SELECTED LEADS FROM THE 1984 OCCUPATIONAL MORTALITY SURVEILLANCE DATA

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July 25, 1989

ABSTRACT

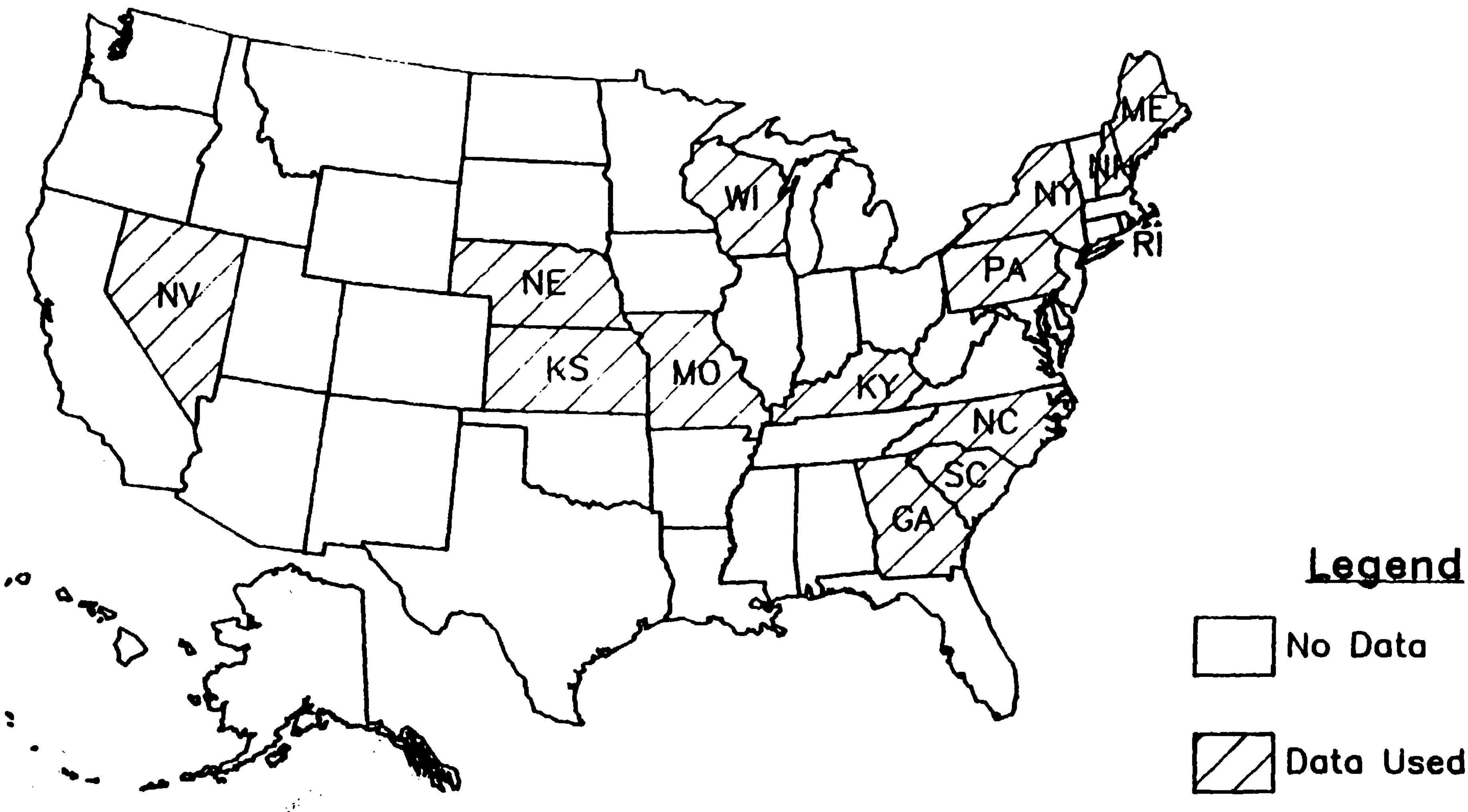
The occupational mortality experience of fourteen U.S. states was recently evaluated. The purpose of the evaluation was to identify leads--occupational groups that appeared to be at excess risk for cause-specific mortality. Occupational groups not easily studied by other methods, such as small businesses and non-unionized industry were emphasized. We observed significant excess proportionate mortality in the fourteen state data for several not easily studied occupations. This is described in our report for the purpose of hypothesis generation, research prioritization, and the design of follow-up studies.

Deaths for 880,012 adults over age 15 were included from Georgia, Kansas, Kentucky, Maine, Missouri, Nebraska, Nevada, New Hampshire, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina and Wisconsin. The majority of deaths occurred in 1984, although a few states included deaths from other years, 1979-83 and 1985. Age-adjusted, race- and sex-specific proportionate mortality ratios (PMRs) were analyzed by occupation to detect unusual patterns or clusters of deaths. Significantly increased PMRs were observed for several occupations and evaluated in comparison with previously reported surveillance studies. The associations described in this report included leukemia mortality in communications workers; intestinal and bladder cancer in dry cleaning workers; acute myocardial infarction in textile workers; other forms of heart disease in textile and apparel mill workers; rheumatic fever and rheumatic heart disease in teachers, salesmen, and homemakers; cancer of the larynx in printing machine operators; kidney cancer in machinists; and work-related electrocutions. Recommendations for follow-up were made for associations that appeared to suggest fruitful areas for more analytical investigations.

Figure 1

Occupational Mortality Surveillance Data

States Included in 1984 PMR Study



INTRODUCTION

The mortality experience of fourteen states for 1984 and other selected years, 1979-1985, was recently analyzed by occupation and industry. Analyses were based on death certificate statements of usual industry and occupation for 880,012 decedents. The states included in analyses were Georgia, Kansas, Kentucky, Maine, Missouri, Nebraska, Nevada, New Hampshire, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, and Wisconsin (Figure 1). All of these states contributed deaths for 1984. Some of the states that participated in the SCANS (Lalich 1989) program of surveillance cooperative agreements also contributed deaths from other years, including 1979-83 and 1985.

The data were obtained by the Surveillance Branch of NIOSH through collaboration with the state health departments during the development of routine coding of occupation and industry entries on death certificates (Lalich 1989). Coding of decedent industry and occupation was done by trained clerks who maintain a standard of 95% accuracy. The fourteen states were among the first of the state health departments to develop such capability, although now 31 states are routinely coding decedent occupation and industry.

Surveillance of cause-specific mortality patterns by occupation and industry is a simple and relatively inexpensive approach to the detection of clues to potentially occupationally-related disease (Dubrow 1987). The purpose of this evaluation was to identify particular occupational groups in the fourteen states that appeared to be at excess risk for mortality. Occupational groups not easily studied, such as small businesses or non-unionized industry were emphasized in this report. In addition, we had received requests from several researchers in the Industry-wide Studies Branch for PMRs for occupations and industries being considered for in-depth epidemiologic study. We included these PMRs in this report for purposes of dissemination, since many of these PMRs represent the less studied industries or occupations. Proportionate mortality studies can often provide leads worth pursuing about causal relations (Rothman 1986). Because the purpose of this report was to identify increased risks, only selected elevated PMR's are shown in the tables. More in-depth analyses are available upon request, from the investigators.

We have completed a preliminary review of the results of the analyses. Selected elevated proportionate mortality ratios (PMRs) were evaluated in comparison with the findings of previously reported studies. Many of the associations that we observed between occupation or industry and particular causes of death were reported previously in similar surveillance studies. Recommendations for follow-up studies have been made for several of the significantly elevated PMRs discussed in this report. This report describes some of the more striking associations from the fourteen state analysis that, when interpreted in conjunction with other information, appeared to suggest fruitful areas for the development of more analytical investigations.

METHODS

Occupational mortality analyses were conducted on these data for selected occupational and industry groupings for decedents aged 15 or more years at death. The age-adjusted proportionate mortality ratio (PMR) was the index used to measure occupational mortality. PMRs are usually calculated when data are not available for the population at risk. The relative advantages and disadvantages of PMRs have been discussed in several articles (Registrar 1986, Lalich 1989).

A computer program developed at NIOSH was used to calculate PMRs (Dubrow 1986). The PMR was defined as the ratio of the number of observed deaths divided by the number of expected deaths and multiplied by 100. The expected number of deaths for a particular cause in an occupation or industry group was calculated based on the proportion of all deaths due to that cause in the entire study population. Causes of death were coded according to the 9th Revision of the International Classification of Diseases (WHO 1975). The corresponding codes appear in the tables. Occupation and industry were coded according to the 1980 Census and these codes appear also in the tables.

Industry-specific occupation analyses were run for the manufacturing industries, in addition to the PMR analysis by industry and occupation. For this, broad groups of industry-specific blue-collar occupations were analyzed. Please refer to the Appendix for a more detailed description. The section on kidney cancer in machinists illustrates these analyses.

Significance testing at ($p<.05$) and ($p<.01$) was done using the chi-square statistic (Lilienfeld 1980). For PMRs based on fewer than five expected deaths, 95% and 99% significance factors for the ratio of an observed value of a Poisson variable to its expectations were applied to test for statistical significance (Bailar 1964). Future analyses of the occupational mortality surveillance data are planned to include about two and a half million deaths, through 1986. This should tend to alleviate the problem of calculation of PMRs based on small numbers of deaths. Because multiple comparisons were made and no cause of death was hypothesized a priori to be occurring in excess, the p values were evaluated in the context of hypothesis generation. Age-adjusted mortality odds ratios (Mantel 1959) were calculated, in addition to PMRs, for selected groupings to enhance the validity of the comparisons.

The association of elevated risk for leukemia and other cancers with environmental exposures to extremely low frequency, non-ionizing electromagnetic fields emitted by electrical installations and equipment using alternating current at 50-60 Hertz has caused increasing concern in the last ten years. Some state-based or other studies of the association between cancer and occupation have reported elevated risks for leukemia, particularly acute myeloid leukemia (AML) for occupations involving work with electricity generation and transmission equipment.

Elevated PMRs between 200-300 for acute leukemia (AL) or acute myeloid leukemia (AML) have been reported in telegraph and telephone operators (Calle 1985, McDowall 1983, Milham 1982). A PMR of 239 was reported for AML in amateur radio operators (Milham 1985). PMRs for AL mortality in power or telephone linemen were reported to be 143 (Calle 1985) and 183 (Milham 1982), although a tumor registry-based study in Los Angeles reported highly significant PMRs of 816 for power linesmen and 768 in telephone linesmen (Wright 1982). Elevated PMRs for both leukemia mortality and incidence were reported for men employed in electrical occupations in England and Wales (McDowall 1983). Aluminum workers, known to be exposed to strong magnetic fields in the aluminum-reduction process, were reported to have a PMR of 189 for all leukemia (Milham 1982). The possibility that occupational exposures to frequencies high enough to cause thermal changes in exposed workers has been hypothesized as the biological cause of the elevated risks for leukemia.

Proportionate mortality risk due to leukemia was elevated significantly in the fourteen state data among men whose usual occupations may have involved direct or indirect exposures to electromagnetic radiation or body currents. The occupations included jobs in the communications, electronics, and primary aluminum industries. According to the NIOSH job exposure matrix, potential exposure to a form of electromagnetic radiation was observed during the NOHS survey (Sieber 1989) for some occupations in the electronics industry and the communications industry, including the telephone industry and telephone installers and repairers, as shown in Table 1. It is known that aluminum industry pot room workers have exposures to electric currents and excess leukemia risk has been reported for aluminum workers (Milham 1982).

In Table 1, the fourteen state elevated PMRs for leukemia are displayed for these occupations. The highest PMRs were observed in communications workers. The PMR for AML in white male telephone and telegraph workers was almost five times that expected for other occupations (PMR=499, 3 deaths observed, $p<.05$). The PMR for AML in telephone line repairers was over 3 times as high as other occupations, although not significant based on 2 deaths (PMR=347, 2 deaths observed).

Several significantly elevated PMRs were observed for all leukemia. The PMR for AL in the electronic computing equipment manufacturing industry was almost twice as high as expected (PMR = 193, 18 deaths observed, $p<.01$). The PMR for telephone line repairers and installers aged 15-64 and presumed working at time of death, was almost four times as high as expected (PMR=398, 4 deaths observed, $p<.05$).

The fourteen state mortality data suggest that telephone and telegraph workers and telephone line repairers and installers, in particular, may be experiencing excess mortality for leukemia, particularly myeloid leukemia. The PMR for white female telephone and telegraph workers was not elevated, suggesting gender-related job exposure differentials. Confirmation of these and previously reported PMRs should be sought in a carefully designed case-control study of leukemia incidence where interviews can be conducted with living incident cases and follow back can be made to identify and measure any potential occupational exposure. The elevated PMRs observed in the electronics computing equipment manufacturing industry and in computer programmers suggest that this industry may be at increased risk for leukemia mortality. This possibility should be confirmed by more in-depth research.

The appropriate measurement of electromagnetic radiation field exposures as well as identification of the other occupational or environmental exposures that may be associated with excess risk for leukemia should be addressed in any future studies. The elevated proportionate leukemia risk observed for some communications industry occupations and other occupations, should be interpreted conservatively until workplace exposures are more carefully evaluated and well-designed epidemiologic studies are conducted on workers at risk.

Table 1

Elevated PMRs For Leukemia Mortality Among White Males Whose Potential Occupational Exposures May Have Included Electromagnetic Fields

Industry	Occupation	All++ Leukemia PMR(No.Obs)	Acute++ Myeloid Leukemia PMR(No.Obs)	All++ Myeloid Leukemia PMR(No.Obs)	Acute++ Lymphoid Leukemia PMR(No.Obs)
Communications Industry+(440-42)		120(32)	159(13)	132 (16)	319*(15)
Telephone+ (Wire and Radio)(441)		118(24)	144(9)		
Radio, TV broadcasting(440)		130(5)	242(3)		
	Telephone & Telegraph Operators (306, 348-53)	194(4)	499*(3)	334(3)	
	Telephone Line Repairers & Installers (527)	398*(4) age 15-64	347(2)	347*(3) age 15-64	
	Telephone Installers & Repairers+ (529)	125(8)			933*(2) age 15-54
Electronic Computing Equipment Mfg.+ (322)		193**(18)			
	Computer Programmers (229)		535*(3) age 15-54		
Primary Aluminum(272)		358*(6)			

* p<.05
** p<.01
+Exposure is per NIOSH job exposure matrix.
++ICD codes: All Leukemia 204-8; Acute Myeloid Leukemia 205.0; All Myeloid Leukemia 205; Acute Lymphoide Leukemia 204.0.

Intestinal and Bladder Cancer in Dry Cleaning Workers

Two previous mortality studies have reported finding elevated, but not significant, risks for intestinal cancer among dry cleaning workers. An SMR of 136 was reported for intestinal cancer in a historical cohort study of dry cleaning workers potentially exposed to perchloroethylene (Brown 1987). Perchloroethylene is not regulated as a carcinogen, although a National Toxicology Program study found a dose-related increase of liver cancer in mice and an increased incidence of kidney cancer in rats. Brown also reported an SMR of 400 for bladder cancer among female dry cleaning workers in the same cohort. The excess risk appeared related to length of employment. In an earlier proportionate mortality study of a laundry and dry cleaning workers union, a PMR of 152 was reported for intestinal cancer (Blair 1986).

In the fourteen state data, statistically significantly elevated PMRs were observed for intestinal cancer for men and women employed in the laundry, cleaning and garment services industry. Women employed as laundry and dry cleaning machine operators were found to have a statistically significant PMR for cancer of the small intestine (PMR=598) (Table 2). White male laundry, cleaning and garment services workers had a significantly elevated PMR for colon cancer (PMR=131). Cancer of the bladder was significantly elevated in females (PMR=178) but not in males (Table 2).

We recommended that the proportionate excess of death be followed up with analysis at the state or county level using existing data. Dry cleaning workers have been found to be difficult to study because of their employment pattern in small businesses. Because regional use of the perchloroethylene process has been reported, county level analysis of this industry may be useful. For example, the use of petroleum solvents, rather than perchloroethylene, as the primary dry cleaning solvent is more common in Oklahoma.

Table 2

Elevated Risk For Intestinal and Bladder Cancer in Dry Cleaning Workers

Industries/Occupations	Colon Cancer (153) PMR (No. obs).	Bladder Cancer (188) PMR (No. obs).
Laundry Cleaning & Garment Services (771)		
white males	131*(53)	
white males, ages 15-64	186*(18)	
females		178*(14)
Laundry & Dry Cleaning Machine Operators (748)		
females	598*(3) (small intestine)	221(8)

*p<.05

Acute Myocardial Infarction Mortality in Textile Workers

Only limited evidence exists for excess coronary heart disease (CHD) mortality in previous studies of textile workers. Statistically significant excess mortality from coronary heart disease was reported among Rhode Island textile workers in the previous decade (PMR = 106, p<.01) (Dubrow, 1988), among a cohort of U.S. cotton mill workers of both sexes engaged in yarn processing (SMR = 137 p<.01) (Merchant 1981), and among Finnish viscose rayon textile workers exposed to carbon disulfide (Nurminen 1982).

In the fourteen state data, significantly elevated PMRs were observed for acute myocardial infarction (AMI) for several textile industry groupings. PMRs were elevated for all four race-sex groups in the textile mill products industry and in yarn, thread and fabric mills (Table 3). These excess risks are striking for two reasons. First, they occurred in more than one race-sex group in each occupation. Second, many deaths were affected, although the PMRs exhibited relatively small increased ratios. Significantly elevated PMRs are shown in Table 3 for both black male and white female textile and apparel and winding and twisting machine operators.

We controlled for geographic region in a subsequent analysis because coronary heart disease mortality in the general population varies regionally, (CDC 1985). Textile mill workers in Southern states were found to have a higher proportion of deaths due to AMI than other workers did. The Southern states included were Georgia, Kentucky, South Carolina and North Carolina. The PMR for the mills in the Southern region was significant at p<.01 for 3 race sex groups: white males, black males and white females when compared to Southern workers in all other occupations. This indicated that geographic region was not a factor in the excess.

Occupational factors and blue collar status (Holme 1980) have been shown to be risk factors for heart disease mortality, although coronary heart disease has a multi-factorial etiology. Cigarette smoking, hypertension and cholesterol are considered the primary determinants of excess risk in the general population (Harlan 1981). Blue collar status as a risk factor in textile industry workers will be controlled in subsequent analyses of the 14 state data set.

Data describing the occupational environment of textile workers was reviewed. There may be several different potential exposures in textile mills that may be cardiotoxic, including noise, dust, and solvents (Merchant 1981). The textile industry is non-unionized and has been traditionally difficult to study. Since exposures vary by types of textile industry, county employment percentages may be useful in identifying textile industries at risk.

Data from the 1978-80 National Health Interview Survey smoking questionnaire (Brackbill 1988) are somewhat contradictary for textile industry workers. Overall, textile industry workers had a very high proportion of never-smokers; and smoked about as many cigarettes as other industries; although they had the highest percent of current smokers.

Table 3

Elevated PMRs For Acute Myocardial Infarction (410)
Mortality In Textile Mill Workers

Occupation/Industry	White Males PMR(No.Obs)	Black Males PMR(No.Obs)	White Females PMR(No.Obs)	Black Females PMR(No.Obs)
Textile, Apparel, Furnishings Machine Operators (738-49)		130*(57)	108**(2227)	
Winding & Twisting Machine Operators (738)		183(5)	117**(592)	
Shoe Machine Operators (745)			120**(205)	
Textile Mill Products Mfg. (132-50)	109**(2710)	135**(173)	111**(1926)	116(45)
Yarn, Thread, Fabric Mills Mfg. (142)	108**(2211)	140**(162)	111**(1578)	118(38)
Miscellaneous Textile Mill Products Mfg. (150)	128**(119)			

* $p < .05$
** $p < .01$

Other Forms of Heart Disease in Textile and Apparel Mill Workers

"Other Forms of Heart Disease" (ICD 420-9) is a cause of death category that includes other less common types of heart disease. Included are pulmonary heart disease; acute pericarditis, endocarditis or myocarditis; valve and conduction disorders; cardiomyopathy; cardiac dysrhythmias; ill-defined or complications of heart disease (WHO 1978). Some of these diseases, arrhythmias and cardiomyopathies, may be directly related to occupational exposures (CDC 1985). Fatal and nonfatal arrhythmias have been reported previously in animal studies, case series or case reports following exposures to common industrial solvents and fluorinated hydrocarbons (Robinson 1988). Cardiomyopathies have been associated with occupational exposure to some metals. Chronic exposure to occupational noise has been associated with sustained increases in blood pressure, particularly in workers with noise-induced hearing loss. Some kinds of heart failure have been associated with restrictive lung disease (CDC 1985).

Table 4 shows highly significant raised PMRs in the 14 state data set for "other forms of heart disease" among white men and women who worked in textile and apparel mills. Occupations with high PMRs in Table 4 were textile sewing machine operator and pressing machine operator. Significantly elevated PMRs were observed for female workers (PMR = 116, 659 deaths, $p<.01$) and male workers (PMR = 120, 172 deaths, $p<.05$) in apparel and accessories manufacturing. Men whose usual industry was miscellaneous fabricated textile products manufacturing had significant excess risk for heart disease mortality (PMR = 167, 27 observed deaths, $p<.01$). Excess respiratory disease mortality and morbidity has been associated with cotton and other textile mill work (Merchant 1981). The raised PMRs for other forms of heart disease might be evaluated further in surveillance data using multiple cause of death codes to see if these workers experienced any excess of respiratory disease as contributory causes of death.

Table 4

Elevated PMRs For Other Forms Of Heart Disease (415-29)
Mortality In Textile and Apparel Mill Workers

Occupation/Industry	White Males PMR (No. obs deaths)	White Females PMR (No.obs deaths)
Textile Sewing Machine Operators (744)	130*(58)	110**(666)
Pressing Machine Operators (747)		140**(55)
Apparel & Accessories Mfg, exc Knit (151)	120*(172)	116**(659)
Misc. Fabricated Textile Products (Mfg) (152)	167**(27)	

*p<.05
**p<.01

White Collar Occupations with Raised PMRs for Rheumatic Fever and Rheumatic Heart Disease (RFRHD)

Table 5 displays significantly increased PMRs for Rheumatic fever and Rheumatic Heart Disease (RFRHD) among teachers (PMR = 195), salesmen (PMR = 130), and white male chemists (PMR = 390). Significantly increased PMRs were noted among white female teachers (PMR = 124) and housewives (PMR =109). It was hypothesized that secondary attacks of rheumatic fever and rheumatic heart disease causing increasing valvular damage could be occurring at an increased rate in susceptible teachers. Susceptible teachers were defined as having had at least one initial attack of rheumatic fever complicated by rheumatic heart disease and who are not maintaining regular prophylactic penicillin G. This would be especially risky for teachers in an occupational environment where respiratory disease rates are higher than normal as in the schools. With each subsequent strep throat infection, a susceptible teacher could sustain valvular heart damage as a result of the complication of rheumatic heart disease.

Apparent increases in Acute Rheumatic Fever (ARF) have been reported recently in several states, including Utah, Pennsylvania and Ohio, particularly in mountainous areas (CDC 1988). (Of these three states only Pennsylvania was included in the fourteen state analyses). ARF is known to occur following no treatment or unsuccessful treatment of strep throat, an intensively contagious upper respiratory tract infection. The incidence of RFRHD morbidity has been reduced for the last four decades through the use of penicillin and improvements in the standard of living for most of the Western countries. However, it apparently is still responsible for significant morbidity and mortality in the developing countries that make up about 2/3 of the world's population (Kaplan 1985). Although this disease has not been directly related to an occupational risk factor, the need for carefully designed epidemiologic studies to evaluate the complex factors that influence its distribution have been emphasized (Kaplan 1985).

The role that an occupational setting may play in the spread of this disease, and in these deaths, should be investigated further. The work setting of these occupational groups may present unique opportunities for intervention and prevention.

Table 5

Elevated PMRs for Rheumatic Fever and Rheumatic
Heart Disease (390-98) in White Collar Workers and Housewives

Occupation/Industry	White Males PMR (No. obs)	White Females PMR (No. obs)
Chemists, exc. Biochemists (73)	390** (7)	
Teachers (113-59)	195** (27)	124* (98)
Sales Occupations (243-85)	130** (130)	
Housewives, Homemakers (914)		109** (1319)

*p<.05
**p<.01

Cancer of the larynx in the printing industry

Epidemiologic studies have linked cancer of the larynx with tobacco and alcohol use. Suspected occupational exposures include asbestos, nickel and mustard gas (Schottenfeld 1982). An analysis of the mortality rate from laryngeal cancer, by county, for 1950-1969 in the United States found that increased mortality was correlated with the presence of chemical and printing industries and shipyards in the counties (Blot 1978).

The fourteen state analysis found highly significant PMRs for laryngeal cancer for white men in the printing industry, and especially for printing machine operators. These results are shown in Table 6. Printing machine operators have significantly elevated PMRs for both the 15-64 and the 65 and over age groups. Those in the Northeast region of our regional analysis had over a three-fold excess of laryngeal cancer.

This association was found in two other state surveillance reports, the Rhode Island 1979-1984 report (Buechner 1988) and the Washington State 1950-1979 report (Milham 1983). The PMR for male printing machine operators in Rhode Island was 764 ($p < 0.01$) with 6 observed deaths. White male printing pressmen, plate printers and type setters in Washington State experienced a PMR of 216 ($p < 0.05$) with 8 observed deaths. Five studies of the printing industry show varying results, as seen in Table 7. Three of the five had increased mortality.

Since the Rhode Island data were included in the fourteen state analyses, case-control analyses with and without the Rhode Island data were done to assure that the excess deaths were not primarily from Rhode Island. Odds ratios were calculated for white male printing machine operators employed in the printing industry. (For an explanation of the method used to calculate an industry-specific occupation analysis, please refer to the appendix.) To control somewhat for lifestyle factors, the comparison group was machine operators in all other industries who had not died of cancer. The results of this analysis are displayed in Table 8. While the odds ratio decreased without the deaths from Rhode Island, there was still a two-fold excess ($p<.01$).

Although the results from other studies are not highly supportive of this association, the strength of the association in the fourteen state analysis suggests a need for followup. The association remains highly significant when printing machine operators are compared with machine operators in other industries, suggesting that there is a risk factor other than lifestyle.

This lead could be evaluated with a death certificate-based case-control study. The Northeast states had the highest concentration of printing industry deaths. A follow-up study could use all of the available Northeast state data not included in this analysis. This would be primarily the 1985 and 1986 data received through NCHS. Death certificates would be used to verify and add to the industry and occupation information. If the study confirmed the lead, a case-control study of printing machine operators, with detailed work histories to identify potential exposures and information on smoking and alcohol consumption, should be considered.

Table 6

Laryngeal Cancer (161) PMRs in White Male Printing Machine Operators (734)

Occupation/Industry	Age 15-64 PMR(No. obs)	Age 65+ PMR(No. obs)	Age Total PMR(No. obs)
Printing machine operators	300 (9)**	265 (10)*	280 (19)**
Printing machine operators/ Northeast	286 (7)*	328 (10)**	310 (17)**

*p<.05
**p<.01

Table 7

Other Studies Reporting PMRs for Laryngeal Cancer in the Printing Industry

Study	Observed	Expected	PMR
London Newspaper workers (Greenberg)	0	>1	-
Printing Union Members (Lloyd)	19	14	136
U.S. Government Printing Office Employees (Greene)	3	7.5	40
Milan Newspaper Workers (Bertazzi)	3	1.5	196
Swedish Cancer Registry (Malker)	18	16.4	110

Table 8

Laryngeal Cancer (161) Odds Ratios in White Male Printing Machine Operators (734) in the Printing Industry (171-2)

Data Source	Age 45-64 OR(No. Deaths)	Age 65+ OR(No. Death)	Age Total OR(No Deaths)
14 States	2.82 (8)**	2.62 (12)**	2.69 (20)**
Without Rhode Island	2.97 (8)**	1.57 (7)	2.09 (15)**

**p<.01

Kidney Cancer in Machinists in the

Machinery Manufacturing Industries

Only a few studies have suggested that occupational exposures may be related to kidney cancer. Cigarette smoking appears to be the major known risk factor. It was estimated that from 85% to 90% of kidney cancer cases in the U. S. in 1983 would arise in the renal parenchyma; these are called renal cell cancer (Cutler 1975). An estimated 10% of kidney cancers would arise in the renal pelvis; these are called renal pelvis cancer. Risk factors for the two types of cancer may be different.

A recent study of occupational risks for kidney cancer used data from the Swedish Cancer-Environment Registry for the years 1960-1979 (McLaughlin 1987). This is a population-based registry for the entire country. They examined renal cell cancer and renal pelvis cancer separately, by industry and occupation. Standardized incidence ratios (SIR'S) were computed. SIR's for the machine industry were elevated for both types of kidney cancer (renal cell cancer SIR=1.13, $p<.05$, renal pelvis cancer SIR=1.60, $p<.01$). Among the occupations with elevated SIR's for renal pelvis cancer was 'machinists and toolmakers (SIR=1.52, $p<.05$).

A case-control study of renal pelvis cancer in Minnesota (McLaughlin 1983) found an increased risk associated with occupational exposure to mineral or cutting oils (OR=2.8, $p<.05$). Since machinists have exposures to mineral and cutting oils, this suggests that renal cancer in machinists is biologically plausible.

The 14 state analyses by occupation and by industry showed no statistically elevated PMRs for kidney cancer for machinists nor for the two machinery manufacturing industry groups. However, results from the industry-specific occupation analyses showed an elevated risk for kidney cancer in several occupation/industry categories (Table 9). The results for white males showed elevated PMRs for precision production occupations (which includes machinists and toolmakers) in the electrical machinery manufacturing industry (observed deaths=22, PMR=200 p<.01) and the non-electrical machinery manufacturing industry (Observed deaths=34, PMR=141 p<.05). For black males, the results were elevated for precision production occupations in the non-electrical machinery manufacturing industry (observed deaths=3, PMR=739, p<.05) (Table 9). Because industry-specific analyses include only blue collar workers, they are controlling crudely for socio-economic status and for other risk factors related to lifestyle. (Please refer to the Appendix for an explanation of methods used in the blue collar analysis.)

A search of other surveillance studies found that the NIOSH Rhode Island 1968-1978 analysis (Dubrow 1985)reported a non-significantly elevated PMR of 155 (15 observed deaths) for kidney cancer in machinists. The non-electrical machinery manufacturing industry had a PMR of 158, p<.05. The Roswell Park cancer study (Decoufle 1977) reported a relative risk of 3.59, based on three cases, for machinists. Other surveillance studies did not report statistically significantly elevated ratios for kidney cancer in these groups.

Since there appears to be a difference in the etiology of renal cell cancer and renal pelvis cancer, an initial follow-up step could be to obtain the death certificates for decedents in the machinery manufacturing industries with renal cancer as the underlying cause of death. Information from the certificates could be used to try to obtain medical records reporting the cell type. We recommend that a follow-up death certificate-based case-control study of the machinery manufacturing industries be conducted.

Table 9

Kidney Cancer PMRs in the Industry-specific Occupation Analysis

for Precision Production Occupations in the

Non-Electrical Machinery Industry

Occupation/Industry	15-64 PMR(No.obs)	65+ PMR(No.obs)	Total PMR(No.obs)
White males			
Precision production occupations			
Electrical machinery mfg	226 (12) **	176 (10)	200 (22) **
Non-electrical machinery mfg	203 (20) **	89 (14)	141 (34)*
Black males			
Precision production occupations			
Non-electrical machinery mfg	1177 (3) **	0 (0)	739 (3) *

* p < .05

** p < .01

8. Occupational Electrocutions

Work-related electrocutions are the fifth highest cause of occupational injury deaths. Based on data provided both by the Bureau of Labor Statistics and the National Safety Council, electrocutions account for between 7 and 10% of occupational fatalities, ranging between 700 and 1000 electrocution fatalities in 1984 (National Safety Council 1984, Bureau of Labor Statistics 1984). NIOSH has, through the Fatal Accident Circumstances and Epidemiology (FACE) study conducted by the Division of Safety Research, completed up to 145 separate investigations that define preventive mechanisms of occupational electrocutions; follow-up such as this is critical. However, only one study has reported specific industries or occupations at the highest risk of occupational electrocutions (Hristitj 1973).

The fourteen state analysis results showed that some broad industry and occupational categories have a significantly higher proportion of electrocutions than expected (See Tables 10 and 11). For instance, 20 observed electrocutions in the electric and gas industry resulted in nearly an 8- fold greater than expected number of deaths from accidents caused by electricity (Table 10). One would expect that most of these electrocutions are occupationally related, since workers in professional and related services, who were at low risk of electrocution, experienced only 6 electrocutions, resulting in a PMR of 38. Although those in farming and construction occupations have an excess risk of death from electrocutions, those employed as electricians or firefighters are at a higher proportionate risk (PMR = 639, $p < .01$) in contrast to Service occupations (PMR=41, $p < .01$) (Table 11).

When the number of deaths that occurred in 1984 were stratified by type of electrical wiring and age at death, Table 12 shows the following:

1. There were at least 50% (34% vs. 22%) proportionately more deaths in the younger working group of 20-29 year olds than the other age groups in table 12. According to Employment and Earnings statistics, the number of men employed in 1984 in the 20-29 age group and 30-39 are nearly equal (BLS). This suggests that 20-29 year olds are at a much higher risk of occupational electructions than other age groups.

2. Again, for accidents occurring in electric power generating plants and power distribution stations (ICD 925.1), there were more than twice as many deaths from electrocutions in the 20-29 group as compared to 30-39 group (17 vs. 7 observed deaths).

3. However, for accidents occurring in industrial wiring plants (ICD 925.2), the number of deaths in the 30-39 age group accounted for nearly half of the deaths for that cause category with the 20-29 year olds having the second largest number of deaths.

We propose using death certificate data further in evaluating occupational injury fatalities due to electrocution. This is particularly important for assessing programs such as FACE. It is interesting to note that two methods of ascertaining deaths from electrocution compare relatively well. Table 13 shows that for the same year, 1984, the National Traumatic Occupational Fatality (NTOF) data base did not obtain substantially different estimates from the fourteen state data (1984 deaths only) for the total number of electrocutions. NTOF first collected the death certificates from the individual states by selecting those that had accident on the job checked 'yes' and had an E 800-999 ICD code. The counts shown in Table 13 for NTOF resulted from searching cause of death for mention of electricity. The number of most likely directly industrially related deaths (ICD 925.1 and 925.2) are underenumerated according to the NTOF data. It is even more important to evaluate this information, when one considers that of the 145 electrocutions investigations by FACE, 89 (61%) fall into ICD 925.1, accidents occurring in power generating plants or distribution systems.

Table 10

PMRs by Industry for Accidents Caused by Electricity (E925) males

Industry	Number Observed Deaths	PMRs
Construction (60)	80	221**
Agriculture (10-20)	22	207**
Utilities and Sanitary Services, Electric & Gas (462)	20	847**
Professional and Related Services (812-899)	6	38*

* p<.05
** p<.01

Table 11

PMRs by Occupational Groups for Accidents Caused by Electricity (E925) in males

Occupational Group	Number Observed Deaths	PMR
Farming and related occupations (473-9, 484-9)	28	227**
Construction Laborers (869)	16	192**
Carpenters (554, 567, 569)	14	186*
Electricians and power transmission installers (555, 575-7)	31	798**
Firefighting occupations (413, 417)	4	639**
Service occupations (403-69)	9	41**

* p<.05
** p<.01

Table 12

Distribution of electrocutions by age and ICD
for accidents caused by electricity, all males, 1984 deaths only

ICD	AGE 17-19	20-29	30-39	40-49	50-59	60+	Total
Number of Deaths in:							
E925.0,	3	2	3	4	1	4	17(11.0%)
Domestic wiring	17.6%	11.8%	17.7%	23.5%	5.9%	23.5%	100.0
E925.1	1	17	7	10	5	0	40(25.2%)
Electric power generating plants and power distribution	2.5%	42.5%	17.5%	25.9%	12.5%	0.0%	100%
E925.2	1	4	8	3	1	0	17(10.7%)
Industrial wiring	5.9%	23.5%	47%	17.6%	5.9%	0.0%	100%
E925.8	5	22	15	12	4	1	59(37%)
Other - Schools, outdoors farms, public places	8.5%	37.3%	25.4%	20.3%	6.8%	1.7%	100%
E925.9	2	9	3	7	3	2	26(16.1%)
Unspecified	7.7%	34.6%	11.5%	26.9%	11/5%	7.7%	100%
Total Number of Deaths	12	54	36	36	14	7	159
Total Percent	7.6%	34%	22.6%	22.6%	8.8%	4.4%	100%

Table 13

Comparison of number of electrocutions for 1984 by state for NTOF AND 14 States data

State	Total NTOF	Total 14-States	ICD E925.1, 925.2 14-States
GA	25	19	4
KA	9	14	1
KY	13	15	4
ME	2	3	1
MO	13	18	9
NB	7	9	1
NV	8	2	1
NH	2	2	1
NY	18	15	8
NC	18	23	12
PA	19	26	8
RI	0	0	0
SC	9	7	5
WI	8	11	3

REQUESTED PMRs

Requests were received from researchers in Industry-Wide Studies Branch for selected PMRs from the surveillance occupational proportionate mortality analyses. In response, the PMRs for specified causes of death and/or specified occupation and industry groups were retrieved. These PMRs are displayed in Tables 14 and 15 included for the reader's discretionary use. Table 15 lists the PMRs requested for white males and Table 14 lists PMRs for white females. Ages 15-64 was separated from ages 65+ because both occupation and cause-of-death information is known to be less reliable for older retired persons. In Table 14 the phrase "none reported as high" indicates that the PMR for that cause was not elevated or lowered significantly in at least one of the age groups. Only elevated PMRs were included in Tables 14 and 15.

PMRs for several of the requested occupations were available only as part of a larger grouping. As more mortality data is acquired with the addition of more states and more recent years, the larger data set will permit the selection of more specific industrial groupings, as well as the analysis of trends.

Table 14
Requested PMRs, Males

Occupation	Industry	Cause of Death	AGES 15-64 No. Obs	15-64 PMR	65+ No. Obs	65+ PMR	All No. Obs	All PMR
Janitors (453)		Bladder Cancer	39	134	89	110	128	117
Welders (783-4)		Lung Cancer	203	120**	229	115*	432	118**
Welders (783-4)	Fabricated Metal production(281-301)	Lung Cancer	34	140*	-	-	56	116
Welders (783-4)	Machinery, exc. elect.(310-32)	Lung Cancer	30	161*	-	-	53	126
Welders (783-4)	Transport. Equipment (351-70)	Lung Cancer	-	-	37	121	-	-
	Hospitals(831)	Myeloid Leukemia	18	182**	10	106	28	145*
Health Diagnosing Occupations (84-9)		Non-Hodgkins's Lymphoma	20	240**	22	167*	42	196**
Health Diagnosing Occupations (84-9)		Myeloid Leukemia	6	153	11	166	17	162*
Physicians (84)		Non-Hodgkin's Lymphoma	10	211	11	134	21	162*
Dentists (85)		Non-Hodgkin's Lymphoma	6	298*	7	218	13	249**
Dentists (85)		Myeloid leukemia	2	213	6	363*	8	308*
Truck Drivers(804-5)		Lung Cancer	997	120**	871	114**	1868	117**
Shoe Machine Operators (745)	Shoe Industry	Respiratory Cancer	17	131	46	136*	63	135*

- Dashes in the table indicate that the PMR was not elevated.
* $p < .05$
** $p < .01$

Table 14, Continued

Occupation	Industry	Cause of Death	AGES 15-64 No.Obs	PMR	65+ No.Obs	PMR	All No.Obs	PMR
	Footwear, exc Rubber & Plastic (221)	Respiratory Cancer	52	113	127	117	179	116*
Machine Operator (703-79)	Leather Production (220-2)	Lung Cancer	32	120	67	123	99	122*
Machine Operator (grouped) (703-79)	All Printing (171-2)	Larynx Cancer	12	269**	14	250**	26	259**
		Bladder Cancer	9	173	22	140	31	148*
Printing Machine Operator (734)		Larynx Cancer	10	301**	10	256*	20	277**
Printing Machine Operator (734)		Bladder Cancer	7	183	19	173*	26	176**
Printing Machine Operator (734)		Chronic Liver Dis/Cirrhosis	35	122	-	-	-	-
Welders (783)		Pnenumia/Influenza	-	-	-	-	-	-
	Chemical (180-92)	Bladder Cancer	-	-	-	-	-	-
Electrical Generators requested:								
	Electrical Gas Utilities(460-2)	Electrocution	20	847**	0	-	20	847**
	Electrical,Light & Power (460)	Electrocution	14	990**	0	-	14	936**
	Electrical, Gas & Other Combinations(462)	Electrocution	6	1172**	0	-	6	1113**
	Chemical (180-92)	Alzheimer's Disease	-	-	-	-	-	-
	Medical (812)	Alzheimer's Disease	-	-	83	132**	128	116

Table 14 continued

Occupation	Industry	Cause of Death	AGES 15-64 No.Obs	15-64 PMR	65+ No.Obs	65+ PMR	All No.Obs	All PMR
Fireworks requested:								
	Chemical (180-92)	Accident due to Fire, Flames, other than dwelling	5	697**		0	5	402*
		Accident due to Explosives	3	660*		0	4	754**
	Ordnance (292) (fireworks)	Burns	-	-	-	-	-	-
Chrome Plating requested: Metal Plating Machine Operators (723)		Respiratory Cancer	-	-		-	-	-
Fishermen (498)		Water Trans. Accident	16	1638**			17	1647**
		Drowning, Submersion	14	530**			14	505**
		Lung Cancer	27	134	41	130	68	132*
		Suicide	32	142*	0		32	128
		Dis Gall Bladder and Biliary Tract			4	389*	4	321
	Glass Mfg. (250)	Stomach Cancer	-	-	-	-	-	-
	Soap Mfg. (182)	Larynx Cancer	-	-	-	-	-	-
Jewelers (647)		Cirrhosis	4	325	1		5	232
Priests requested: Clergy (176)		Male Genital Cancer	-	-	-	-	-	-
	Semiconductor Ind requested: Elect Mach Equip Supp, NEC (Mfg) (342)	Malignant Melanoma	13	190*	5	154	18	179*
		Poisonings	-	-	-	-	-	-
	Foundries, Iron & Steel (271)	Dis Resp Sys	30	109	134	133**	164	128**
		Pneumonia/Influenza	-	-	35	120	42	115
		COPD	18	121	76	130**	94	134**

Table 14 continued

Occupation	Industry	Cause of Death	15-64 No.Obs	15-64 PMR	65+ No.Obs	65+ PMR	All No.Obs	All PMR
		Pneumoconioses	4	636**	9	172	13	222**
		Lung Cancer	-	-	-	-	-	-
		Tubercolosis	1		6	482**	7	328*
Machine Operator (703-79)	Iron/Steel Foundries	Dis Resp Sys			47	159**	54	145**
		COPD	5	105	28	170**	33	155**
		Pneumoconioses- due to other silicates			2	1825**	3	2029**
Machinists (637-9)		Lung Cancer	-	-	-	-	-	-
		Colon Cancer	89	115			272	104
		Dis Resp Sys	-	-	-	-	-	-
		Multiple Sclerosis	5	111	8	271*	13	175*
Steel pickling: Steel Laborers (889)	Blast Furnaces(270)	Diabetes M	9	175	18	147	27	155*
	Chemical industries: Chemical & Allied Prod(180-92)	Colon Cancer	61	123	92	116	153	119*
	Plastics, Synthet. Resins (180)	Colon Cancer	10	123	14	151	24	138
	Industrial & Misc Chem. (192)	Colon Cancer	34	131	61	131*	95	131**
	Chem & Allied Prod: (180-92) Prec Prod (633-9)	Colon Cancer	8	148	13	129	21	135
	Chem & Allied Prod: (180-92) Prec Prod (633-9)	Colon Cancer	-	-	11	203*	13	163

Table 15

Requested PMRs, White Females

Occupation	Industry	Cause of Death	15-64 No. Obs	15-64 PMR	65+ No. Obs	65+ PMR	All No. Obs	All PMR
Nurses (95, 207)		Non-Hodgkin's Lymphoma	35	127	-	-	78	107
		Chronic Myeloid Leukemia	11	201*	5	116	16	164*
	Hospitals (831)	Lymphoid Leukemia	9	126	-	-	-	-
		Myeloid Leukemia	39	127	34	120	73	123
		Chronic Myeloid Leukemia	16	166*	10	151	26	160*
		Alzheimer's Disease	14	233**	-	-	58	103
	Health Services (812-40)	Alzheimer's Disease	17	188*	-	-	74	99
Registered Nurses (95)		Alzheimer's Disease	5	199	35	140*	40	145*

\- Dashes in the table indicate that the PMR was not elevated.
* p < .05
** p < .01

Acknowledgements

The authors would like to thank John Sestito for his insightful review; Todd Frazier and Larry Fine, for encouragement and support, and Pam Schumacher, Cheri Nordman, and Marie Goller for clerical assistance. The helpful comments and expertise of Dave Sundin, Karl Sieber, Dave Garrabrant, Lois Schuster, and other co-workers and colleagues is gratefully acknowledged.

The authors acknowledge the contribution of Eugene C. Moss to the section entitled "Leukemia Mortality in Communications Workers" and the contribution of David P. Brown to the section entitled "Intestinal and Bladder Cancer in Dry Cleaning Workers."

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Appendix

Industry-specific occupational analyses were conducted in order to help narrow and refine exposure categories. The industry-occupation specific analyses were restricted to white males in blue collar occupations (codes 503-889) to eliminate risk factors associated with social class. Nine occupational categories were formed from the blue collar occupations (Table A). The nine occupation categories were then cross-classified with 20 manufacturing industries (codes 100-382) to form 180 industry-specific occupation categories (Table A). An example of an industry-specific occupation category is machinists and repairers employed in the food and kindred products manufacturing industry.

PMRs were computed for 180 industry-specific categories. Blue collar workers in non-manufacturing industries were included in the total population used for computing expected values. This increased the sample used to calculate the expected, thus increasing the precision of the PMR.

Table A

Titles and Codes of Occupation and Industry Groups
Included in the Industry-specific Occupation Analyses

Occupation Title	Occupation Code
Mechanics and repairers	503-549, 864
Construction trades	553-599, 865, 869
Precision production occupations	633-699
Machine operators and tenders, except precision	703-779
Welders, cutters, solders and brazers	783-784
Assemblers	785
Production inspectors, testers, samplers, and weighers	796-799
Freight, stock and material handlers	875-883
Laborers, except construction	889

Manufacturing Industry Titles	Industry Code
Food and kindred products	100-122
Textile mill products	132-150
Apparel and other finished textile products	151-152
Paper and allied products	160-162
Petroleum and coal products	200-201
Chemicals and allied products	180-192
Petroleum and coal products	200-201
Rubber and miscellaneous plastics products	210-212
Leather and leather products	220-222
Lumber and wood products, including furniture	230-242
Stone clay, glass, and concrete products	250-262
Blast furnaces, steelworks, rolling and finishing mills	270
Iron and steel foundries	271
Primary aluminum, industries	272
Other primary metal industries	280
Fabricated metal products	281-301
Machinery, except electrical	310-332
Electrical machinery, equipment, and supplies	340-350
Transportation equipment	351-370
Professional and photographic equipment, and watches	371-382