U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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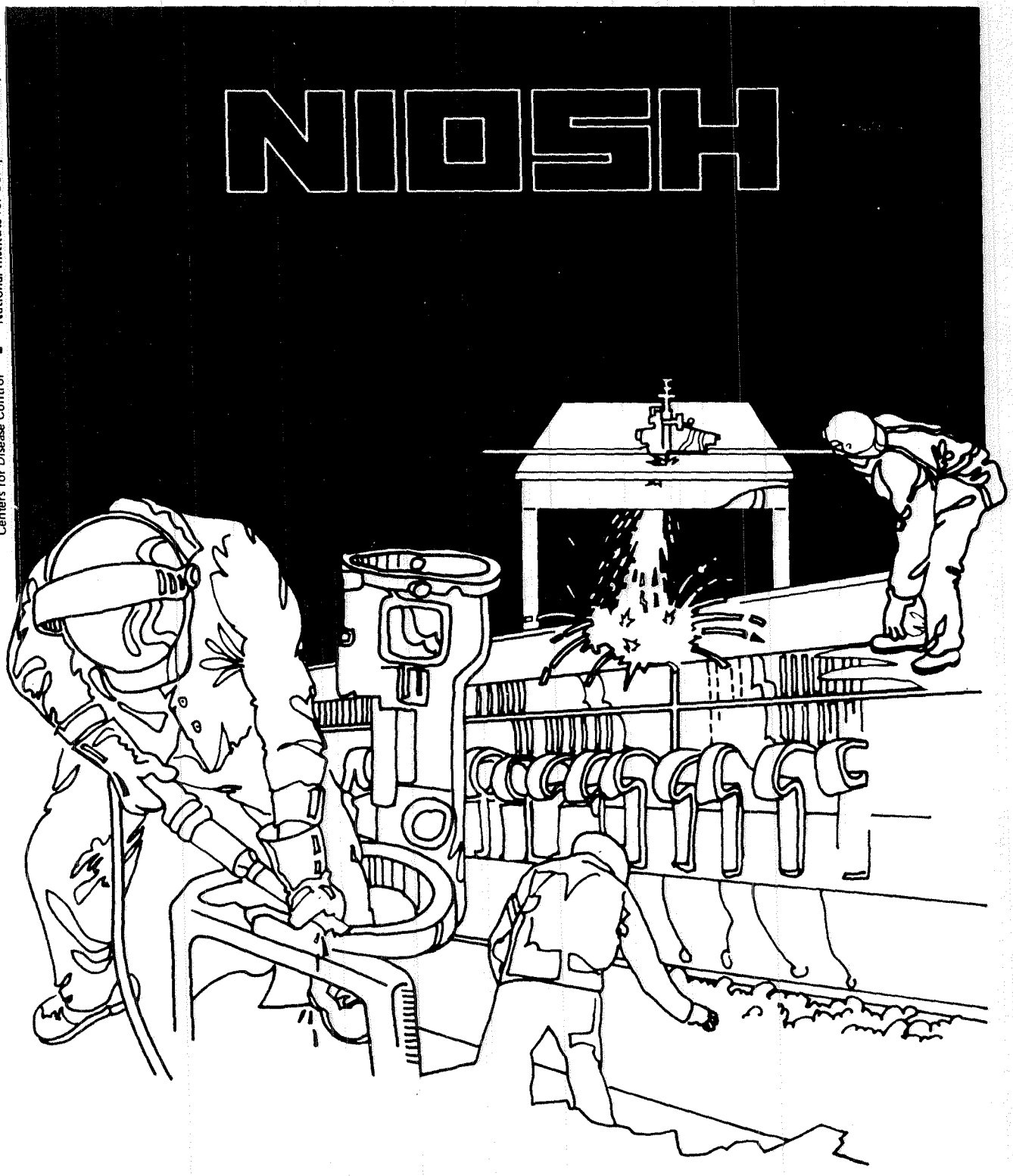
NIOSH



Health Hazard Evaluation Report

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HETA 80-004-1436
FORD MOTOR COMPANY
STERLING HEIGHTS, MICHIGAN

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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FORD MOTOR COMPANY
STERLING HEIGHTS, MICHIGAN

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I. SUMMARY

In 1979, 10 deaths due to cancer were reported to the National Institute for Occupational Safety and Health (NIOSH) by a former employee of a rear axle assembly plant of the Ford Motor Company in Sterling Heights, Michigan. Because of this employee communication regarding a reported cluster of 10 deaths due to lung, stomach, and bone cancer among employees at the plant, an industrial hygiene walk-through survey was conducted and a proportional mortality study was performed. Cutting fluid mists (possibly containing nitrosamines), metal dusts, and metal fumes were exposures of concern.

Mortality patterns were examined among a group of 345 deceased white males whose last Ford Motor Company employment was at one of two rear axle assembly plants and who died between 1977 and 1981. No statistically significant excess for any cancer site nor for any other disease was detected. However, the study was limited in its ability to examine specific exposures, because no records of detailed job histories on individual workers existed. The results must be viewed with caution because of the limitations of both the data and the statistical methodology used.

Based on this proportionate mortality study, NIOSH investigators were unable to substantiate the report of excess lung, bone, and stomach cancer among workers at this plant.

KEYWORDS: SIC 3714 (Motor Vehicle Parts and Accessories); cutting fluids; nitrosamines; metal dusts; fumes; lung cancer; stomach cancer; bone cancer; liver cancer.

II. INTRODUCTION

In 1979, a cluster of 10 lung, stomach and bone cancer cases was reported to the National Institute for Occupational Safety and Health (NIOSH) by a former employee of a Ford Motor Company rear axle assembly plant in Sterling Heights, Michigan. Because of this employee communication, an industrial hygiene walk-through survey was conducted and a proportional mortality study of workers from two rear axle assembly plants was performed. Cutting fluid mists, possibly containing nitrosamines, metal dusts, and metal fumes were exposures of concern.

III. BACKGROUND

The deceased in this investigation were men whose last Ford Motor Company employment was at one of two Ford Motor Company rear axle assembly plants in Sterling Heights, Michigan, one of which started operations in 1953 (the Sterling Plant), and the second of which (the Van Dyke Plant) began operations in 1969. Many of the operations in the Sterling Plant were moved there from a third plant (the Mound Road Plant) when it closed in 1956.

Employees at the three plants processed unfinished metal parts received from a foundry. The following is a list of the primary functions that were performed: cutting, grinding, drilling, stamping, broaching, boring, burnishing, lapping, threading, heat treating and pressing, welding, assembling, and painting.

Potential hazards at the plants included metal dusts from grinding; heat, fumes and gases from heat treatment furnaces; burns, fumes, gases, ultraviolet radiation, and electrical shock from welding; and oil mists from cutting and grinding operations.

Cutting, grinding and similar operations were commonly performed using cutting and grinding fluids to flood the point of contact between the metalworking tool and the metal part. Cutting and grinding fluids are classified into three broad categories: insoluble petroleum-based fluids, emulsifiable petroleum-based fluids, and synthetic water-based fluids. Records did not allow identification of which types of cutting and grinding fluids were used at the three plants. During some operations the fluid becomes an aerosol and results in a mist exposure.[1] Potential carcinogenic effects of occupational exposure to cutting fluid mist, particularly cutting fluid mist containing nitrosamines, have been suggested by several researchers.[2-10]

IV. METHODS

Deceased employees from the two axle assembly plants were identified from a company computer tape, which listed individuals who died while they were active plant workers or pensioners. The pensioners were former employees over 25 years of age who had last worked in one of the two plants and whose deaths were reported to the company from October, 1977, through July, 1981. The minimum period of disability-free employment required for employees to receive a pension was 10 years. All active plant employees and all pensioners of the company were covered by a life insurance policy, the premiums for which were paid by the company.

A death certificate or death certificate abstract was available for the deceased for whom life insurance benefits were claimed from the company paid life insurance policy. No death information was available for workers who left employment before qualifying for a pension and who, therefore, were not covered by the company paid life insurance policy. A copy of the death certificate was made by the insurance carrier and routed to the company. Using this death certificate file, 438 deceased workers who died from 1977 through 1981 were identified by the company, and the corresponding death certificates were made available to NIOSH. These years were selected because death records had only been kept by the company in a computer data base since 1977.

The deceased workers selected for study included 347 white males, 79 nonwhite males, 3 white females, and 8 nonwhite females (Table 1). One additional deceased male was of unknown race; no death certificate was obtained for this individual. Deaths included in the mortality analyses were limited to white males due to the lack of sufficient numbers for reliable study of women workers or men from the nonwhite group. The cause of death of one of the 347 white males was considered unknown because the death certificate was illegible. This death was excluded from PMR analyses. Additionally, one of the white male deaths was a foreign death, which was also excluded from the PMR analyses. Thus the basic PMR analysis was restricted to 345 white males.

The exposure histories of individuals could not be reconstructed for a number of reasons. First, complete work records were not available for more than a few of the deceased. Second, information on an individual's employment with the Ford Motor Company, aside from his having worked at the two plants considered here, was not available. Thus other possibly confounding exposures at different Ford Motor Company sites could not be taken into account. Third, the jobs and departments worked in were coded by a numerical system that changed over time, and the meaning of the older codes was no longer known (the coding scheme was discarded). Finally, employees who worked entirely at one of the two plants may have moved from position to position within the plant during their employment, thus possibly experiencing a variety of exposures to metal dusts, fumes and different amounts and types of cutting fluid mists. All that could be concluded was that these men may have had exposure to oil mists, metal dusts, metal fumes, and gases by virtue of their being employed at the plants.

Cause of death determination was made by a qualified nosologist from death certificate diagnoses and the causes were coded according to the 8th Revision of the International Classification of Diseases. The indicator of mortality used was the cause-specific proportionate mortality ratio (PMR). The PMR is the ratio, for a given cause of death, of the number of observed deaths to the number of expected deaths. The calculation is as follows:

PMR = (observed/expected) X 100.

PMRs for specific causes of death were estimated using a computer program developed by Monson.[11] To obtain "expected deaths" the program applied age-, calendar period-, and cause-specific proportions of all deaths in the total United States white male population to the study group of deceased white male workers. Most of the deaths in the study data occurred during the period 1976-1980. Because lung cancer mortality for most age groups has been increasing sharply in the United States, and because United States comparison statistics were only available through 1975, age-specific mortality proportions for lung cancer were projected into the midpoint of the study period (1977) and used in the analysis.[12] Causes of death coded according to the 8th Revision of the International Classification of Diseases, Adapted, (ICDA) were converted by a NIOSH computer program to 7th Revision ICDA codes as required by the Monson program.

Two-tailed significance tests for the PMRs were performed, assuming a Poisson distribution for the number of deaths observed.[13] The test for difference of PMRs by latency in Table 7 was made using a formula for testing trend suggested by Breslow.[14]

Statistical power calculations were performed to provide information about the adequacy of the sample size in relation to specific diseases. Power calculations, the results of which are given in the discussion section, employed a formula derived by Breslow for approximate sample size for variables assumed to follow a Poisson distribution.[15] For these calculations PMRs of 150 for all cancer and digestive cancer and a PMR of 200 for respiratory cancer were chosen as the hypothetical effect sizes of interest, based on results of previous studies.[6,8,10]

To determine if time of employment had any influence on mortality, the study population was divided into two time periods by year of hire. The year 1950 was chosen to divide the subjects into two groups, because roughly equal numbers of subjects for analysis in the two groups was created by division on this year.

V. RESULTS

Of the 347 white male deaths, 305 (89%) occurred among workers last employed at the Sterling Plant (formerly the Mound Plant), 41 (12%) occurred among workers last employed at the Van Dyke Plant, and one death (0.3%) could not be classified as to which of the two plants was the place of last Ford employment.

The distribution by age at death for the deceased white and nonwhite male workers is shown in Table 2. The average age at death was 63 years for the white males and 61 years for the nonwhite males. About 84% of the white males died at ages 40 to 79 years; the corresponding figure for nonwhite males was 88%.

A breakdown by length of employment of deceased workers for whom length of employment data was available is given in Table 3. Due to lack of data on hire and retirement for many deceased white male workers, duration of employment could be examined for only 207 deaths. About 61% of the deceased white males were employed for 20 or more years, and relatively few of the deceased had worked less than 10 years (2.9%) or 40 or more years (2.9%).

The proportionate mortality analyses excluded the foreign death and the death with unknown cause. The cause-specific PMRs for the remaining 345 white male deaths are presented in Table 4. The PMRs were elevated (over 100) for several causes of death, including all cancers combined, but there were no elevated PMRs that were statistically significant. Lung cancer was elevated by 21%, based upon 36 observed and 29.8 expected deaths. The number of deaths due to diseases of the digestive system was significantly less than expected, based upon 6 observed and 15.6 expected deaths.

The PMRs for "all malignant neoplasms" for those hired before 1950 and those hired in 1950 or later were similar (Table 5). Among those hired before 1950, mortality from liver cancer was elevated (PMR = 456), but this elevation was not statistically significant and was based on only two deaths. Among the deceased that were hired in 1950 or later, mortality from cancer of the rectum was elevated (PMR = 301, based on three deaths), but this elevation was not statistically significant. There was a slight lung cancer deficit among those hired before 1950 (PMR = 96, 11 observed) in contrast to a 22% excess among those hired in 1950 or later (PMR = 122, 20 observed). The difference was not statistically significant.

Mortality by duration of employment is shown in Table 6. Deceased workers were classified into three tenure groups -- those with less than 15 years employment, those with 15-24 years, and those with 25 or more years employment. Due to small numbers, the only cause of death categories examined were all malignant neoplasms, lung cancer, circulatory system diseases, nervous system diseases, and deaths due to external causes. There was a consistent pattern of increasing mortality from all malignant neoplasms by duration of employment, but this trend was not statistically significant. No statistically significant excess disease appeared in any duration of employment group.

Mortality by latency is shown in Table 7, where latency was defined as the time interval between date of hire and date of death. An inverse relationship between both all cancer and lung cancer mortality and latency was indicated by the data, showing a greater excess mortality among those with 1-19 years latency than among those with latency of 20 or more years; however this apparent trend was not statistically significant.

VI. DISCUSSION AND SUMMARY

Concerning the causes of death of initial interest, no statistically significant excesses of lung or stomach cancer deaths were found, and there were no deaths found due to bone cancer. Regarding other causes of death examined, among workers hired before 1950, liver cancer deaths were in excess (2 observed versus 0.44 expected), but the excess was not statistically significant. When the cause of death categories were examined by duration of employment, no significant trends were seen. When time interval between death and first employment (latency) was examined, all cancer and lung cancer mortality, as indicated by the PMR, were higher in the 1-19 year latency group than in both the 20-29 years and the 30 or more years latency groups. This result is inconsistent with what one would normally expect in workers exposed to carcinogens.

A review was made of the available epidemiologic literature to determine if the results of the present study correspond with previous findings on the effects of oil mists and cutting fluids. It was found that some researchers have reported increases in digestive and respiratory system cancers, with the evidence being strongest for digestive cancer.

Respiratory cancer. It was reported by Hendricks, et al., in a 1962 paper of exposures to oil mist, that very little was known about lung cancer and inhalation of oil mist. It was suggested that what was reported might be explained by chance variation because of the small number of observations.[2] The type of cutting fluids involved in the studies they reviewed was not reported. It was found in a 1950 study by Huguenin, et al., of 112 lung cancer cases in Paris, that there were 32 cases involving workers with repeated and prolonged contact with oils, 18 of the 32 occurring in metalworkers.[3] Twenty-one cases of bronchogenic carcinoma were reported, of which 8 cases involved individuals exposed to hot oil mists. It must be noted, however, that estimates of the risk relative to a reference population were not made by the authors.

In a study by Waldron of 288 men exposed to oil mist at their jobs, an excess rate of carcinoma of the larynx and the bronchus was found, although the method of analysis was poorly described and thus difficult to evaluate.[4] The type of oil used was not reported. In a study by Menck and Henderson, which used death certificates from 2161 white males aged 20-64 years who had died from lung cancer from 1968-1970 and 1777 lung cancer cases among white males in a Los Angeles county cancer registry, it was concluded there was a 67% greater risk of lung cancer for machine shop workers compared with the

risk for workers aged 20-64 years in all occupations.[5] Exposure to polycyclic aromatic hydrocarbons was mentioned as being a possible etiologic factor. In a study by Decoufle of oil mist exposed men, a small excess was reported for lung cancer (11%), which rose to 26% after 10 years latency.[6,7] It was pointed out that insoluble, soluble and synthetic cutting fluids had been used in the plants connected with this study.

In an unpublished cohort mortality analysis by Nicholson of a study of workers engaged in the manufacture of ball bearings for the automobile industry, no excess lung cancer was found. Synthetic as well as soluble and insoluble oils were reported as having been used as cutting and grinding fluids, and it was pointed out that the nitrite rust inhibitors used, in combination with the amines present in some of the fluids, might have produced nitrosamines, which are possible human carcinogens. It was also suggested that the asbestos on high temperature annealing furnaces might have been dislodged during maintenance and repair activities.

Digestive cancer. In the previously cited Decoufle study of oil mist exposed workers, a small excess was reported for digestive system cancer (25%), which rose to 50% after 10 years latency.[6,7] In the Nicholson study of ball bearing manufacturing workers cited above, it was concluded that causes of death due to kidney and colorectal carcinoma were statistically significantly in excess compared to the United States population.[8] In a study by Jarvholm, et al., involving 792 men who had worked in a bearing ring plant, a statistically significant excess of digestive system cancer was reported, but it was concluded that oil mist exposure was not related to lung cancer.[10] It was reported by the authors that the cutting fluids used were crude mineral oils, soluble and insoluble acid-refined mineral oils, with vegetable or animal oil and sulfur additives, and aqueous sodium carbonate solution with sodium nitrite and dialkanolamines added; it was also noted that the metal processed in the plant contained about 1.5% chromium.

The current study did not detect an overall statistically significant elevation for any cancer. Since the power of the study to find effects of interest among all white male workers for all cancer and for respiratory cancer was high (99%), and for digestive system cancer reasonably good (64%)[15], the negative results may reflect a true absence of any carcinogenic effect. Nevertheless a few caveats should be noted: (1) PMRs are only approximations of the true increased risk of dying from specific causes of death, because an unusual relative frequency for one cause of death may affect risk estimates for other conditions[16]; (2) there may have been a large dilution factor due to the inclusion of workers with no or only slight exposure to cutting fluids or other agents; (3) it is not known whether the deceased individuals studied were representative of the entire population at risk (the deaths studied were only those of active workers or pensioners from 1977 through 1980 that were reported to the company); if these deaths were not representative of all deaths, then it is possible that the PMRs for some causes of death may be biased high or low; and (4) characterizing the work experience of each decedent in terms of calendar period, department, and job was not possible, and the specific kinds and amounts of exposures were not

available. Definite conclusions about work experience and increased risk could not, therefore, be drawn; in particular, estimation of risk specifically for cutting fluid mists or other hazardous substances or conditions was not possible.

VIII. REFERENCES

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IX. DISTRIBUTION/AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available from the National Technical Information Service (NTIS), Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH at the Cincinnati address.

Copies of this report have been sent to:

1. International Union, UAW, Health and Safety Dept.

2. Ford Motor Company Environmental Affairs Dept.

3. OSHA, Region V.

4. NIOSH, Region V.

For purposes of informing the affected employees, the employer shall promptly post copies of this report in a prominent place(s) accessible to the affected employees for a period of 30 calendar days.

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Table 1:
Distribution of Deaths among Workers by Race and Sex

Race	Sex		
	Male	Female	Total
White	347	3	350
Nonwhite	79	8	87
Unknown	1	-	1
Total	427	11	438

Table 2:
Distribution of Deaths among Male Workers by Age at Death and Race*

Age (years)	Number of Deaths**		Percent	
	White	Nonwhite	White	Nonwhite
20-29	8	4	2.3	5.1
30-39	11	3	3.2	3.8
40-49	28	7	8.1	8.9
50-59	59	16	17.0	20.2
60-69	130	25	37.5	31.6
70-79	75	22	21.6	27.8
80 and Over	36	2	10.4	2.5
Total	347	79	100.0	100.0

* Average age at death for white men = 63 years, and for nonwhite men = 61 years.
**1 male death was excluded because of unknown race.

Table 3:
Distribution of Deaths among Male Workers by Years Employed and Race

Years Employed	Number of Deaths* White	Number of Deaths* Nonwhite	Percent White	Percent Nonwhite
0-9	6	0	2.9	0.0
10-19	74	10	35.8	20.4
20-29	85	31	41.1	63.3
30-39	36	7	17.4	14.3
40 and Over	6	1	2.9	2.0
Subtotal	207	49	100.0	100.0
Unknown Years Employed**	140	30	--	--
Total	347	79	--	--

* 1 male death was excluded because of unknown race.
**Last date employed and/or first date employed were unknown. Includes one foreign death.

Table 4.
PMRs and Observed and Expected Deaths among White Male Workers*
for Selected Cause of Death Categories

Cause of Death	Observed	Expected	PMR
All Causes	345	345	100
All Malignant Neoplasms	90	78.02	115
Malignant Neoplasms by Site:			
Buccal Cavity and Pharynx	2	2.27	88
Esophogus	1	1.78	56
Stomach	5	3.02	165
Large Intestine	6	6.84	88
Rectum	4	1.98	202
Liver	2	1.10	182
Pancreas	3	4.05	74
Larynx	1	1.09	92
Lung	36	29.82	121
Prostate	5	5.29	94
Testis	0	0.36	0
Kidney	3	1.85	163
Bladder	2	2.27	88
Skin	1	1.31	76
Brain and other Central Nervous System	3	1.99	151
Lymphosarcoma and Reticulosarcoma	2	1.28	157
Diabetes Mellitus	7	4.88	143
Arteriosclerotic Heart Disease, including Coronary Heart Disease	139	129.38	107
All Respiratory Disease	21	22.48	93
All Diseases of the Digestive System	6	15.57	39**
All External Cause of Death	28	30.90	91
Suicide	9	7.61	118
Other	54	63.77	85

* One foreign death and one death of unknown cause were excluded.
**Significant at the .05 level. In this and following tables, two-sided significance tests shown.

Table 5.
PMRs and Observed and Expected Deaths among White Male Workers for Selected Cause of Death Categories By Year of Hire*

Cause of Death	Year Hired: Before 1950 Obs	Exp	PMR	1950 or Later Obs	Exp	PMR
All Causes	127	127	100	183	183	100
All Malignant Neoplasms	34	29.98	113	48	41.59	115
Malignant Neoplasms by Site						
Buccal Cavity and Pharynx	0	0.86	0	2	1.27	158
Esophogus	0	0.69	0	1	0.96	104
Stomach	1	1.19	84	3	1.53	195
Large Intestine	4	2.71	148	2	3.45	58
Rectum	1	0.79	127	3	1.00	301
Liver	2	0.44	456	0	0.56	0
Pancreas	2	1.59	125	1	2.12	47
Larynx	0	0.43	0	1	0.59	170
Lung	11	11.52	96	20	16.37	122
Prostate	3	2.32	129	2	2.04	98
Testis	0	0.06	0	0	0.28	0
Kidney	1	0.69	146	2	1.04	192
Bladder	1	0.96	105	0	1.02	0
Skin	0	0.39	0	1	0.83	120
Brain and other Central Nervous System	1	0.61	163	2	1.31	153
Lymphosarcoma and Reticulosarcoma	1	0.44	225	1	0.75	134
Diabetes Mellitus	4	1.87	213	2	2.51	80
Arteriosclerotic Heart Disease, including Coronary Heart Disease	50	50.85	98	74	64.19	115
All Respiratory Disease	8	9.21	87	10	10.35	97
All Diseases of the Digestive System	2	5.13	39	4	9.43	42
All External Causes of Death	7	5.52	127	21	24.27	87
Suicide	3	1.46	206	6	5.93	101
Other	22	24.44	90	24	30.66	78

*35 white males were excluded because of unknown dates of first employment; also, one foreign death and one death of unknown cause were excluded.

Table 6.
PMRs and Observed and Expected Deaths among White Male Workers for Selected Cause of Death Categories by Duration of Employment*

Cause of Death	Years Employed: 1-14 yrs. Obs	Exp	PMR	15-24 yrs. Obs	Exp	PMR	25 or more yrs. Obs	Exp	PMR
All Malignant Neoplasms	9	10.31	87	20	19.71	101	27	20.82	130
Lung Cancer	6	4.02	149	8	7.53	106	10	8.21	122
All Diseases of the Nervous System and Sense Organs	4	3.45	116	3	7.06	43	2	6.76	30**
All Diseases of the Circulatory System	21	19.88	106	48	38.89	123	39	40.81	96
Arteriosclerotic Heart Disease, including Heart Disease	17	16.83	101	40	32.84	122	34	34.56	98
All External Causes of Death	2	1.58	126	1	3.05	33	6	3.70	162

* 139 white male deaths were excluded because of unknown dates of employment; also, one foreign death and one death of unknown cause were excluded.
**Significant at the .05 level.

Table 7.
PMRs and Observed and Expected Deaths among White Male Workers for Selected Cause of Death Categories by Latency (Years Between Hire and Death)*

Cause of Death	Latency: 1 - 19 years Obs	Exp	PMR	20 - 29 years Obs	Exp	PMR	30 or more years Obs	Exp	PMR
All Malignant Neoplasms	21	17.01	123	31	28.04	110	30	26.53	113
Lung Cancer	9	6.49	139	14	11.25	124	8	10.15	79

* 35 white males were excluded because of unknown latency; also, one foreign death and one death of unknown cause were excluded.