area and in no other area

	NAME	CODE
1	NITRO CASSELLA CAKE	M61350
2	VAT BROWN GR BASE SF DRY	M89658

Table E10

List of raw materials used in building 108 in 1967

	NAME	CODE
1	ACETIC ACID GLACIAL	K00575
2	ACETIC ANHYDRIDE	K00585
3	ACETONE	K00740
4	ACETONE DRY	K00742
5	ACINTOL FA 2	K00830
6	ACRYLONITRILE	K00920
7	ACTIVATED ALUMINA 100 MESH	J00931
8	ADIPIC ACID	K01200
9	AEROSOL OT	J01235
10	ALBEGAL CL	K01764
11	ALCOHOL FURFURYL	K01770
12	ALUMINUM HYDROXIDE COMP GEL	J02050
13	AMINO BUTYL PHENOL	K03615
14	N AMINO ETHYL PIPERAZINE	K04175
15	O SMINOPHENOL	K06550
16	AMMONIA LIQUOR 100	J07050
17	ANILINE DIST TECH	K07750
18	ANTIFOAM B D C	K09810
19	ANTIFOAM Q	K09892
20	ANTIMONY PENTACHLORIDE	J10600
21	ARTUC RED OIL	K15101
22	BEHENYL AMINE TECH	K16510
23	BENZOYL PEROXIDE	K18450
24	BENZYL CHLORIDE	K18675
25	BICARBONATE	J18900
26	BISPHENOL	K19150
27	BORIC ACID GRANULAR TECH	J20650
28	BORON FLOURIDE DEE COMPLEX	J20675
29	BORON TRIFLOURIDE DIHYDRATE	J20702
30	BUTANEDIOL	K23050
31	BUTANOL NORMAL	K23075
32	BUTYL ACETATE	K23120
33	BUTYLACRYLAMID	K23130
34	BUTYL MELAMINE ETHER	K23145
35	4 PRCT CALCIUM DRIEV	J24248
36	CALCIUM MOLYBDATE	J24258
37	CARBON BLACK	K24373
38	CAUSTIC POTASH FLAKES	J24540
39	CAUSTIC POTASH PURE	J24541
40	CAUSTIC SODA FLAKE DC	J24548
41	CAUSTIC SODA GRD	J24549
42	CAUSTIC SODA LIQUOR 50	J24551
43	CAUSTIC SODA LIQUOR 50 DRUMS	J24552
44	CELLOSOLVE ACETATE	K24850
45	CELLSOLVE ANHY	K24855
46	CETYLALCOHOL	K24950
47	CHLOROBENZENE	K26420
48	P CHLOROPHENEXY ANILINE	K26651

49	CLAY ASP 100	
50	CMC 7 LT	J28900
51	CMC LZ 852	K29094
52	6 PCT COBALT DRIER	K29100
53	COCOFATTY ACID	J29220
54	CREAM SOFTENER JB	K29250
55	O CRESOL 99	K29899
56	CYANURIC CHLORIDE	K29952
57	CYCLOHEXANONE	K31100
58	DASD CAKE PURCH	K31200
59	DEXTRO LINONENE	K32502
60	DIACETONE ALCOHOL	K34355
61	DIBUTYL PHTHALATE	K34500
62	DICALITE	K35380
63	ODICHLORBENZENE TECH	J35410
64	DICRYLAN 1504 PURCH	K35530
65	DICYANDIAMIDE	K35681
66	DIETHANOLAMINE	K35735
67	DIETHYLAMINE	K36000
68	DIETHYL CARBITOL	K36060
69	DIETHYLENEGLYCOL	K36073
70	DIETHYLENETRIAMINE	K36076
71	DIMETHYLAMINOPROPYLAMINE	K36085
72	DIMETHYL CABAMYL CHLORIDE	K37000
73	DIMETHYL COCAMINE	K37292
74	DIMETHYL FORMAMIDE	K37300
75	DIMETHYL SULFATE	K37320
76	DIOXYETHYL COCAMINE	K37445
77	DISPERSING AGENT SF	K37873
78	DOWICIDE 1	K38485
79	DOWICIDE G	K40024
80	DRY ICE	K40025
81	ELVANOL 50 42	J40560
82	EMPOL 1014	K42080
83	EMULFOR EL 719	K42127
84	EMPOL 1022	J42128
85	EPI PURCH	K42129
86	ETHANOL SOLVENT	K42181
87	ETHYL ACETATE	K42458
88	ETHYLACETOACETATE	K42490
89	ETHYLACERYLATE HQ	K42500
90	ETHYLENE GLYCOL	K42529
91	ETHYLENE OXIDE TANKS	K42820
92	EXKIN NO 1	K42830
93	FILTER AID FIBEA FLO 7C	K42850
94	FLOREX A RVM	J43185
95	FORMALDEHYDE	J43564
96	GENETRON 11	K43600
97	GLYCERINE	K44300
98	HEXAMETHYLENE DIISOCYANATE	K44760
99	HEXANETRIOL	K45450
100	HYDROABIETYL ALCOHOL	K45516
101	HYDROQUINONE	K46565
102	HYDROXYACETIC ACID	K46800
		K46830

103	ISOPROPANOL 99	K48570
104	LACTIC ACID	K51425
105	LAURYL ALCOHOL	K51550
106	LYOFIX E W 300 PURCH	K52495
107	MEK	K53700
108	MEK PEROXIDE	K53580
109	METHANOL 100	K53780
110	METHANOL DENATURING GRADE	K53783
111	METHYL CELLOSOLVE	K54100
112	METHYL DIETHYLAMINOCOUMARIN	K54328
113	MI KETONE	K54800
114	MONOETHANOLAMINE	K55500
115	MONOETHYLAMINE	K55600
116	MONOETHYLANILINE N TECH	K55630
117	MONTON WAX	K55860
118	MORPHOLINE	K55870
119	MURIATIC ACID	J56500
120	MURIATIC ACID LI	J56501
121	NACCONAL S L	K58105
122	NONYLPHENOL	K64570
123	NUCHAR	J65500
124	NULLAPON BF 78	K65580
125	OCTYL ALCOHOL	K66200
126	OCTYL PHENOL	K66300
127	OLEIC ACID	K66490
128	OLEUM 25	J66510
129	OLEYL ALCOHOL	K66520
130	ORASOL RED B	K66940
131	OREMASIN EMULSIFIER 2757 PURCH	K66960
132	OXALIC	K67200
133	PARAFFIN H M	K68668
134	PARAFFIN L M	K68670
135	PARAFORM FLAKES	K68700
136	PENTA BASE AMINE	K68800
137	PERCHLORETHYLENE	K68940
138	PETROLEUM JELLY	J69140
139	PHENOL	K69300
140	PHOBOTEX TNT 250	K69920
141	PHOSGARD C Z Z R	K69990
142	PHOSPHORIC ACID NF GRADE 75	J70110
143	PHTHALIC	K70400
144	PINE OIL	K71300
145	POLYACRYLATE SODIUM SOL	K71975
146	POLYETHYLENE GLYCOL 200	K71994
147	POLYGLYCOL P 1200	K72013
148	POLYPROPYLENE GLYCOL 425	K72025
149	POMALUS GRANULES	K72047
150	PROPANOL NORMAL	K72720
151	RESORCINOL	K74650
152	R O 11 S	K75150
153	SALICYLIC	K76125
154	SALT BAG	J76150
155	SANDOZOL KB	K76200
156	SANTOMERSE SX	K76355

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157	SODA ASH BAG	J77700
158	SODA ASH M PROOF	J77703
159	SODIUM METAL BRICKS	J77740
160	SODIUM BISULFATE	J77900
161	SODIUM IODIDE	J78140
162	SODIUM METHYLATE 2570	K78175
163	SODIUM SULFATE	J78500
164	SOLVASOL	K78900
165	SOLVENT SDA 40	K79050
166	SOLVESSO 100	K79090
167	STANNIC CHLORIDE	J79400
168	STERAMIDE S	K79592
169	STEARIC ACID TP	K79600
170	STERARYL ALCOHOL TECH	K79650
171	STEARYL AMINE TECH	K79660
172	STEPHANOL B 153	K79670
173	STYRENE OXIDE	K79700
174	SULFAMIC ACID	J80000
175	SULFURIC 96	J81410
176	TALLOW ALCOHOL	K82040
177	TALLOW AMINE	K82050
178	TARTARIC ACID	K82175
179	P TERT BUTLY PHENOL	K82270
180	TETRABROM BISPHENOL	K82340
181	TETRAHYDROFURAN	K82530
182	TETRAHYDROFURFUROL	K82535
183	THIOTHENE DICARBOXYLIC ACID	K82860
184	TITANEX A C G	J82947
185	TOLUENE NITRATION GRADE	K83150
186	TOLUENE 2 DEG	K83155
187	TOLUBNE 4 SULFONIC	K83210
188	M TOLUIDINE TECH	K83300
189	TONSIL OPTIMUM N F F	J83760
190	TRIAMYLAMINE	K83861
191	TRICRESYLPHOSPHATE	K84160
192	TRIETHANOLAMINE	K84200
193	TRIETHYLENE TETRAMINE	K84250
194	TRI ISOPROPANOLAMINE	K84290
195	TRIMETHYLHEXYL ALCOHOL	K84300
196	TURKEY RED OIL 50	K84799
197	ULTRAWET K	K86205
198	UNITAL A C D	K86280
199	UREA	K86360
200	WOOD ROSIN GRADE WW	K96000
201	XYLENE	K97500
202	XYLENOL R 9 C	K97515
203	ZINC FLUROOBORATE	J99436
204	ZIRCONIUM BUTYLATE	K99498

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Table E11

List of products manufactured in building 108 in 1967

	NAME	CODE
1	ARALDITE 502	A11100
2	ARALDITE 9018	A11120
3	ARALDITE 506	A11200
4	ARALDITE 9005	A11420
5	ARALDITE 7071	A12700
6	ARALDITE 7072	A12710
7	ARALDITE 7097	A12800
8	ARALDITE 571 T 75	A48700
9	ARALDITE 597 E T 55	A49500
10	ARALDITE SC 416	A51030
11	ZEROSTAT C	D02992
12	PHOBOTEX FTC PASTE	D554050
13	PHOBOTEX FTC	874504
14	ALBATEX POK	850504
15	SOLVADINE-5	D02885
16	SILVATEX	D02871
17	ULTRAVON JF/100	884501
18	ULTRAVON JU 100	D02930
19	UNIVADINE W100	88550B
20	RADUL S	876102
21	UVITEX NSI 500	D860500
22	UVITEX PRS HIGH CONC	D800335
23	UVITEX PRSA LIQUID/CONC	D895100
24	UVITEX RT 100	B86821
25	UVITEX RT 700	B86822
26	UVITEX RTP	B86823
27	UVITEX WGS CONC/LIQUID	B86975
28	ETHANOL SOLVENT/DENATURED	K42458
29	CATALYST RB	853504
30	CIBALAN SALT S100	854504
31	CIBAPHASOL C	D158100
32	CIBAPHASOL AS/NEW	D150100
33	DICRYLAN 32550	D214100
34	DYEING ASSISTANT 54	D275100
35	LYOFIX DDBR	D413100
36	LYOFIX ZVA	D424085
37	MICROFIX BINDER 59	D470100
38	NEOVCADINE AN 025	872804
39	NEOVADINE AN 200	873004
40	NEOVADINE AN 100	872904
41	9057	A10665
42	LYOFIX EWA LIQUID	870204
43	RETARDER O	D635100
44	RETARDER O2	D635050
45	SAPAMINE OC BASE 500/SS	878603
46	SAPAMINE WLS BASE 600	D705600
47	SAPAMINE P A / P B	D685100

48	SAPAMINE WL BASE 400	879504
49	SAPAMINE OC FLAKES 400	878503
50	SAPAMINE FLK	87800B
51	SAPAMINE WL PASTE 100	87930B
52	SAPAMINE OC BASE 500	878604
53	VIRANIT F C A	89720B
54	CHLOROXURON ICS DRY SOLU	L27693
55	BUTYLACRYLAMID / PURCH	K23130