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Application of the Traditional Epidemiological Model to Predict Occupational Injury Rates in Manufacturing Industries

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APPLICATION OF THE TRADITIONAL EPIDEMIOLOGICAL MODEL TO

PREDICT OCCUPATIONAL INJURY RATES IN MANUFACTURING INDUSTRIES

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ABSTRACT

APPLICATION OF THE TRADITIONAL EPIDEMIOLOGICAL MODEL TO PREDICT OCCUPATIONAL INJURY RATES IN MANUFACTURING INDUSTRIES

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Although better than in the past, the human and economic costs associated with occupational work hazards continue to be high. Since sixteen percent of the workforce is employed in the manufacturing industry, and a high percentage of occupational injury and illness cases occur in this industry, the manufacturing sector is worthy of more in-depth study to identify potential workplace hazards, create new safety strategies, and implement more effective training programs.

This study was designed to test the usefulness of the Traditional Epidemiological Model of disease causation in modeling occupational injury rates and the presence of occupational illness in the manufacturing industry. More specifically, this research involved use of the agent, host, and environment constructs of the Traditional Epidemiological Model to examine the effects of five environmental-related workplace health and safety practices on occupational injury and illness. Data from the National Occupational Exposure Survey (NOES), conducted by the National Institute for Occupational Safety and Health (NIOSH) in 1981-1983, were used to ascertain the presence of specific workplace characteristics and to calculate occupational injury rates and illness presence in the manufacturing establishments included in the sample. Linear and logistic regression models were used in analyses of the relationships between the agent, host, and environmental factors and the health outcomes of the study.

Findings of this study suggest that implementation of certain environment-related health and safety workplace practices, including the presence of occupational health professionals and labor unions, aid in lowering risk of occupational injury and illness occurrence in manufacturing establishments. Several host characteristics, including a greater percentage of female employees in the workforce, larger company sizes, and geographical location of establishments, were also found to have positive relationships to occupational injury and illness occurrence in the manufacturing industry.

Although the Traditional Epidemiological Model was not found to be appropriate for use in this research study, its application may be effective in future occupational health research related to direct causes of specific occupational diseases. This model would be useful in future research involving the identification of causal relationships or the presence of specific injuries or illnesses, rather than in examining overall injury or illness rates.

Information gained in this study may be used to funnel resources into the areas of greatest need and to make decisions regarding funding for programs and services that are most likely to reduce workplace injury and illness. Changes in the work environment and technological advances have made it necessary for continuous evaluation of current employer health and safety practices and the development of new prevention strategies.

This study provides baseline occupational safety and health data for manufacturing establishments during the 1981 to 1983 timeframe. Future studies will allow researchers to illustrate the progression of occupational safety and health, to identify trends, and more importantly, to provide direction regarding the identification of the most effective measures in reducing occupational injury and illness.

DEDICATION

This dissertation is dedicated to Heather; my wife, partner, and best friend. Her constant and tireless attention makes this dissertation as much hers, as it is mine.

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CHAPTER I: INTRODUCTION

Purpose of the Study

The purpose of this research was to test the usefulness of the Traditional Epidemiological Model of disease causation in modeling occupational injury rates and the presence of occupational illness in the manufacturing industry. More specifically, the research used the agent, host, and environment constructs of the Traditional Epidemiological Model, to examine the effects of the following five environmental characteristics on occupational injury rates and the presence of occupational illness: (1) the formation of a labor union; (2) the utilization of industrial hygiene consultation services within the past twelve months; (3) the hiring of a full-time, on-site occupational safety professional; (4) the hiring of a full-time, on-site occupational health professional; and (5) the hiring of an industrial hygienist. The manufacturing establishment served as the unit of analysis in this study. The National Occupational Exposure Survey (NOES), conducted by the National Institute for Occupational Safety and Health (NIOSH) in 1981-1983, was the data set used to conduct this research study.

Background of the Research Problem

Treatment of Workers

The Industrial Revolution in the United States (mid 1800s) resulted in a shift from farm work to factory work. Although the establishment of factories brought work and financial gain to American workers, it also led to poor treatment of workers, as factory owners were more concerned with increasing production than in employee safety (Anton, 1989). Newly created industries had only primitive safety techniques (Musacchio, 1975). Occupational injuries and deaths were considered a small price to pay for industrial and economic progress (National Safety Council (NSC), 2001). As people flocked from rural areas and other countries looking for work, there was a surplus of workers and an opportunity for exploitation of employees. Employees were viewed as expendable; injured or sick employees could be replaced with newer, younger, and healthier workers (Musacchio, 1975).

To combat the poor treatment of employees, workers eventually organized and formed unions that fought for safer work environments, including protection against hazardous machinery and restitution in cases of disability or death (Anton, 1989). Although safety of the American worker has significantly increased with the advent of labor unions and the establishment and enforcement of occupational health and safety legislation, the human and economic costs associated with occupational work hazards continue to be high (NIOSH, 2000).

Number of Workers Affected

Approximately 131,463,000 people aged sixteen or older were employed in the United States as of 1998 (Current Population Survey (CPS), 1999). Of the total number of workers employed in 1998, approximately sixteen percent, or 20,734,000 workers, were employed in the manufacturing industry. Approximately sixty-one percent of manufacturing employees worked in the production of durable goods (non-food products), while approximately thirty-nine percent worked in the production of non-durable goods (food products) (CPS, 1999).

Injury and Illness in the Manufacturing Industry

The manufacturing industry is one in which workers continue to be exposed to worksite hazards that may increase their occupational injury or illness risk. It was ranked second for nonfatal occupational injuries with 1,662,000 cases (8.9 cases per 100 full-time workers) occurring in 1997. It was ranked third for fatal occupational injuries, with 13,056 cases during the 1980 to 1995 time period (National Traumatic Occupational Fatalities (NTOF) Surveillance System, 1999). Furthermore, the manufacturing industry has been identified as having the highest risk of all industrial categories for nonfatal occupational illnesses. Nearly 60 percent, or 260,000 cases, of nonfatal occupational illness occurred in the manufacturing industry (138.5 cases per 100,000 workers) in 1997 (Survey of Occupational Injuries and Illnesses (SOII), 1999).

Employees of the manufacturing industry had the highest rate of restricted work activity resulting from nonfatal occupational injuries during the 1992 to 1997 time period (SOII, 1999). Forty-eight percent of the nonfatal injury cases occurring in 1997 resulted in lost workdays, up from thirty-two percent in 1992 (a sixteen percent increase) (SOII, 1999). Table 1-1 provides an illustration of the distribution of nonfatal occupational injury cases that resulted in days away from work, broken down by type of injury, occurring in the manufacturing industry and all other industries for the year 1997.

Type of Injury	**Percent Cases Occurring in the Manufacturing Industry**	**Percent Cases Occurring in all Other Industries Combined**
Sprains, strains, tears	21%	79%
Back injuries, spine injuries, spinal cord injuries	21%	79%
Bruises, contusions	24%	76%
Cuts, lacerations	28%	72%
Fractures	25%	75%
Heat burns, scalds	26%	74%

Table 1-1. Distribution of nonfatal occupational injury cases occurring in the manufacturing industry versus all other industries, 1997. (Source: SOII, 1999)

Type of Injury	Percent Cases Occurring in the Manufacturing Industry	Percent Cases Occurring in all Other Industries Combined
Amputations	51%	49%
Total Injury	**29%**	**71%**

Table 1-1. Continued.

In 1997, sixty percent of all nonfatal occupational illnesses occurred in the manufacturing industry (SOII, 1999). According to SOII (1999), nonfatal occupational illness occurred at a rate of 138.5 per 100,000 workers in the manufacturing industry in 1997, while the average rate for all industries was 49.8. Table 1-2 provides an illustration of the distribution of nonfatal occupational illness cases, broken down by type of illness, occurring in the manufacturing industry and all other industries in 1997. Poisoning and physical agent exposure were the two types of nonfatal occupational illness cases that were higher, each with fifty-five percent, in the manufacturing industry than in all other industries combined.

Type of Illness	Percent Cases Occurring in the Manufacturing Industry	Percent Cases Occurring in all Other Industries Combined
Carpal Tunnel Syndrome	42%	58%
Tendonitis	45%	55%
Skin diseases and disorders	45%	55%
Dust diseases of the lungs	33%	67%
Respiratory disorders attributable to toxic agents	37%	63%
Poisoning	55%	45%
Physical agents (heat, cold, radiation)	55%	45%

Table 1-2. Distribution of nonfatal occupational illness cases occurring in the manufacturing industry versus all other industries, 1997. (Source: SOII, 1999)

Type of Illness	Percent Cases Occurring in the Manufacturing Industry	Percent Cases Occurring in all Other Industries Combined
Anxiety, stress, and neurotic disorders	20%	80%
Total distribution of cases	**60%**	**40%**

Table 1-2. Continued.

The distribution by industry type of other nonfatal occupational illnesses, including permanent hearing loss and respiratory disorders (asthma, silicosis), has been reported by other researchers. In its 1999 work-related lung disease surveillance report, the NIOSH (1999) reported that forty-two percent of all asthma cases and seventy-five percent of all silicosis cases occurred in the manufacturing industry during the 1993 to 1995 time period. Rosenman et al. (1999) reported that fifty-one percent of permanent hearing loss cases in Michigan during 1998 occurred in the manufacturing industry.

Rates of Occupational Injuries and Illnesses Over Time

The NSC (1980) reported that fatal injuries in the manufacturing industry declined seventeen percent from 1959 to 1969 and ten percent from 1969 to 1979. Another report from the NSC (1990) estimated an eighty-one percent decline in the occupational fatality rate per 100,000 workers from 1912 to 1989. Table 1-3 provides an illustration of the occupational fatality rates per 100,000 workers from 1949 to 1989 in the manufacturing industry as well as the average rate for all industries.

Year	Fatal Occupational Injury Rate per 100,000 Workers (Manufacturing Industry)	Fatal Occupational Injury Rate per 100,000 Workers (Average for all Industries)
1949	15	26

Table 1-3. Fatal occupational injury rates in the manufacturing industry versus all industries, 1949-1989. (Sources: NSC, 1960, 1965, 1970, 1975, 1980, 1985, & 1990)

Year	Fatal Occupational Injury Rate per 100,000 Workers (Manufacturing Industry)	Fatal Occupational Injury Rate per 100,000 Workers (Average for all Industries)
1954	12	25
1959	12	22
1964	10	21
1969	10	18
1974	8	15
1979	9	13
1984	6	11
1989	6	9

Table 1-3. Continued.

According to the NTOF (1999), there were 93,929 reported cases of death from occupational injuries during the 1980 to 1995 time period. Nearly fourteen percent, or approximately 13,000 of these cases, occurred in the manufacturing industry (NTOF, 1999). During the 1980-1995 time period, fatal occupational injuries in the manufacturing industry occurred at an average annual rate of 4.0 per 100,000 workers; while the average rate for all industries was 9.8 (7.5, excluding the mining industry) (NTOF, 1999). The Census of Fatal Occupational Injuries (CFOI) (1999) reported a fatal occupational injury rate of 3.6 per 100,000 workers in the manufacturing industry in 1997; while the average rate for all industries was 9.4 (7.7 excluding the mining industry).

Direct and Indirect Costs of Occupational Injuries and Illnesses Over Time

In addition to the human losses associated with occupational hazard exposure, there are direct and indirect economic costs of occupational injury and illness which continue to rise. The cost per worker (across all workers, injured or not) resulting from occupational injuries has risen from $65 in 1959 to $910 in 1998 (NSC, 2000). Total costs for occupational injuries in 2000 were $131.2 billion, up from $4.2 billion in 1959 (NSC, 2001).

Direct and indirect costs arise from injuries and illnesses sustained by employees in the workplace. Direct costs of occupational injuries and illnesses include medical costs, worker's compensation costs, worksite medical facility maintenance costs, and insurance premium costs (Schneid & Schumann, 1997). Following are indirect costs of occupational injuries and illnesses: (1) time lost by non-injured/ill workers assisting injured/ill workers, (2) production slowdowns, (3) non-compensated time lost by the injured/ill worker, (4) overtime costs, (5) reduced productivity of substitute workers, (6) reduced productivity of the injured worker after return, (7) supervisors' activities, (8) recordkeeping, investigation and claims processing, and (9) equipment and materials damage (Miller, 1977).

To date, there has been no consensus in determining the most effective procedures for calculation of the direct and indirect costs of occupational accidents. In fact, the NSC's procedures for estimating the costs associated with occupational injuries and illnesses were revised in 1993 (NSC, 2000). Furthermore, as more accurate information becomes available, it is used in future calculations. As a result, cost estimates may not be constant and comparable from year to year (NSC, 2000). Some researchers have, however, tried to quantify and compare these costs. Schneid and Schumann (1997) reported that the indirect costs of occupational accidents might be up to fifty times greater than the direct costs. Data from the NSC illustrate that, at least until 1989, the indirect costs of occupational injuries and illnesses were equal to or greater than the direct costs.

Total costs of occupational injuries were estimated to be eight percent higher in 1959 than in 1958, four percent higher in 1964 than in 1963, and nine percent higher in 1969 than in 1968 (NSC, 1970). Table 1-4 provides an illustration of the annual cost per worker (across all workers, injured or not), defined as "the value of goods or services each worker must produce to offset the cost of work injuries", resulting from occupational injuries (NSC, 2000).

Year	Direct and Indirect Costs Per Worker to Industry
1959	$65
1964	$75
1968	$110
1974	$175
1979	$280
1984	$320
1989	$420
1994	$990
1998	$910

Table 1-4. Annual cost per worker to industry of occupational injuries. (Source: NSC, 2000)

In addition to the steady increase in annual cost per worker resulting from occupational injuries, the direct and indirect costs of worker injuries have increased over the last forty years. Table 1-5 provides an illustration of the direct and indirect costs for specific years arising from occupational injuries as calculated by the NSC. Direct and indirect costs were calculated according to 1982 dollars to reflect the value of the dollar at the time NOES data were collected (Bureau of Labor Statistics (BLS), 2001). By doing this calculation, the cost of occupational injuries can be more accurately illustrated. The table shows an overall trend of rising costs for occupational injuries from 1959 to 1998.

Year	Direct Costs (Billions)	Indirect Costs (Billions)	Total Cost (Billions)
1959	$6.96	$6.96	$13.92
1964	$8.09	$8.09	$16.18
1968	$11.09	$13.86	$24.95
1974	$13.31	$16.64	$29.95
1979	$16.75	$19.54	$36.29
1984	$14.30	$16.35	$30.65
1989	$17.51	$20.23	$37.74
1994*	$68.83	$9.77	$78.60
1998	$63.52	$9.06	$72.58

Table 1-5. Direct, indirect, and total costs of occupational injuries. (Source: NSC, 1960, 1965, 1970, 1975, 1980, 1985, 1990, 1995, & 2000)

*The National Safety Council revised its procedures for estimating costs associated with occupational injuries in 1993. The large disparity in costs between 1989 and 1994 may be due to the revision in calculation method (NSC, 2000).

Emergency Room Visits

The root cause of many emergency room visits is occupational injury or illness. Results of a study conducted by McCaig, Burt, and Stussman (1998) indicated that a minimum of twelve percent of all injuries seen in hospital emergency departments were work related. Furthermore, McCaig, Burt, and Stussman (1998) reported that the root cause of 6.7 million emergency room visits from October 1995 through September 1997 was occupational injury or illness.

The impact of having such large numbers of emergency room visits resulting from occupational injuries has yet to be thoroughly investigated. Treatment of occupational injuries and illnesses requires the use of resources, which could be used in increasing the level of medical care for other underserved populations. Because hospitals are primarily established in more densely populated urban areas, where needs are higher and where health professionals can serve the majority of the population, reducing the burden of occupational injury and illness treatment would allow for the funneling of resources into other areas, such as injury and illness prevention and health promotion.

Occupational Injury and Illness Defined

According to the NSC (2002), occupational injury is defined as "injury such as a cut, fracture, sprain, amputation, etc., which results from a work accident or from a single instantaneous exposure in the work environment". Occupational injuries are classified as fatal or nonfatal. Fatal occupational injury is defined as death occurring as a direct result of injuries sustained while on the job (NIOSH, 2000). A nonfatal occupational injury is one in which the injury does not result in death (NSC, 2002). Occupational illness, which also may be classified as fatal or nonfatal, has been defined by the NSC (2002) as "any abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment". Occupational illnesses can either be acute or chronic conditions and may be caused by inhalation, absorption, ingestion, or direct contact with agents in the work environment.

Causes of Occupational Injuries and Illnesses

Fatal Occupational Injuries

During 1980 to 1995, the most common causes of fatal occupational injuries, according to the NTOF (1999), were motor vehicle accidents, machine-related deaths, homicides, falls, and electrocutions. The most common causes of fatal occupational injuries during the 1995 to 2000 time period were transportation incidents, assaults and violent acts, contact with objects and equipment, falls, exposure to harmful substances or environments, and fires and explosions (BLS, 2000).

Motor vehicle accidents have been identified by both the NTOF (1999) and the BLS (2000) as the leading cause of fatal occupational injury from 1980 to 2000. Motor vehicle accidents occurred most often in truck drivers, with nearly eighty percent of truck driver fatalities occurring as a result of transportation-related incidents in 1997 (CFOI, 1999). Fifty-one percent of all occupational injuries sustained by truck drivers in 1997 resulted in fatality (CFOI, 1999).

Although in a gradual decline since 1980, machine-related injury was still the second leading cause of fatal occupational injury from 1980 to 1989 (NTOF, 1999). Machine-related fatal injuries occurred most often in farm occupations and in laborers (except construction). Tractor-related injuries accounted for thirty-seven percent of the fatal injuries sustained by farmers in 1997 (CFOI, 1999). Twenty percent of fatalities among laborers in 1997 were related to injuries sustained by being caught in equipment (CFOI, 1999).

During 1990 to 1995, homicides were the second leading cause of fatal occupational injuries (NTOF, 1999). Taxi cab drivers, police and detectives, sales counter clerks, security guards, restaurant and hotel managers, sales supervisors, and cashiers have been identified as occupations at highest risk for homicides.

Although the rate of fatal occupational injuries from falls made a gradual decline during the 1980 to 1992 time period, fatalities from falling increased approximately nineteen percent from 1992 to 1997 (CFOI, 1999). Falls, which accounted for twelve percent of all fatal occupational injuries in 1997, occurred most often in the construction industry (CFOI, 1999). Approximately thirty-one percent of fatalities among construction workers occurred as the result of injuries sustained from falls.

Fatal occupational injuries caused by electrocution made a gradual decline from 1980 to 1995. The death rate from electrocution, which was approximately 0.6 per 100,000 workers in 1980, dropped to approximately 0.25 in 1995 (NTOF, 1999).

Nonfatal Occupational Injuries

Primary types of nonfatal occupational injuries include the following: (1) sprains, strains, and tears; (2) back, spine, and spinal cord injuries; (3) bruises and contusions; (4) cuts and lacerations; (5) fractures; (6) heat burns and scalds; and (7) amputations (SOII, 1999). In 1997, primary causes of sprain, strain, and tear injuries included overexertion, falls, contact with an object, and slips and trips (SOII, 1999). Table 1-6 provides an illustration of the distribution of primary causes of sprain, strain and tear injuries.

Distribution of Nonfatal Injury by Cause				
Overexertion	Falls	Contact with Object	Slips and Trips	Other
51%	13%	6%	6%	24%

Table 1-6. Distribution of sprain, strain, and tear injury cases with days away from work by cause, 1997. (Source: SOII, 1999)

Fifty-one percent of all amputation cases in 1997 occurred in the manufacturing industry (SOII, 1999). Approximately ninety-four percent of all nonfatal amputation injury cases were to fingers. Machinery was the primary cause of amputation in fifty-seven percent of the cases.

The most common sources of back, spine, and spinal cord injuries in 1997, according to the SOII (1999), were containers (twenty-six percent of cases), worker motions or positions (seventeen percent of cases), parts and materials (twelve percent of cases), floors, walkways or ground surfaces (ten percent of cases), and being a health care worker (ten percent of cases). In 1997, the most common cause of back, spine, and spinal cord injury cases was overexertion (sixty-three percent of cases) (SOII, 1999).

Primary sources of bruise and contusion injury cases in 1997 were floor and ground surfaces (twenty-six percent of cases), vehicles (fifteen percent of cases), parts and materials (thirteen percent of cases), containers (twelve percent of cases), and machinery (nine percent of cases) (SOII, 1999). In 1997, the primary cause of bruises and contusions in the workplace was being struck by, struck against, or caught in objects, equipment, or materials (SOII, 1999).

In 1997, approximately twenty-eight percent of cut and laceration cases with days away from work occurred in the manufacturing industry (SOII, 1999). The primary sources of cut and laceration injuries were floors and ground surfaces (twenty-five percent), machinery (twenty-one percent), parts and materials (twenty percent), and containers (eight percent) (SOII, 1999).

Approximately twenty-five percent of all nonfatal fracture injuries occurred in the manufacturing industry in 1997 (SOII, 1999). Floor and ground surfaces (forty-three percent) and parts and materials (fourteen percent) were the most common sources of fracture injuries in 1997 (SOII, 1999). Being struck by an object and falls on the same level were the most common causes of nonfatal fractures, each accounting for more than twenty-five percent of all cases.

In 1997, approximately twenty-six percent of heat and scald burn injury cases occurred in the manufacturing industry (SOII, 1999). The hand (except fingers), multiple body parts, the foot or toe, and the head were the areas of the body most affected by heat and scald burn injuries.

Fatal Occupational Illnesses

To date, no data on industry-specific occupational illness fatalities have been collected. As a result, the true impact of fatal occupational illnesses in the manufacturing industry cannot be calculated. In addition, occupational illnesses are more difficult to link to workplace exposures than injuries because health professionals often fail to link illnesses with occupational exposures. Also, disease is sometimes attributed to age rather than to prolonged occupational exposure. Pneumoconiosis, malignant pleural neoplasm, hypersensitivity pneumonitis are fatal illnesses considered to be solely or predominantly related to workplace exposures (NIOSH, 2000).

Pneumoconiosis is a class of respiratory diseases, including asbestosis, coal workers' pneumoconiosis, silicosis, and byssinosis, thought to be solely related to occupational exposures (NIOSH, 2000). According to the NIOSH (2000), 114,557 fatalities from pneumoconiosis were recorded from 1968 to 1996 in the United States.

Malignant pleural neoplasm, or cancer of the lung lining, has also been associated with occupational exposures (NIOSH, 2000). Asbestos exposure is thought to be a primary cause of this fatal illness. Deaths recorded as having malignant pleural neoplasm as an underlying or contributing cause increased from 390 in 1968 to 510 in 1996 (NIOSH, 2000).

The NIOSH (2000) reported a gradual increase in deaths from hypersensitivity pneumonitis, a fatal lung disease predominantly related to occupational exposures, during the 1980 to 1996 time period. Number of deaths recorded as having hypersensitivity pneumonitis as an underlying or contributing cause increased from fifteen in 1980 to fifty-one in 1996.

Nonfatal Occupational Illnesses

Approximately sixty percent of nonfatal occupational illness cases occurred in the manufacturing industry in 1997 (SOII, 1999). Nonfatal occupational illnesses include the following classifications: (1) repeated trauma disorders (e.g. carpal tunnel syndrome (CTS), tendonitis); (2) noise-induced hearing loss; (3) skin diseases and disorders (allergic and irritant dermatitis, skin cancer); (4) respiratory disorders (dust diseases of the lungs, allergic and irritant asthma, chronic bronchitis, reactive airway dysfunction, chronic obstructive pulmonary disease (COPD), asthma); (5) poisoning/toxicity (exposures to heavy metals such as lead, toxic gases such as carbon monoxide, organic solvents, pesticides, and other substances such as formaldehyde); (6) infections in health care workers (Tuberculosis and bloodborne exposures such as Human Immunodeficiency Virus (HIV) and Hepatitis B); (7) physical agents (heatstroke, sunstroke, heat exhaustion, frostbite, ionizing radiation such as X-ray and radium exposure, nonionizing radiation such as welding flash and microwave exposure); and (8) anxiety, stress, and neurotic disorders (NIOSH, 2000).

Although the manufacturing industry houses only sixteen percent of the workers, it sustains a disproportionate amount of injury. In 1997, seventy-two percent of all repeated trauma disorders, including forty-two percent of CTS cases and forty-five percent of tendonitis cases, occurred in the manufacturing industry (SOII, 1999).

Approximately fifty-one percent of permanent hearing loss cases in 1998 occurred in the manufacturing industry (Rosenman et al., 1999). According to the SOII (1999), approximately forty-five percent of skin diseases and disorders occurred in the manufacturing industry in 1997. Thirty-three percent of dust diseases of the lungs cases, thirty-seven percent of respiratory disorder cases attributed to toxic agents, fifty-five percent of poisoning cases, fifty-five percent of cases of disorders related to physical agents, and twenty percent of anxiety, stress, and neurotic disorders cases occurred in the manufacturing industry in 1997 (SOII, 1999). According to the Sentinel Event Notification System for Occupational Risk (SENSOR) conducted by NIOSH (1999), forty-two percent of occupational asthma cases and seventy-five percent of silicosis cases occurred in the manufacturing industry during the 1993 to 1995 time period. Twenty-nine percent of other nonfatal occupational illnesses, including illnesses such anthrax, brucellosis, malignant and benign tumors, food poisoning, and histoplasmosis, occurred in the manufacturing industry in 1997 (SOII, 1999).

High Risk Industries for Fatality

During the 1980 to 1995 time period, the manufacturing industry was ranked third for fatal injury incidence, while the transportation and public utilities industry was ranked second, with a 17.6 percent distribution. The occupation at highest risk for fatal injuries, according to the NTOF (1999), is the construction industry. An average of approximately eighteen percent of all fatal occupational injuries during 1980 to 1995 occurred in the construction industry. The NTOF (1999) reported that approximately fourteen percent of all occupational fatalities occurred in the manufacturing industry during this same time period.

The occupation at highest risk for nonfatal injuries is the construction industry, followed by the manufacturing industry. In 1997, nonfatal occupational injuries occurred at a rate of 9.3 per 100 full-time workers in the construction industry and 8.9 in the manufacturing industry (SOII, 1999).

Occupations at highest risk for fatal illnesses vary according to the type of illness. No data on the impact of fatal occupational illness in the manufacturing industry, however, have been collected. The National Surveillance System for Pneumoconiosis Mortality (NSSPM) (1999) reported that during the 1987 to 1996 time period, insulation workers were found to have the highest proportionate mortality ratios (PMRs) for asbestosis. Workers in metal and plastic processing, hand molding and shaping, and crushing and grinding in mining had the highest PMRs for silicosis while textile machine operators and repair workers had the highest PMRs for byssinosis. According to the National Center for Health Statistics (NCHS) (1999), boilermakers, sheet metal workers, plumbers, pipefitters, steamfitters, stationary engineers, and electricians had the highest PMRs for malignant pleural neoplasm during the 1987 to 1996 time period. Nonhorticultural farmers were found to have the highest PMRs for hypersensitivity pneumonitis during the same time period.

At highest risk for nonfatal occupational illness are workers in the manufacturing industry. Nonfatal occupational illness occurred at a rate of 138.5 per 10,000 full-time workers in 1997; whereas the average incidence rate for all industries was 49.8 (SOII, 1999).

Development of Legislation

In response to rising occupational-related disease and illness rates, the

Occupational Safety and Health Act (OSHAct) of 1970 was enacted. The Act was established "to assure that no employee will suffer material impairment of health or functional capacity" from exposures in the workplace (OSHAct, 1970). The OSHAct mandated that all employers provide a work environment which is free from recognized hazards that are known to cause or are likely to cause death or serious physical harm to employees (OSHAct, 1970). Furthermore, the legislation required employers to comply with occupational safety and health standards promulgated under the Act. The legislation did, however, give leniency in the methods used by employers to comply with the standards.

Enforcement of Legislation

The Occupational Safety and Health Administration (OSHA), a division of the U.S. Department of Labor, was established to provide information and education about workplace safety, to issue safety standards, and to ensure employer compliance with the standards established in the OSHAct. Enforcement of OSHA standards can be accomplished through workplace inspections, citations, and the imposing of fines (McCaffrey, 1982).

Because of the large number of private industries operating in the United States, the OSHA has been unable to keep up with employer compliance to the health and safety standards imposed by the OSHAct. The NIOSH (1999) reported that 6.5 million private companies were operating in the United States in 1994, and they employed more than 96.7 million employees. The large number of companies in operation makes it impossible for the OSHA to accomplish its mission through enforcement action only. As a result, the OSHA encourages companies to implement self-help programs that will aid in providing safe and healthful working environments for employees (Moran, 1996).

Another major problem in the enforcement of OSHA standards included, up until the last decade, an industry perception that the OSHA was weak, with out-dated standards and penalties not severe enough to take seriously (Sullivan, 1995). Sullivan (1995) also reported that OSHA compliance officers had inadequate training and were often perceived as incompetent. Employers soon became aware that the chances of being inspected were small and that infractions often resulted in penalties less severe than the time and expense required to make the corrections necessary for compliance with OSHA standards.

OSHA resources are allotted to conduct inspections and establish risk reduction and prevention programs in companies thought to have increased health risks for employees. Because compliance officers cannot visit all companies on a regular basis to ensure compliance with regulatory standards, the OSHA has employed an inspection plan that includes programmed-related, fatality/catastrophe-related, and complaint/referral-related inspections to be used in determining which companies to inspect. Approximately seventy-five percent of OSHA inspections are programmed inspections, inspections conducted on a random basis in companies with certain standard industrial classification (SIC) codes (Moran, 1996). Companies that fall under SIC codes that have higher illness and injury rates are given priority when determining which companies to inspect. Fatality/catastrophe inspections are automatically conducted within twenty-four hours after an employee has died or after more than one employee has been hospitalized due to exposure to a hazard in the workplace (Moran, 1996). OSHA also conducts inspections based on complaints from employees who feel they are working in unsafe environments or from referrals from other sources such as civil activists or physicians who have treated patients with injuries or illnesses arising from hazards in the workplace (Moran, 1996).

Unless a company meets one of the criteria that falls under the OSHA's inspection plan, an inspection to assess workplace safety and health risk may never be conducted. These businesses may still have health risks for employees that go undetected. In many cases, the OSHA relies on the voluntary establishment of workplace safety improvement plans and expects that companies will follow the safety guidelines established in the OSHAct. Unfortunately, employers may be unaware of the health hazards to which employees are being exposed or, in some cases, employers may knowingly ignore exposure to health hazards in order to avoid the costs of risk reduction.

Project Justification

Occupational injury and illness data must be collected in an effort to track health outcomes and to create prevention strategies. NIOSH (2000) reported that an inability to enforce safety legislation, the continued human and economic costs associated with occupational injuries and illnesses, and the lack of information concerning types of industries at higher risk for employee health hazards have made it necessary for continued examination of methods for identifying and preventing health hazards in the workplace. A lack of information concerning policies that work in the prevention of occupational injury and illness makes it necessary for further investigation.

Inability to Enforce Legislation

The OSHA is currently unable to strictly enforce safety legislation. As a result, high-risk establishments, such as those in the manufacturing industry, are encouraged to implement self-help programs to assist in maintaining the safest work environment possible. The inability of the OSHA to enforce safety regulations, along with the voluntary nature of self-help programs, make it necessary to continue research related to establishing and maintaining safe work environments in the manufacturing industry.

Distribution of the Workforce

The manufacturing industry was reported to have employed approximately sixteen percent of the total workforce in 1998 (SOII, 1999). The manufacturing industry was ranked third in occupational injury fatalities during the 1980-1995 time period, accounting for approximately fourteen percent of all work-related deaths (SOII, 1999). The manufacturing industry had the highest number of nonfatal occupational injuries in 1997 (SOII, 1999). In addition, nearly sixty percent of nonfatal occupational illness cases occurred in the manufacturing industry during the same year. Because of the high distribution of workers employed in the industry and the high percentage of occupational injury and illness cases occurring in the industry, the manufacturing sector is a field worthy of more in-depth study to identify potential hazards, create new safety strategies, and implement more effective training programs.

A Need for More Information

With the high human and economic costs associated with occupational-related injuries, illnesses, and deaths, there has been an increase in research concerning occupational hazard exposure in recent years. Since most Americans spend approximately forty percent of their waking hours at work, steps to ensure their safety in the workplace are necessary (Leigh et al., 1997). Today's work environment is in a continual state of change. New information regarding types of hazards and maximum exposure limits is necessary to ensure safer working environments for employees working in all types of industry. Information obtained from this study can be used to determine which health and safety practices are most effective in lowering occupational injury and illness rates. More specifically, this study examined the usefulness of the Traditional Epidemiological Model of disease causation in modeling the effects of certain health and safety practices on rates of occupational injury and illness in manufacturing establishments.

Urban Services Relevance

Higher Occupational Injury/Disease Rates in Urban Areas

Workplace injuries are an important threat to the health of urban populations. Results of a study of occupational injury surveillance in Illinois conducted by Forst, Hryhorczuk, and Jaros (1999) indicated that eighty-one percent of occupational injuries occurred in urban settings. Like hospitals, most private companies are located in urban areas. In order to generate more business and increase profits, business owners are likely to start businesses in metropolitan areas, where more business can be solicited and where there is more access to potential workers. Companies employing the largest number of people tend to be housed in urban areas, where access to potential workers is greatest. Past research suggests a correlation between employment size and occupational illness rate. In 1997, private companies with 1,000 or more employees were recorded as having the highest occupational illness rates, with an incidence of 147.7 per 10,000 full-time employees (NIOSH, 2000). That same year, companies having one to ten employees had the lowest occupational illness rate, with an incidence of 10.9 per 10,000 full-time employees.

Theoretical Framework Overview

Bernardino Ramazzini began the study of workplace hazards and occupational diseases in the late seventeenth century (Susser, 1973). During the years prior to the formation of the Traditional Epidemiological Model, Ramazzini and other scientists viewed the environment as merely the source of an agent, rather than as an interrelated factor. It was not until the latter part of the nineteenth century that scientists began studying the environment as an interrelated variable in the process of disease causation.

This dissertation study tested the ability of the Traditional Epidemiological Model to model the relationship between an agent, a host, and the environment that may lead to the occurrence of occupational injury and/or illness in manufacturing industries. When this system is balanced, the host is in a state of equilibrium and health is maintained. This model postulates that when any of the three variables included in the model change, the health of the individual (the outcome of interest) will undergo change (Fox, Hall, & Elveback, 1970). It is during this time of unbalance that changes in injury, illness, or disease rates may occur.

In this dissertation study, manufacturing establishments, rather than individuals, served as the host variable. Host characteristics included company size, geographical location, number of years in operation, gender composition, and occupational composition. The specific industry, defined by the SIC code under which the host is classified, served as the agent variable in this study. Agent characteristics included production of durable goods versus production of non-durable goods. Five employer health and safety practices, including the presence of a full-time, on-site occupational health professional, the presence of a full-time, on-site occupational safety professional, the presence of an industrial hygienist, the presence of a labor union, and the utilization of industrial hygiene consultation services within the past twelve months were used for the environment variables. This study examined the effects of the agent, host, and environment variables on occupational injury rates and the presence of occupational illness.

This dissertation study provided a model of the interaction effects of industry type, employer health and safety practices, and the work environment. Using information regarding specific workplace health and safety practices obtained in this study, the Traditional Epidemiological Model may be applied to illustrate the effects of certain work environments on occupational injury rates and presence of occupational illness.

Research Questions

This research sought to answer the following question: Can occupational injury and illness in the manufacturing industry be modeled with the Traditional Epidemiological Model?

More specifically, this research attempted to determine the effects of five workplace health and safety practices on occupational injury rates and the presence of occupational illness when controlling for other factors. Specific questions explored in this research included the following:

- Within the manufacturing industry, do establishments with labor unions have lower occupational injury rates and presence of occupational illness?
- Within the manufacturing industry, do establishments that have received industrial hygiene consultation services during the past twelve months have lower occupational injury rates and presence of occupational illness?
- Within the manufacturing industry, do establishments that employ a full-time, on-site

safety professional have lower occupational injury rates and presence of occupational illness?

- Within the manufacturing industry, do establishments that employ a full-time, on-site occupational health professional have lower occupational injury rates and presence of occupational illness?
- Within the manufacturing industry, do establishments that employ a full-time industrial hygienist have lower occupational injury rates and presence of occupational illness?

Methodology Overview

The National Occupational Exposure Survey (NOES) conducted by the NIOSH in 1981-1983 was the data set used to conduct this research study (Seta, Sundin, & Pedersen, 1998). A total of 4,490 establishments participated in the study.

The target population for the NOES study was establishments or job sites located in the United States. To be included in the study, establishments had to employ a minimum of eight employees and have a primary activity or type of business included in the list of target Standard Industrial Classification (SIC) codes established by the Office of Management and Budget (OMB, 1987). Included in this study were establishments in the following SIC categories: (1) agricultural services, (2) oil and gas extraction, (3) construction, (4) manufacturing, (5) transportation, communications and utilities, (6) wholesale and retail trade, (7) services, and (8) health services.

Establishments included in the NOES study were administered a sixty-six item survey (see Appendix A). Questions included in the survey pertained to the establishments' managerial policies regarding employee safety and health practices.

Using the NOES data set, this study involved the comparison of occupational injury rates and illness presence among manufacturing establishments. A sample of all 320 manufacturing establishments employing 500 to 2499 employees was extracted from NOES data and used in this study. The data were analyzed concerning the specific health and safety practices of manufacturing establishments. After completion of these analyses, the effects of specific health and safety practices on occupational injury rates and occupational illness presence were discussed.

Relevance Of the Data

Despite the age of the data contained in the NOES, the nationally representative information obtained in the 1981-1983 study is still the most recent source of data of this kind (see Appendix B) (W. K. Sieber, personal communication, October 22, 2002). NOES data continues to be used as a relevant source of occupational exposure agents and kinds of safety and health programs at the plant level (Lentz, Sieber, Jones, Piacitelli, & Catlett, 2001). Although NOES data was collected almost twenty years ago, NOES data has more recently been used in the investigation of influence of company economic characteristics and workplace hazards on the prevalence of workplace medical testing (Boden & Cabral, 1995); the development of a job exposure matrix for linking occupations with potential occupational exposures (Sieber, Seta, & Young, 1994); and the study of worker exposure awareness in various industries and occupations (Behrens & Brackbill, 1993).

CHAPTER II: REVIEW OF THE LITERATURE

Review of the Theoretical Framework

The Traditional Epidemiological Model, also called the Ecological Model, provides a framework of health and its determinants (Fox, Hall, & Elveback, 1970). The framework conceptualizes a multiple cause/multiple effect view of health, while illustrating the effects of risk factors on the equilibrium of the individual's health. As illustrated in Figure 2-1, the model takes a holistic approach that incorporates environment, along with agent and host, as one of the interrelated factors that contributes to occurrence of disease or injury.

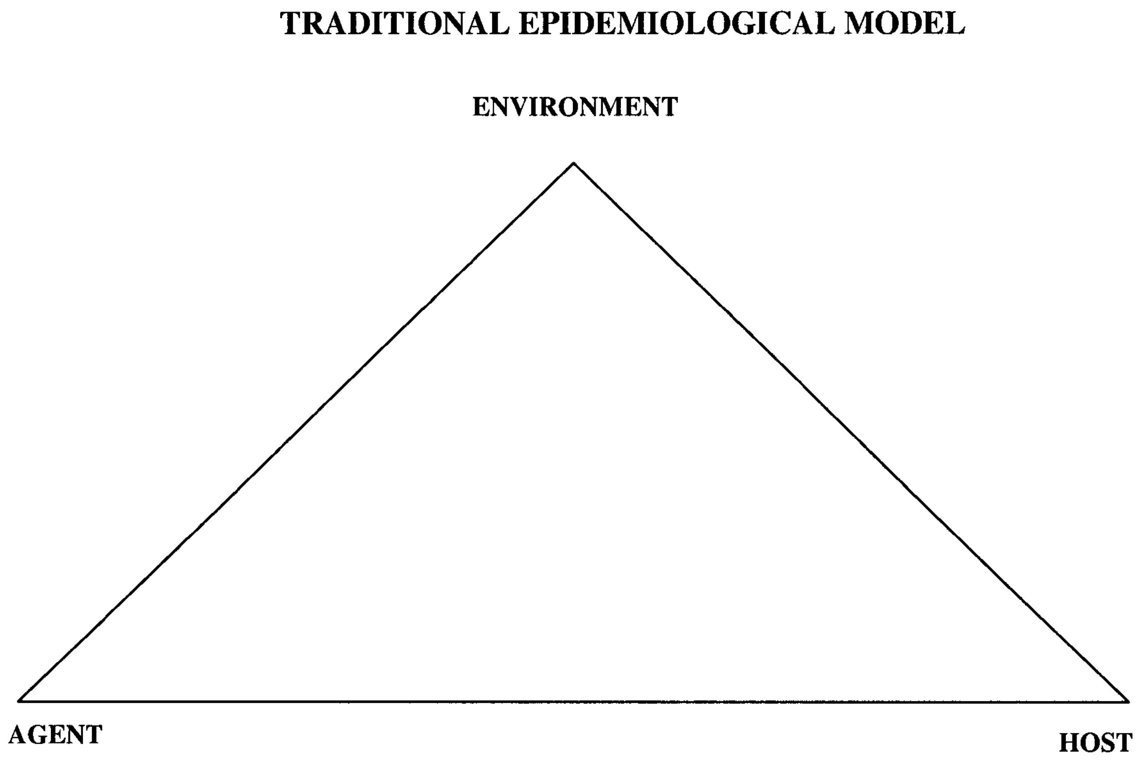


Figure 2-1. The Traditional Epidemiological Model. (Source: Fox, Hall, & Elveback, 1970)

The Traditional Epidemiological Model was first developed to illustrate the link between the three factors (agent, host, environment) and infectious disease (Fox, Hall, & Elveback, 1970). The model, however, is not limited in its application to infectious disease causation. The Traditional Epidemiological Model has also been used to examine relationships among non-infectious etiological agents, hosts, and environments (McCormack-Brown & McDermott, 1991; Hazy, 1995; Karol, 1991; Cullen, 1996; Bhopal, 1991). In particular, the model has been applied to many public health issues, including dental caries in school-age children (McCormack-Brown & McDermott, 1991), occupational injuries in a hospital setting (Hazy, 1995), allergic reactions to indoor air pollutants (Karol, 1991), and fatal pedestrian injuries in children (Rivara, 1990).

For purposes of this study, the Traditional Epidemiological Model was used to illustrate the causal sequence of events between an agent, a host, and the environment. The model takes the form of a triangle, with the agent in one point, the host in another, and the environment in the third point. Changes in any one of the three variables can disrupt the state of equilibrium and lead to injury, illness, or disease (Fox, Hall, & Elveback, 1970).

Interaction of the three factors, agent, host, and environment, is a primary concept of the Traditional Epidemiological Model. The model illustrates the holistic nature of the three interrelated factors that contribute to the occurrence of injury or illness. Because of this interrelation, changes in one factor may elicit changes in the other factors. The model conceptualizes a cause and effect view of health, showing the impact of the interrelation between factors. Injury or illness is the "effect" that occurs after exposure to the "cause". This study used the model to examine the relationship between various environmental characteristics and injury rates and occupational illness presence in manufacturing establishments.

Research Studies Supporting the Theory

Much research has been conducted which supports the Traditional Epidemiological Model. So much has been done in this area, in fact, that the model is an underlying theme of most epidemiological studies. The model has been applied to numerous public health issues, and not just to studies of occupational injuries and illnesses. The following section will include a presentation of past research done in occupational health to support the model. Table 2-1 provides a summary of past research that illustrates the entire model.

Study	Health Outcome	Agent Characteristics	Host Characteristics	Environment Characteristics	Findings
Cullen, 1996	Occupational Asthma	Airborne dusts, gases, vapors, fumes	History of allergy, response to skin pricks, pre-existing airway disease, histamine reactivity	Indoor air samples from work spaces	Host factors are most important in determining occupational asthma occurrence
Hazy, 1995	Lost workdays resulting from occupational injuries	Type of injury, frequency and severity of injury	Age, length of service, gender, occupation, time of service	Department trends, monthly trends of a 341 bed, level III, tertiary care metropolitan hospital	Injuries from overexertion, falls, & repetitive motions resulted in highest # of lost workdays
Bhopal, 1991	Incidence of Legionnaires' Disease	Virulence of the agent	Susceptibility level of host	Environmental conditions specific to the geographical area	Incidence of Legionnaires' Disease in different geographical areas was due to differences in agent & host characteristics

Table 2-1. Summary of past research illustrating the concepts of the Traditional Epidemiological Model.

Study	Health Outcome	Agent Characteristics	Host Characteristics	Environment Characteristics	Findings
Siebenaler & McGovern, 1992	Development of Carpal Tunnel Syndrome (CTS)	Occupational stresses, awkward positions and postures	Employees	Work stations, work processes	Environmental factors play a primary role in the outcome of CTS

Table 2-1. Continued.

Much of past research related to occupational injuries and illnesses has focused on the byproducts of illness and injury, such as direct and indirect costs, morbidity and mortality rates, and specific causal agents from different industrial processes. Although not studied in the model framework, the host factors and the physical and chemical agent factors involved in occupational injury and illness are fairly well understood. The impact of specific environmental factors and certain employer health and safety practices, however, is less understood (Fox, Hall, & Elveback, 1970). In-depth study in this area is necessary in order to develop more effective regulations, to allot limited resources most appropriately, and to aid in the reduction of occupational injury and illness occurrence. Identifying deficiencies in current safety standards will aid in the development of new and improved standards. After more effective strategies for safety regulation development and implementation have been identified, resources can be funneled into the areas of greatest need for cost effectiveness.

The Interaction Concept

The interaction concept of the Traditional Epidemiological Model was used by Reifsnider (1995) to design interventions for families with children having non-organic failure to thrive (NOFTT), a condition of growth failure resulting in small stature, poor growth, slow development, and low intellect in which no physical cause can be found.

Although the causes of NOFTT, which is more commonly seen in children of low socioeconomic status, are not completely understood, the condition has been attributed to such factors as character disorders in the mother, environmental deprivation, malnutrition, lack of mothering, psychosocial factors, and disturbances in mother-child interactions. Because of NOFTT's multi-factorial etiology, Reifsnider used the interaction concept of the Traditional Epidemiological Model in the study to aid in assessment of the condition as well as to design appropriate interventions for care for those afflicted.

For purposes of the study, Reifsnider used food quality, food quantity, feeding practices, and weaning practices as agent characteristics, the child's temperament and susceptibility to infection as host characteristics, and parent-child interactions, daily family activities, interactions between different environments, and the community as environment characteristics. The researcher observed and interviewed mothers of NOFTT children and used information from this process to assess the hosts. The mothers were then given suggestions for correcting deficits, and changes in the agent and environment variables were observed during subsequent home visits to see their effects on the host. Reifsnider found that addressing factors related to the development of NOFTT resulted in significant changes in the growth, home environment, and parent- child interactions of NOFFT children. Reifsnider's study supports the interaction concept of the Traditional Epidemiological Model that postulates that disease develops when there is a weakness in the agent, the host, or the environment that cannot be compensated for by one of the other factors.

The interaction concept of the Traditional Epidemiological Model was utilized in a study of dental caries risk factors in school-age children conducted by McCormack-Brown and McDermott (1991). Because dental health professionals lack agreement as to the etiology of dental caries and so that dental health professionals can most effectively educate and treat patients, McCormack-Brown and McDermott conducted a study to determine the causes and sources of dental caries. The model was used to examine the interrelationship of agent, host, and environment factors in the causation process of dental caries. The researchers found that gender, age, race, tooth arrangement, sugar consumption, and knowledge, attitudes, and behaviors were host factors that influence caries formation risk, while various microorganisms with cavity-forming potential were agent factors and type of community (urban or rural), socioeconomic status, dental services use, and fluoride were environmental factors. Findings of the study may be useful in identifying and educating children who are at higher risk for dental caries. Through its analysis of the interaction effects of various agent, host, environment characteristics on the disease causation process, the study conducted by McCormack-Brown and McDermott supported the interaction concept of the Traditional Epidemiological Model.

The Agent Variable

An etiological factor of disease, conceptualized in the model as an agent, may be defined as "a substance, living or inanimate, or a force, sometimes rather intangible, the excessive presence or relative lack of which is the immediate or proximal cause of a particular disease" (Fox, Hall, & Elveback, 1970). Disease, which is the "effect", occurs after exposure to the "cause", which is the agent. Without the presence of an agent, disease cannot occur.

A primary focus of research in the industrial hygiene field is the study of occupational injury, illness, or disease causation agents. In industrial hygiene, these agents are classified as chemical, physical, biological, or ergonomic agents (NSC, 1983). Examples of types of chemical agents commonly studied in the industrial hygiene field include mists, vapors, gases, dusts, and fumes. Radiation, noise, vibration, temperature, and pressure are examples of physical agents. Insects, molds, fungi, and bacterial contamination are examples of biological agents. Improperly designed work stations or tools are examples of ergonomic agents commonly studied by industrial hygienists.

The presence of certain agents in the work environment as well as the frequency and duration of exposure to these agents are of primary interest in the industrial hygiene field. The effects of host exposure to certain types of agents, such as industry type, on host susceptibility or resistance to disease have yet to be thoroughly examined. Because changes in agent characteristics alter the balance of the system and elicit changes in host susceptibility level, the agent concept plays a significant role in the scheme of the Traditional Epidemiological Model.

For purposes of this study, industry type served as the agent when exposed to which the hosts' level of risk for disease is altered. Type of industry was defined by SIC code. This study examined the manufacturing industry as the agent variable, including establishments that produce durable goods (non-food products) and those that produce non-durable goods (food products). These agents are necessary factors in calculating the final effect of the model, occupational injury and illness.

Research Supporting the Agent Concept

Hazy (1995) used the Traditional Epidemiological Model in a study of occupational injuries in a hospital setting to determine agent characteristics that make hospital employees more susceptible to lost work days due to injuries sustained at work. 2,093 employees of a 341-bed, level III, tertiary care metropolitan hospital served as hosts in the study. Hazy examined host variables, including age, length of service, gender, occupation, and time of occurrence, and environment variables, including department trends and monthly trends, during the study. Type of exposure, as well as the frequency and level of exposure, served as agent characteristics in the study. Hazy's study focused on the agent characteristics that place hosts at higher risk for lost workdays. Hazy found that of the 811 cases of occupational injuries reported in 1993, twenty-four percent were related to body fluid exposures, nineteen percent to harmful substance contact, and seventeen percent to overexertion. The researcher also found that injuries from overexertion, falls, and repetitive motions, which resulted in the highest number of lost workdays, accounted for fifty percent, twenty-five percent, and twelve percent of total lost workdays respectively. Results of the study support the need for implementation of safety education programs, pre-employment physical examinations, ergonomic evaluations, and case management procedures to help limit host exposure to potentially harmful agents. Hazy's study provides an example of the successful use of the Traditional Epidemiological Model in analyzing the effects of agent exposures on the injury causation process.

Karol (1991) used the agent concept of the Traditional Epidemiological Model to examine how indoor airborne chemical inhalation can lead to allergic sensitization with episodic pulmonary responses occurring during subsequent exposures. Gender, age, ethnic background, and physical well-being were studied as host-related factors of allergic reactions to indoor air pollutants and indoor air samples were studied as environment-related factors. Karol examined the nature and concentration of chemicals and the frequency and duration of exposure to chemicals as agent-related factors of allergic reactions. Results of the study suggest that the interaction between the host's immune system and the environment from which the air sample is taken is the primary determinant of allergic reactions to indoor air pollutants. Findings of Karol's study support the concept of the Traditional Epidemiological Model that changes in the agent factor (i.e. changes in the nature or concentration of the chemical agent or changes in the level of exposure to the agent) alter the balance of the system, leading to changes in the risk of disease incidence.

Effects of Agent Characteristics

Past research provides evidence of higher employee occupational injury and illness rates in establishments that are classified under certain industry types. The construction, transportation, public utilities, and manufacturing industries are more likely to have higher occupational injury and illness rates than other industry types according to results of a study conducted by NTOF (1999).

Standard Industrial Classification (SIC) Codes

Results of a study conducted by NTOF (1999) indicate that industries in certain SIC codes, such as the construction industry (SIC codes 1500-1700), the agriculture industry (SIC codes 0700-0799), and the manufacturing industry (SIC codes 2000-3999), have higher rates of fatal occupational injury per 100,000 workers than other industries, such as the retail industry (SIC codes 5200-5999) and the services industry (SIC codes 7000-8999). The researchers found that higher injury and illness rates in certain industries are due, in part, to the nature of the industry. Employees working in industry and occupation types requiring more time working in close proximity to hazards are at higher risk for exposure, and therefore, are likely to have higher rates of occupational injury and illness than employees working in administrative and clerical positions that require less time around hazardous exposures.

Manufacture of Durable Versus Non-Durable Goods

Extensive review of the NIOSHTIC-2 and the Health Reference Center Academic databases turned up little information regarding occupational injury and illness rates in manufacturing establishments that produce durable goods compared to establishments that produce non-durable goods. Durable goods are any products, other than food products, that are produced by the manufacturing establishment. In much of past research, all types of manufacturing establishments have been grouped together, making it difficult to distinguish between the manufacture of durable or non-durable goods.

The BLS (2000) however, has broken down nonfatal occupational injury rates by type of good being manufactured. There may be higher rates of occupational injury in manufacturing establishments producing durable goods than in manufacturing establishments producing non-durable goods. According to the BLS (2000), there was a 9.8 nonfatal occupational injury and illness rate in the manufacturing of durable goods industry. In the manufacturing of non-durable goods industry, the nonfatal occupational injury and illness rate was 7.8.

The Host Variable

The host in the scheme of the Traditional Epidemiological Model is the particular individual or group of individuals of interest. Host factors may be biological or behavioral. Biological factors of the host include age, gender, race, immunity to the agent, or other individual characteristics that may make an individual more susceptible or resistant to disease (Fox, Hall, & Elveback, 1970). Behavioral factors of the host, on the other hand, are controlled by an individual's habits and customs and can influence types and levels of exposure. Examples of behavioral factors that may influence likelihood of exposure include risk-taking, perception of safety, and past experiences.

The proportion of employees having certain biological factors varies among industries but may be present in higher proportions in certain types of industry. Employees of certain ages, races, or genders may tend to work in certain types of industries that have higher or lower occupational injury and illness risks. In addition, employees with certain host characteristics may be more susceptible to or resistant to certain occupational illnesses.

Following are examples and illustrations of how host characteristic distributions vary according to type of fatal illness or distribution of nonfatal occupational injury and illness cases. In 1997, the workforce was composed of fifty-five percent men and forty-five percent women (SOII, 1999). Males had higher rates of nonfatal occupational injury and illness cases with days missed from work, with sixty-seven percent occurring among males in 1997. Table 2-2 provides an illustration of the distribution of fatal occupational illnesses during the 1987 to 1996 time period, broken down by gender of the worker.

Type of Fatal Illness	**Distribution by Gender**	
	Male	**Female**
Malignant Pleural Neoplasm	76%	24%
Hypersensitivity Pneumonitis	71%	29%

Table 2-2. Distribution of fatal occupational illness by gender, 1987-1996.
(Sources: NCHS, 1999 and NSSPM, 1999)

Type of Fatal Illness	Distribution by Gender	
	Male	Female
Asbestosis	96%	4%
Coal Workers' Pneumoconiosis	99%	1%
Silicosis	96%	4%
Byssinosis	72%	28%
Other	97%	3%

Table 2-2. Continued.

In 1998, white, non-Hispanic workers made up seventy-four percent of the workforce, while black, non-Hispanic workers made up eleven percent (BLS, 2000). Hispanic workers made up eleven percent, and Asian workers and workers from other racial groups made up four percent. According to the NTOF (1999), black workers had the highest average rate of fatal occupational injuries during the 1980 to 1995 time period. Table 2-3 provides an illustration of the distribution of fatal illnesses during the 1987 to 1996 time period, broken down by race.

Type of Fatal Illness	Distribution by Race		
	White	Black	Other
Malignant Pleural Neoplasm	94%	5%	1%
Hypersensitivity Pneumonitis	95%	4%	1%
Asbestosis	93%	6%	1%
Coal Workers' Pneumoconiosis	97%	3%	0%
Silicosis	84%	14%	2%

Table 2-3. Distribution of fatal occupational illness by race, 1987-1996.
(Sources: NCHS, 1999 and NSSPM, 1999)

Type of Fatal Illness	Distribution by Race		
	White	Black	Other
Other	93%	6%	1%

Table 2-3. Continued.

In 1997, seventeen percent of the workforce was composed of employees aged sixteen to twenty-four years, while fifty-three percent of employees were aged twenty-five to forty-four years, and twenty-nine percent were aged forty-five years or older (CPS, 1999). Table 2-4 provides an illustration of the distribution of nonfatal occupational injury and illness cases requiring days away from work in 1997, broken down by age of the worker. The distribution of fatal occupational injuries during the 1980 to 1995 time period was 14.6 percent among workers aged sixteen to twenty-four years, 47.5 percent among workers aged twenty-five to forty-four years, and 37.9 percent among workers aged forty-five years or older (NTOF, 1999).

Age Group	Distribution of Private Industry Workforce	Distribution of Nonfatal Injury and Illness Cases Requiring Days Away from Work
16-24 years	17%	15%
25-44 years	54%	59%
45+ years	29%	26%

Table 2-4. Distribution of private industry workforce and nonfatal occupational injury/illness cases requiring days away from work by age of worker, 1997. (Sources: CPS, 1999 and SOII, 1999)

Host changes may alter the balance of the system by causing changes in overall composition of the population. Population changes such as increases or decreases in birth rates, death rates, the number of people working in certain industries, and the number of establishments in operation under certain SIC codes affect the number of hosts susceptible to a particular agent exposure.

The host, the particular individual or group of individuals of interest, is another primary concept of the Traditional Epidemiological Model. In the field of industrial hygiene, employees typically serve as hosts in the scheme of the model. Changes in the agent or the environment bring about changes in the level of immunity or susceptibility of the host to the outcome of the model, the occurrence of disease. In the context of industrial hygiene, the effects of changes in the agent, the hazard to which employees are exposed, and in the environment, characteristics specific to the workplace, are examined in relation to the risk of disease causation in the host. Characteristics, such as age, race, gender, and behavior, which may make the host more susceptible or resistant to disease, are commonly examined when applying the Traditional Epidemiological Model to industrial hygiene studies.

The host in this study was manufacturing work establishments. More specifically, company size, geographical location of the company, number of years of establishment operation, gender composition, and occupational composition of manufacturing establishments served as host characteristics. As illustrated in the model, employees of manufacturing companies are likely to experience changes in the outcome of the model, disease causation, when changes in the agent factor or the environment factor occur.

Research Supporting the Host Concept

To examine the host concept of the Traditional Epidemiological Model, Rivara (1990) conducted a study of 1,852 fatal pedestrian injuries in children. Rivara analyzed data on children aged zero to nineteen years who had been victims of fatal pedestrian injuries in 1985 to determine host characteristics that placed children at higher risk for pedestrian injury. Rivara examined the interaction effects of certain host characteristics, including gender, age, and socioeconomic status, motor vehicles, which served as the agent characteristic in the study, and roads, sidewalks, and other pedestrian walkways, which served as the environment characteristic in the study, on fatal pedestrian injury rates.

Rivara found that host characteristics related to higher injury rates included being male, being between the age of five and nine years, and being of low socioeconomic status. These findings are thought to be due in part to the knowledge that males are more likely to exhibit risky behaviors and poor neighborhoods are likely to have lesser traffic control. Rivara's study of pedestrian injuries in children supported the Traditional Epidemiological Model's concept that certain host characteristics may make the host more susceptible or vulnerable to injury when exposed to certain agents or environments.

Cullen (1996), in his study of occupational asthma, used the Traditional Epidemiological Model to examine how specific host factors may increase risk for disease occurrence. Because much research has already been done to identify agent exposures that increase occupational asthma risk, Cullen focused his study efforts on the identification of host factors and the dose-response relationship of the disease. The researcher used history of allergies, responses to skin tests, presence of airway disease, and histamine reactivity level as host factors in his study. Cullen examined airborne dusts, gases, vapors, and fumes as agent factors and air samples from various workspaces as environment factors.

Cullen concluded that although agent, host, and environment factors all played a part in the disease causation process, host factors were the most important determinant of occupational asthma incidence. In fact, the researcher found that high-risk employees (i.e. employees with a history of allergies, positive responses to skin pricks, pre-existing airway disease, or high histamine reactivity levels) in a well-controlled environment were more likely to get occupational asthma than lower risk employees in a high agent exposure environment. Results of Cullen's research support the concept of the Traditional Epidemiological Model that host characteristics play a major role in the disease causation process. Cullen found that it is not merely exposure to a specific agent that predetermines whether one will experience the health outcome in question, but rather the combined effects of certain host, agent, and environment factors.

Effects of Host Characteristics

Past research suggests that certain host characteristics, such as gender composition and occupational composition of a company, may place an establishment at higher risk for occupational injury or illness (Fox, Hall, & Elveback, 1970; NTOF 1999). Additionally, some research suggests that the geographical location of the establishment, as well as the size of the establishment, as defined by the number of workers employed, and the number of years of establishment operation may have a profound impact on occupational injury and illness rates (Jones, 1997; Leigh, 1989; NTOF,1999; Yacher, Heitbrink, & Burroughs, 1997).

Gender Composition

Gender is a host characteristic that may place employees at greater risk for occupational injury or illness occurrence (Fox, Hall, & Elveback, 1970). Past research overwhelmingly suggests higher rates of occupational injury and illness in males than in females (Forst, Hryhorczuk, & Jaros, 1999; McCaig, Burt, & Stussman, 1998; Islam et al., 2000; SOII, 1999; NCHS, 1999; NSSPM, 1999).

Forst, Hryhorczuk, and Jaros (1999) conducted a study evaluating the usefulness of the Illinois Trauma Registry (ITR) in tracking occupational injuries for the years 1993 and 1994. In their analyses, the researchers found that eighty-six percent of the 5,844 reported occupational injury cases occurred in males.

McCaig, Burt, and Stussman (1998), who conducted a study examining work-related emergency room visits in the United States during 1995-1996, also found that males had higher occupational injury rates than females. The researchers found that males had a work-related injury emergency room visit rate of 4.3 per one hundred full-time equivalents (FTEs), while females had a visit rate of 2.4.

Islam et al. (2000) examined the epidemiology of work-related burn injuries using a state-managed workers' compensation database. The researchers found that the incidence rate of occupational burns was significantly higher in males than in females, even in occupations, such as cooks and nurses aides, employing a higher proportion of females than males. Furthermore, the researchers reported that the industry-specific incidence rate of work-related burn injuries among males was highest in the manufacturing industry.

Higher rates of nonfatal occupational injury and illness with days missed from work have been reported in males than in females (SOII, 1999). In 1997, sixty-seven percent of days missed from work due to occupational injury or illness occurred in males. The NCHS (1999) and the NSSPM (1999) found higher rates of all types of fatal occupational illness, including malignant pleural neoplasm, hypersensitivity pneumonitis, asbestosis, coal workers' pneumoconiosis, silicosis, and byssinosis, in male workers than in female workers.

Occupational Composition

Employees who work in manufacturing establishments but whose primary duties involve administrative tasks rather than traditional manufacturing tasks are likely to have lower occupational injury and illness rates (NTOF, 1999). Therefore, manufacturing establishments employing a greater percentage of administrative employees are likely to have lower occupational injury rates and illness presence than manufacturing establishments with a lower percentage of administrative workers.

According to a study conducted by NTOF (1999), administrative support workers had the lowest average annual rate of fatal occupational injuries during the 1980 to 1995 time period (0.6 per 100,000 workers). The average annual rate for all industries during this time period was approximately 7.8. The study also concluded that fatal occupational injuries occurring within the administrative support occupational group accounted for less than two percent of all occupational fatalities occurring during the 1980 to 1995 time period.

Company Size

Results of past research suggest that companies employing a larger number of workers are likely to have greater awareness of risks and safety measures (Jones, 1997; Seligman et al., 1988). Furthermore, some research suggests that larger establishments often spend more time and money in providing safer work environments, thereby leading to lower occupational injury and illness rates (Leigh, 1989; CFOI, 1999).

Findings of a study conducted by Jones (1997) suggest that employees of small businesses are less likely to perceive the seriousness of high occupational injury rates because of the low number of employees affected. As a result, companies with a fewer number of employees were found to be at higher risk for work hazard exposures. Employees of large companies, on the other hand, were found to have a greater awareness of health risks in the work environment. Other factors found to increase the risk of occupational injury in smaller establishments included lower employee retention rates, more informal management systems, lack of unions, and fewer employee safety training programs.

Using NOES data, Seligman et al. (1988) conducted a study examining the effects of company size on injury record keeping practices. The study involved the survey of 4,185 companies employing a minimum of eleven employees. Results of the study indicated that number of employees was positively associated with OSHA record maintenance compliance. Ninety-five percent of companies with 500 or more employees kept injury records, while only sixty-one percent of companies with eleven to ninety-nine employees kept injury records. The authors concluded that noncompliance in record keeping regulations in smaller establishments is likely to result in more workers being uninformed and unaware of workplace injury and health risks.

A study conducted by Leigh (1989) suggests that large establishments with over 1,000 employees have the most accurate injury and illness records as well as the lowest injury and illness rates. Leigh used data obtained from the U.S. Department of Labor to examine the effects of company size on rates of occupational injury and illness. The study involved dividing a sample of twenty-eight manufacturing firms into size categories based on number of employees. Data on the manufacturing establishments were then analyzed to determine whether larger or smaller firms provided the safest working environments. Findings of the study suggest that larger establishments are likely to spend more time and money on employee interviewing and screening, and therefore, may be hiring healthier and safer employees. Study findings also suggest that larger manufacturing firms, which face stricter OSHA standards, tend to spend more time and money on keeping the work environment safe in order to comply with OSHA regulations.

Results of a study conducted by the CFOI (1999) indicated that in 1997, the rate of occupational injury fatalities was 8.6 per 100,000 workers in establishments employing one to ten workers, 3.7 in establishments employing eleven to nineteen workers, 2.9 in establishments employing twenty to forty-nine workers, and 2.7 in establishments employing fifty to ninety-nine workers. The researchers found that the rate of fatal occupational injuries in 1997 in establishments with 100 or more employees was 2.0 per 100,000 workers, less than one fourth of the rate of the smallest business group.

Geographical Location

Extensive review of the NIOSHTIC-2 and the Health Reference Academic Center databases has turned up little research to suggest that establishments located within certain regions of the country are more likely to have higher occupational injury and illness rates. One study, however, was found to suggest that the northwestern region of the country ranked highest for fatal occupational injuries (NTOF, 1999).

During the 1980 to 1995 time period, the NTOF (1999) reported that the northwestern states of Alaska, Wyoming, and Montana had the highest reported fatal occupational injury rates. Alaska had an average annual rate of fatal occupational injuries during 1980 to 1995 equaling 25.2 per 100,000 workers, while Wyoming had a rate of 16.7, and Montana had a rate of 12.4.

Number of Years in Operation

Establishments that have been in operation for a greater number of years are more likely to have higher occupational injury rates and occupational illness presence than establishments that have been in operation for a fewer number of years (Yacher, Heitbrink, & Burroughs, 1997; NSC, 1983; Hoekstra, Hurrell, & Swanson, 1994). Older establishments are more likely to be housed in older facilities and require that employees use older equipment. These two factors may lead to an increased risk of occupational injury and illness in employees working in older establishments.

Establishments that have been in existence for a greater number of years are more likely to be housed in older buildings which may lack the most up-to-date support equipment. Older support equipment that does not function as efficiently as newer models may pose additional health risks to employees. The support equipment housed in older facilities, including ventilation systems, lighting, insulation, and heating and cooling systems, may pose an increased risk of occupational injury or illness (Levy & Wegman, 1995).

A study conducted by Yacher, Heitbrink, and Burroughs (1997) provides an example of how older facilities may house substandard support equipment that may pose additional injury and illness risks to employees. The ability of a commercially available air filter cleaner designed to control mist emissions and to decrease worker exposure to mist was evaluated for effectiveness. The company involved in the study was a producer of off-road vehicle transmissions. The researchers concluded that even after application of the air filter cleaner, the highest concentrations of mist emissions were found in the older machine shop areas which were not well enclosed and were supported by an older ventilation system.

Establishments that have been in existence for a greater number of years are more likely to house older equipment rather than the most up-to-date technology. Older equipment is more likely to be missing parts and may not be calibrated for optimum functioning, resulting in user injury or hazardous exposures (NSC, 1983). In addition, older equipment is not as "worker friendly" as newer models, which may lead to greater ergonomic problems in employees (NSC, 1983). Newer models of furniture and equipment have been ergonomically tested for optimal worker safety and comfort.

Hoekstra, Hurrell, and Swanson (1994) conducted a study of work-related musculoskeletal disorders (WMDs) at two Social Security Administration Teleservice Centers. Results of the study indicated that seventy-three of the 108 subjects included in the study were diagnosed with upper extremity, neck, or back WMDs. Furthermore, the researchers identified higher incidence rates of WMDs in the older of the two facilities, which had older furniture and suboptimal ergonomic conditions.

Although older facilities and equipment may comply with applicable safety standards and regulations, they may not have the most efficient and safety-driven design. By not using the most current design of equipment and facilities available, establishments may not be providing the safest working environments and conditions for employees.

The Environment Variable

Environmental factors may influence the existence of an agent, exposure to an agent, or susceptibility to an agent. Because environmental factors include anything external to the agent or host, they are often subdivided into physical, biological, and socioeconomic classifications (Fox, Hall, & Elveback, 1970). Biological factors in the environment include human populations, flora, and fauna; while socioeconomic factors include occupation, urbanization and economic development, and disruptions. According to the NIOSH (2000), temperature, humidity, and radiation are examples of physical environmental factors generating from seasonal weather conditions that may pose a health risk to employees. For purposes of this study, the socioeconomic factors of the environment, specifically health and safety practices, were examined.

Changes in environmental factors can disrupt the balance of the system. Environmental changes can affect host susceptibility. In particular, sudden changes in the environment may increase agent virulence or decrease host resistance or immunity and eventually lead to disease. Changes in physical environmental factors, such as temperature extremes or high humidity levels, may increase host susceptibility to certain types of occupational injuries and illnesses, particularly when the host is not acclimated to such environmental conditions. Changes in biological environmental factors, such as population increases or shifts may lead to higher exposure to certain types of agents. Changes in socioeconomic environmental factors, such as changes in the distribution of the workforce in certain industries, may also increase exposure risk and host susceptibility (NIOSH, 2000).

In industrial hygiene studies, the workplace of the hosts of interest typically serves as the environment in the scheme of the model. Changes in workplace characteristics, along with changes in agent exposure levels, may alter the level of susceptibility or resistance of the host to disease. Hosts are exposed to certain types of agents at certain levels, depending on the environment in which they work. As a result, the environment plays an important role in the disease causation process of the model.

In this study, the environment was the workplace, as defined by the presence or absence of five employer health and safety practices. Health and safety practices included the following: (1) the presence of an established labor union, (2) the utilization of industrial hygiene consultation services within the last twelve months, (3) the presence of a full-time, on-site occupational safety professional, (4) the presence of a full-time, on-site occupational health professional, and (5) the presence of an industrial hygienist.

Research Supporting the Environment Concept

Siebenaler and McGovern (1992) studied the environment concept of the Traditional Epidemiological Model in their study of carpal tunnel syndrome (CTS). The study examined how the interrelationships between the agent, host, and environment contribute to the incidence of CTS. Using employees as the host variable and occupational stresses, such as awkward positions or postures during work, as the agent variable, Siebenaler and McGovern examined environmental factors in the workplace which increase employees' risk of having CTS. Work stations and work processes were used as environment factors and were analyzed to determine specific characteristics that increase risk for CTS incidence in the host. Findings of the study suggest that identifying and modifying environmental factors in the workplace is a crucial step in the development and implementation of prevention programs for carpal tunnel syndrome. The study conducted by Sienbenaler and McGovern supports the concept of the Traditional Epidemiological Model which states that changes in the environment influence disease causation risk in the host.

Bhopal (1991) examined the environment concept of the Traditional Epidemiological Model in his study of the geographical epidemiology of Legionnaires' Disease in Scotland. Incidence of Legionnaires' disease was calculated by geographical area. Bhopal found that variation of incidence levels in different geographical areas was due to differences in susceptibility level of the host, virulence of the agent, and environmental conditions specific to the geographical area. Findings of Bhopal's study support the environment concept of the Traditional Epidemiological Model which postulates that specific environmental characteristics, such as geographical area, can influence host susceptibility to disease causation at certain agent exposure levels.

Effects of Environment Characteristics

Labor Unions

A labor union is any organization in which any of the facility's employees participate as members and which exists for the purpose of dealing with the employer concerning grievances, wages, working hours, and conditions. Labor unions are the primary organizations that represent the safety needs and concerns of employees. Workers often turn to their union when seeking protection or restitution from workplace hazards. It is estimated that only fourteen percent of employees are covered under union protection (Levy & Wegman, 1995). The influence of labor unions, however, has reached far beyond the individual workplace to include many types of industrial environments.

Labor unions have led to a profound improvement in worker health and safety over the years (Levy & Wegman, 1995; Baker & Scherer, 1997; Federal Coal Mine

Health and Safety Act, 1969; Baugher & Roberts, 1999). Unions do this through: (1) working with employers to form agreements concerning work environment improvements, (2) providing technical aid to members being exposed to hazardous conditions in the workplace, (3) sponsoring training and education programs, and (4) working to create and implement legislation for improved working conditions (Levy & Wegman, 1995). Specifically, worker unions draw public attention to health hazards in the workplace, pressuring employers to ensure safer work environments for its employees. Union activities are centered around the rights and responsibilities of the employer and its employees. Unions function under the premise that employers have the legal responsibility for making working conditions as safe as possible. While employees have the right to safe working conditions, they do have the responsibility to seek out information concerning hazards and to protect themselves from those hazards through training and use of protective equipment and handling procedures.

Whether or not having a organized labor union is beneficial in terms of occupational injury and illness has been a controversial issue. In 1997, Baker and Scherer conducted a study to assess job safety in the construction industry. Data from 3,000 OSHA inspections collected from 1989 to 1994 were analyzed to ascertain differences in job safety between companies with a formal labor union and those without a union. Study results indicated that companies with labor unions tended to have lower rates of lost workdays from injury, total safety violations, and percentages of serious safety violations.

Union member protest, led by the United Mine Workers of America (UMWA) and the Black Lung Association, was a primary catalyst in the passage of the Federal

Coal Mine Health and Safety Act of 1969 (Coal Mine Health and Safety Act, 1969). This legislation served to protect workers against coal mine hazards, thereby reducing injury, disease, and mortality rates of mine workers. Of primary interest to union members was pneumoconiosis, a lung disease resulting from prolonged inhalation of mineral or metallic particles found in coal mines. Union support helped to raise public awareness of pneumoconiosis risk in the coal mining industry and to pressure employers to implement more stringent safety measures to protect mine workers.

Union activity from the Brown Lung Association and the Textile Workers Union was crucial in the passage of a cotton dust standard implemented by OSHA in 1978 (Levy & Wegman, 1995). Union members raised public awareness of the increased risk of byssinosis, a respiratory disease resulting from prolonged inhalation of cotton dust, in the cotton textile industry. The OSHA standard served to reduce the byssinosis rate in the cotton industry, thereby decreasing the respiratory disease rate and preventing irreversible lung damage in many cotton workers .

Since the formation of the OSHA in 1970, unions have been the primary advocates for stricter OSHA standards. Unions play a vital part in the identification of workplace hazards as well as in pushing for legislation that protects the health and safety of workers. Even though workers in all types of industry benefit from the activities of national and international unions, unions at the individual workplace provide additional security for employees. Local unions serve as a watchdog by identifying safety risks and calling for OSHA investigation when employers fail to take the necessary steps in correcting safety issues (Levy & Wegman, 1995).

A case study conducted by Baugher and Roberts (1999) revealed that chemical exposure perception was highest among union workers. Union workers are very aware of their external environment and take serious interest in the level of safety in the workplace. Results of the study indicated that union workers spend more time worrying about exposure risks than non-union workers. Because union workers tend to be more conscious of exposure risks and safety measures, occupational injury rates and the presence of occupational illness are likely to be lower in establishments having a labor union.

Although it is widely accepted that the establishment of labor unions has dramatically improved the working conditions of employees and has led to safer and healthier work environments, there is little information concerning the precise effects of labor unions on worker injury and illness. The activities of labor unions serve to protect the rights of employees, with the right to a safe working environment being a top priority. Therefore, work establishments with formal labor unions are likely to have lower occupational injury rates and occupational illness presence than work establishments with no union support for worker protection.

Industrial Hygiene Consultation Services Use in Past Twelve Months

Work establishments that have utilized industrial hygiene consultation services during the past twelve months are more likely to have lower occupational injury rates and illness presence than work establishments that have not utilized these services (Cook & Kovein, 1995; Schlecht & Cassinelli, 1997; Hawkins, 1989; Miller, 1977; Smith, 1978). The primary purposes of industrial hygiene consultation services is to estimate levels of potentially hazardous exposures within a work environment and to design hazard control programs to protect workers against the identified hazards. Establishments with access to these kinds of services are likely to provide a safer work environment for employees. The NSC (1983) has defined industrial hygiene as "the science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stresses, arising in or from the workplace, which may cause sickness, impaired health and well-being, or significant discomfort and inefficiency among workers or among the citizens of the community". Industrial hygiene services include the identification of and the control for environmental stressors that pose a health or safety risk to employees.

Included in industrial hygiene consultation services is the measurement of stressors and an evaluation of the impact of exposures on employee safety and health. Cohen (1992) conducted a study of industrial hygiene measurement and control techniques and concluded that industrial hygiene services, at a minimum, should include the following: (1) the identification of exposure routes, (2) the design of air sampling programs, (3) the conducting of a preliminary survey to determine points of potential exposure, (4) the conducting of a walk-through survey to observe facility operations, (5) the composing of a report to serve as the basis for monitoring and sampling decisions, and (6) the selection of criteria to be used to determine acceptable exposure limits. In addition, Cohen concluded that the application of professional judgement and the use of scientific methods were important aspects in the application of industrial hygiene services.

McCaffrey (1982) reported a rise in the number of employee and union requests for health hazard inspections and evaluations. Employees, now more than ever, expect their work environment to be made as safe as possible. Establishments are more willing to request the application of industrial hygiene consultation services to help in handling health problems. Because it has become the employer's responsibility, according to the OSHAct, to ensure a safe working environment for employees, many companies are willing to invest the time and money necessary to gain industrial hygiene services. Many companies, especially those in higher risk industries, are able to save money by implementing the safety control measures recommended after use of industrial hygiene services. Expenditures for the prevention of harmful exposures, at times, is less costly than the liability of not providing a safe working environment for employees.

Cook & Kovein (1995) reported on industrial hygiene evaluations conducted at two gasoline service stations in New Jersey to ascertain the safety of the work environment. Industrial hygienists performed evaluation techniques, including air sampling and videotaping of work activities. Evaluation results indicated that improvements in vapor recovery systems and worker safety practices were necessary to increase safety in the work environment. The company was able to use the information submitted by the industrial hygienists to make changes in the work environment to reduce the incidence of hazardous exposures.

A study was conducted by Hawkins and Evans (1989) in which the toluene exposures of batch chemical process workers were measured over a three-week period by industrial hygienists to determine the distribution of exposures and the exposure levels of workers. Results of the study indicated that experienced industrial hygienists have the ability to provide accurate measurements of harmful agent exposure levels and to conduct hazard evaluations.

Schlecht and Cassinelli (1997) conducted a survey of the activities of 347 industrial hygiene laboratories to determine the types of industrial hygiene consultation services most commonly performed. According to results of the study, consulting firms, laboratories, government agencies, and construction firms were industry groups most likely to request industrial hygiene services. The researchers found that testing for asbestos, lead, metals, hydrocarbons, and various organic agents were the most common industrial hygiene services performed.

After completion of environmental stressor evaluations, industrial hygiene services typically include the development of health hazard corrective measures, such as an alteration of work processes so as to limit exposures, the use of less toxic materials in place of harmful substances, the use of protective equipment, the use of better ventilation systems, and the adoption of better storing and disposal techniques for toxic substances (NSC, 1983). Miller (1977) reported that the primary parts of industrial hygiene services include recognizing potential health problems in the workplace and designing hazard control programs. Hazard control programs designed as part of industrial hygiene services include the following: the substitution of less toxic agents for the agents currently being used, the use of local and general exhaust ventilation systems, the employment of job rotation strategies, the design of improved cleaning and handling procedures, the use of personal protective equipment, the enclosure of hazardous equipment, and the establishment of worker education programs (Miller, 1977). Employment of hazard control programs designed by industrial hygiene personnel aid in the creation of a safer workplace and in the reduction of occupational injuries (Miller, 1977).

Results of a study on the role of the industrial hygienist conducted by Smith (1978) are similar to that of Miller (1977). Included in the hazard control strategies of industrial hygiene services, according to Smith (1978), are improvement of ventilation systems, enclosure of potential hazards, use of protective respiratory equipment, and the separation of employees and toxic compounds. Smith (1978) also reported that awareness of current legislation and industrial issues is another primary component of hazard control programs.

Full-Time, On-Site Occupational Safety Professional

Based on the primary job responsibilities of occupational safety professionals, past research suggests that establishments with this type of professional on staff are likely to have lower occupational injury and disease rates (NSC, 1983; Anton, 1989; Levy & Wegman, 1995; Quinn et al., 1998). Safety professionals are responsible for safety functions in the workplace on a daily basis and must be able to make immediate decisions concerning the safety of workers. Occupational safety professionals perform routine accident prevention activities, and in the absence of an industrial hygienist, must evaluate and control hazards in cases of emergency. In addition, it is the responsibility of the safety professional to implement and ensure adherence to any hazard control measures recommended by the industrial hygienist. Although occupational safety professionals are often involved in some industrial hygiene services, of primary interest to safety professionals is the prevention of physical harm, such as broken bones and bodily injuries, to employees (NSC, 1983). With new information on occupational health hazards obtained from current research, however, many safety professionals have now expanded their work to include risk reduction against various occupational hazards and diseases affecting the lungs, skin, kidneys, liver, and brain (NSC, 1983).

Specific job responsibilities of the occupational safety professional include developing and presenting safety training programs, inspecting facilities, overseeing investigations of accidents, maintaining accident records, identifying causal factors in cases of accidents, and developing hazard control programs (Levy & Wegman, 1995). In addition, the occupational safety professional must work with other health and safety professionals to make sure that all designed or purchased equipment and facilities are in safety standard compliance. Because the occupational safety professional may, at times, serve as a liaison between workers and management, he or she should have at least some basic knowledge about the type of industry in which he or she is employed (Anton, 1989). The safety professional may have to convince management that costs arising from the implementation of safety measures are less than the potential costs of accidents, medical care, and worker compensation (Levy & Wegman, 1995). Occupational safety professionals, because of their day-to-day access to and evaluation of worksite safety, have the potential to improve prevention strategies and focus efforts on materials selection and process redesign (Quinn et al., 1998).

OSHA safety standards do not mandate that companies must have an occupational safety professional on staff. As a result, it is often companies employing a larger number of employees that will put forth the finances to hire a full-time safety professional to work on-site (Levy & Wegman, 1995). Nevertheless, even small companies with no full-time safety professional on staff are required to adhere to OSHA safety standards. As a result, companies with no safety professional must designate specific staff members to develop and maintain a safety plan as a collateral duty. The trend in employing full-time safety professionals, according to Levy and Wegman (1995), has been brought on by several factors including: (1) the passage of the OSHAct, (2) the increase in union involvement in employee health and safety issues, and (3) changes in the work environment, such as changes in machine design, plant layout, product safety, fire prevention, security, and employer motives concerning profits.

The effects of employing a full-time, on-site safety professional on occupational injury and illness rates is not fully understood. Based on the primary job responsibilities of occupational safety professionals, establishments with this type of professional on staff are likely to provide safer work environments for employees, and therefore have lower work-related injury and illness occurrence. The hiring of a full-time safety professional is an indicator of the establishment's commitment to creating and maintaining a safe working environment for employees. Hiring a full-time safety professional may be an indication that employee safety is a top priority.

Full-Time, On-site Occupational Health Professional

Past research suggests that based on the primary job responsibilities of occupational health professionals, establishments that have a full-time, on-site occupational health professional on staff are likely to have lower occupational injury rates and illness presence (Anton, 1989; Aday & Andersen, 1975; Shi & Singh, 1998; Pedersen, Venable, & Sieber, 1990). Similar to an occupational safety professional, an occupational health professional has responsibilities concerning employee accident prevention and safety control. Occupational medicine physicians and occupational health nurses, the primary specialties classified under occupational health professionals, often make up the medical department of larger organizations. As with safety professionals, larger companies, for financial reasons, tend to be the hirers of occupational health professionals. Establishments in higher risk industries employing a large number of people are most likely to have an occupational health professional on staff. As opposed to contracting out for medical care, having a full-time, on-site health professional on staff may be more cost effective in reducing liability, conducting safety training and education programs, conducting pre-employment screenings and routine physicals, and giving clearance to resume work activities following injury. Considering the primary job responsibilities of the occupational health professional, establishments having a full-time occupational medicine physician or occupational health nurse on staff are likely to provide a safer work environment than companies contracting out for medical care. Because of the occupational health professional's focus on injury and illness prevention through education, safety training, routine medical screenings, and rehabilitation programs, establishments with an occupational health professional having industry-specific knowledge and experience are likely to have lower occupational injury rates and illness presence.

Primary responsibilities of an occupational medicine physician include conducting preplacement health appraisals, health examinations, and health education programs (Anton, 1989). Occupational medicine physicians must have a thorough understanding of the products being manufactured, the specific work processes required in manufacturing the products, the materials being used in production, the physical requirements of specific jobs, and the potential for hazard exposure. This knowledge is necessary for the occupational medicine physician to develop appropriate education programs and to help in the appropriate placement of workers into certain jobs. More importantly, knowledge of specific work processes will help the occupational medicine physician determine when an employee is able to return to normal job duties following injury or illness. Results of a study conducted by Pedersen, Venable, and Sieber (1990), which used the data from the NOES, the same instrument used in this dissertation, indicated that off-site physician care was less comprehensive in terms of medical screenings, medical examinations, and record keeping than on-site physician care. In addition, having information concerning the manufacture of various products and the materials used in production is necessary for the physician to assess potential for hazard exposure and to help in the creation of effective hazard control methods (Anton, 1989).

The effects of part-time versus full-time access to an occupational health professional is not completely understood. Considering the vast array of job responsibilities of the occupational medicine physician or nurse, the hiring of a full-time professional would likely be more beneficial in establishing and maintaining a safe working environment for employees than the hiring of a part-time professional. Depending on the number of employees on staff, it would be difficult for a part-time professional to thoroughly conduct all the routine examinations, medical screenings, education programs, and program development traditionally required of a health professional.

There currently exists little research regarding the effects of access to an on-site practitioner access versus access to off-site care. Research conducted by Aday & Andersen (1975), however, has shown that individuals having greater access to health services are more likely to use them. Furthermore, access to medical care has been identified by Shi and Singh (1998) as a primary determinant of one's health status. In addition, research suggests that individuals with greater access to medical care are more likely to seek care than individuals having more barriers to medical care. Therefore, workers having greater access to health and medical services through provision of a full-time, on-site occupational health professional are more likely to have lower injury and illness rates. Establishments with a full-time health professional on site are likely to have more comprehensive safety programs, greater access to health care, safer work environments, and lower injury and illness occurrence than establishments with only a part-time professional on staff.

Full-Time Industrial Hygienist

Past research suggests that establishments that employ a full-time industrial hygienist are more likely to have lower occupational injury and illness rates (NSC, 1983; Anton, 1989; Levy & Wegman, 1995; Miller, 1977). If effectively carried out, the major responsibilities of the industrial hygienist aid in the implementation and maintenance of a safer work environment for employees (NSC, 1983; Anton, 1989). Work establishments with a certified industrial hygienist on staff have some assurance of a minimum standard of professional education and experience in hazard identification and control by the industrial hygienist (NSC, 1983; Levy & Wegman, 1995). The industrial hygienist has been identified in past research as being an integral part of occupational health and injury prevention programs (Miller, 1977).

Major responsibilities of industrial hygienists include recognizing and evaluating potential workplace hazards, understanding the effects of various stressors on employees, and specifying corrective measures for safety hazard control (NSC, 1983). The primary goal of industrial hygienists, according to the NSC (1983), is to design engineering controls so as to minimize hazardous exposure potential for employees. Anton (1989) has identified the following activities as major components of the work carried out by industrial hygienists: (1) performing inspections, (2) preparing reports, and (3) interpreting standards. If performed effectively, the major job responsibilities of industrial hygienists are likely to aid in the minimization of hazardous exposures, the prevention of work-related injuries and illnesses, and the review and adaptation of workplace safety standards. As a result, establishments that have access to the expertise of industrial hygienists are more likely to establish and maintain safer work environments for employees. Benefits of having industrial hygienists on staff include reduced workers' compensation costs, increased worker productivity and efficiency, more efficient and effective product design, better process design, and better labor relations (NSC, 1983).

Certification of industrial hygienists by the American Board of Industrial Hygiene helps to ensure that industrial hygienists hired to work in establishments have a minimum degree of expertise (NSC, 1983). In order to gain certification, individuals must meet certain standards of education and experience. Certification is based on academic preparation, experience, and successful completion of a written examination (Levy & Wegman, 1995). As a result, the hiring of industrial hygienists helps to guarantee establishment access to a professional with a certain standard of expertise. Therefore, establishments that employ industrial hygienists to aid in occupational injury and illness prevention are likely to maintain safer work environments for employees.

In a report of industrial hygiene functions, Miller (1977) reported that industrial hygienists play an integral part in the "occupational health team". In his report, Miller discussed the methods in which industrial hygienists, along with physicians, nurses, and other safety professionals, help to satisfy the objectives and functions of the "occupational health team". The primary goal of occupational health professionals, including industrial hygienists, is to create and maintain the safest workplace possible such that employees are able to work most efficiently. Therefore, it is likely that establishments employing industrial hygienists have a higher level of employee safety and lower occupational injury rates and illness presence.

Evaluation of Past Research

Although the Traditional Epidemiological Model has been used in research for many years, the variety of types of studies for which it has been used continues to increase. An extensive review of the NIOSHTIC-2 database, a bibliographic database of research reports supported in whole or in part by the NIOSH (http://outside.cdc.gov/BASIS/niotic/public/tic/sf), and the Health Reference Center Academic database (http://netserv.lib.odu.edu:2077/itw/infomark/1/1/1/purl=rc6_hrca) turned up few studies of occupational injuries and illnesses that used the Traditional Epidemiological Model as a theoretical framework. Past research in occupational health has often failed to take a holistic approach to the study of occupational injuries and illnesses.

Table 2-5 provides a summary of some of the more recent research in occupational health specific to the manufacturing industry. Although there was no evidence that the Traditional Epidemiological Model was applied as the theoretical framework for these studies, the agent, host, and environment concepts of the model may be applied in order to gain a better understanding of the interaction effects of the three variables on health outcomes.

Study	Agent	Host	Environment	Health Outcome
Mori, 2002	Tar and benzoupyrene	332 male manufacturing workers with at least 5 years of service during the 1951-1974 time period	A graphite electrode manufacturing factory	Significantly higher standard mortality ratios and mortality rates for lymphatic and haemoatopoietic cancers than in general and local populations
Department of Consumer and Employment Protection, Government of Western Australia, 2002	Weight of material; bending, stretching, or twisting to reach loads; handling large and awkward loads or loads that are difficult to grasp; carrying loads over long distances, for long periods of time, or in areas where floor surfaces are cluttered, uneven, or slippery; working in an uncomfortable position for a long period of time; applying a force repetitively	Metal products manufacturing employees	A metal products manufacturing factory	Occurrence of Occupational Overuse Syndrome (OOS) and Repetitive Strain Injury (RSI)
Melamed, Froom, Kristal-Boneh, Gofer, & Ribak, 1997	Industrial noise	1,455 male and 624 female healthy manufacturing workers aged 20-64 years	21 manufacturing plants (including metal, textile, light, electronics, foodstuffs, and plywood plants) in Israel	Higher total cholesterol levels, triglyceride levels, and cholesterol ratios in male workers under age 45 years exposed to high noise levels.

Table 2-5. Summary of occupational health research specific to the manufacturing industry.

Mori (2002) conducted a study to determine cancer mortality among 332 male man-made graphite electrode manufacturing workers with at least five years of service during the 1951 to 1974 time period. Tar and benzoupyrene were used as agent variables and a graphite electrode manufacturing factory was used as the environment variable. The researcher found significantly higher standard mortality ratios and mortality rates for lymphatic and haemoatopoietic cancers in the graphite electrode manufacturing employees than in the general and local populations.

The Department of Consumer and Employment Protection of the Government of Western Australia (2002) conducted a study of employees in a metal products manufacturing factory to determine the effects of various agent characteristics on repeated trauma disorders. Agent characteristics investigated in the study included weight of materials, bending, stretching or twisting to reach loads, handling large and awkward loads, carrying loads over long distances, working in uncomfortable positions, and applying a force repetitively. Results of the study indicated higher rates of Occupational Overuse Syndrome (OOS) and Repetitive Strain Injury (RSI) in metal products manufacturing employees than in the general population.

In a study conducted by Melamed et al. (1997), the effects of industrial noise on the cholesterol levels of 1,455 male and 624 female manufacturing workers aged 20 to 64 years was analyzed. The noise level in twenty-one manufacturing plants, including metal, textile, light, electronics, foodstuffs, and plywood plants, in Israel were measured. The researchers found higher total cholesterol levels, triglyceride levels, and cholesterol ratios in the male manufacturing workers under age forty-five years who were exposed to high noise levels.

Summary of Major Findings of Past Research Related to Current Findings

NIOSH publications often contain information stating that the presence of safety and health programs aids in the reduction of occupational injury rates (Cohen & Jensen, 1984; Cohen et al., 1998; Ford & Fisher, 1994; Johnston & Cattledge, 1994). Unfortunately, data supporting these claims is minimal. In past research, the NIOSH has identified specific companies that have reduced the number of injuries and illnesses through formal safety and health program implementation (Erlichman, 1980; McVey, 1981; Wheeler, 1981). However, conclusive data published in scientific reports has yet to emerge.

Although some agent and environmental characteristics have been studied in the past, the effects of the specific agent and environmental characteristics used in this study have yet to be thoroughly examined. Past research has failed to address the impact of the presence of on-site occupational health and safety professionals and industrial hygienists, the presence of labor unions, and the use of industrial hygiene services on occupational injury and illness in manufacturing industries. Additionally, data analysis in previously conducted studies has been primarily bivariate in nature. A more in-depth, multifactorial approach to research must be taken in order to more accurately assess the relationship between the agent, host, and environmental factors that exist in industries.

Filling the Gaps in Information

The Traditional Epidemiological Model has been the cornerstone of infectious disease research for many years. Using the concepts of the model, namely the agent, the host, and the environment, researchers have been able to take a more holistic view of particular phenomena. Applying the Traditional Epidemiological Model in occupational health studies such as this one will illustrate, for the first time, how environmental factors affect occupational injury and illness in manufacturing establishments. Once research studies such as this dissertation study have been completed, policymakers, employers, and occupational health specialists will have more specific information on the environmental factors that positively affect occupational injury and illness rates in the manufacturing industry. Resources can then be most appropriately allocated so as to create and maintain the safest work environment possible for manufacturing employees.

CHAPTER III: METHODS

Chapter III provides a detailed description of the data collection procedures, population, and instrumentation used in the study. The dependent and independent variables are identified and operationally defined. The hypotheses derived from the research questions outlined in Chapter I are presented. Furthermore, the study's limitations and assumptions are discussed. Finally, the data analysis techniques used to test the research hypotheses are specified.

Data Collection

Data from this study came from the National Occupational Exposure Survey (NOES), which was collected during the 1981 to 1983 time period. The NOES was an observational study conducted with a sample of nearly 5,000 establishments nationwide. The NOES was undertaken to obtain data on the types of potential exposure agents found in the workplace, and was intended to represent industries covered under the OSHAct of 1970. Furthermore, the NOES was intended to identify safety and health programs implemented at the plant level (Seta, Sundin, & Pedersen, 1988).

NOES data collection was conducted by Westat Incorporated, a survey research firm contracted by the NIOSH. NOES data collection began in November of 1980 and continued for thirty months. Trained personnel conducted on-site visits of 4,490 establishments to administer the survey and to collect data. Data collection involved the administration of a sixty-six item survey to management personnel (a copy of the NOES questionnaire is located in Appendix A).

Protection of Human Subjects

This study obtained an exemption from the College of Health Sciences Human

Subjects Review Board Committee of Old Dominion University (Appendix C). This study was exempt under Virginia Code because it involved an existing data set that was collected by NIOSH in 1981-1983. No personal identifiers were contained in the data set. No data were collected on individual employees, and there was no contact with individual subjects by the investigator. Because the study involved analysis of already existing data that contained no personal identifiers, there was no risk to the subjects or specific companies.

Sample Selection

The overall sample selection was a stratified random sample. The NOES system for sample selection involved two phases. The first phase involved NIOSH selection of 604 geographically defined primary sampling units (PSUs). The second phase of sample selection involved the stratification of PSUs into ninety-eight strata for the purpose of obtaining groups of PSUs that were of equal size and were homogeneous with respect to the NOES variables of interest. Completion of these two phases made it possible for NIOSH researchers to designate a screening sample.

The target population for the NOES study was defined as those establishments or job sites located in the fifty states reporting eight or more employees and having a primary activity of one of the target SIC codes. Only establishments located in metropolitan and other urbanized areas of the United States that reported a minimum of eight employees in the Bureau of the Census 1978 County Business Patterns (CBP) file and the 1980 Dun and Bradstreet Market Inventory (DMI) file were considered for NOES study inclusion. Additionally, to be considered for NOES study inclusion, an establishment had to conduct business within one of the following SIC codes: (1)

Agriculture: 0700-0799, (2) Oil and Gas Extraction: 1300-1389, (3) Construction or Special Trade Contractor: 1500-1700, (4) Manufacturing: 2000-3999, (5) Transportation, Communication, Electric, Gas, or Sanitary Services: 4000-4999, (6) Wholesale Trade: 5000-5199, (7) Retail Trade: 5200-5999, or (8) Specialized Services: 7000-8999. Not eligible for study participation were establishments engaged in agricultural production, any mining activity except oil and gas extraction, railroad transportation, private households, financial institutions, and all federal, state, and municipal government facilities. Only establishments that were still work sites during the 1981 to 1983 period of data collection were included in the sample (Seta, Sundin, & Pedersen, 1988).

A screening sample made up of 7,392 establishments was contacted by telephone to confirm number of employees and appropriateness of SIC code for study inclusion, and to check on willingness for study participation. After completion of the screening process, 4,504 establishments were designated for field interview. A total of 4,490 establishments actually completed interviews, of these, 2,665 were manufacturing establishments.

For purposes of this dissertation study, all manufacturing establishments that employed greater than 8 employees were selected from the NOES sample (n = 2,621). The smallest (8 to 499 employees) and the largest (2,500+ employees) firms were excluded from the study due to a lack of variation on key environmental variables. Preliminary analysis of the data revealed that manufacturing establishments employing fewer than 500 workers were far less likely to have the environmental variables of interest (i.e. small companies are less likely to employ a full-time, on-site health professional or a full-time, on-site safety professional) than establishments that were somewhat larger. Furthermore, almost all of the manufacturing establishments employing 2,500 or more workers had the environmental variables of interest (i.e. larger companies are likely to employ a full-time, on-site safety professional, to have safety training programs, and to have labor unions). As a result, only establishments classified under manufacturing SIC codes (2000-3999) that employed 500 to 2,499 workers were selected from the NOES sample for study inclusion. Table 3-1 provides an illustration of the distribution of environmental variables in each particular sample size.

Manufacturing Company Size								
	8-499 Employees n=2,168		500-999 Employees n=171		1,000-2,499 Employees n=149		2,500+ Employees n=177	
Labor Union	Yes 40%	No 60%	Yes 57%	No 43%	Yes 72%	No 28%	Yes 72%	No 28%
Use of I.H. Services	Yes 37%	No 63%	Yes 61%	No 39%	Yes 61%	No 39%	Yes 47%	No 53%
Safety Professional	Yes 11%	No 89%	Yes 54%	No 46%	Yes 82%	No 18%	Yes 98%	No 2%
Health Professional	Yes 8% RN 6% MD+RN 2%	No 92%	Yes 73% RN 48% MD+RN 25%	No 27%	Yes 81.6% RN 44.4% MD+RN 37.2%	No 18.4%	Yes 100% RN 11% MD+RN 89%	No 0%
Industrial Hygienist	Yes 2%	No 98%	Yes 16%	No 84%	Yes 39%	No 61%	Yes 68%	No 32%

Table 3-1. Distribution of environmental variables by company size.

Study Variables

Identification of Study Variables

Occupational injury rates and the presence of occupational illness served as the dependent variables in the study. Agent, host, and environmental factors were the independent variables in the study. The following environmental factors were examined in the study: presence of an established labor union; utilization of industrial hygiene services within the past twelve months; presence of a full-time, on-site occupational safety professional; presence of a full-time, on-site occupational health professional; and presence of an industrial hygienist. Host variables included gender composition of the establishment (percentage of male versus female employees), occupational composition of the establishment (percentage of administrative versus manufacturing employees), size of the establishment (number of employees), number of years that the establishment has been in operation, and geographical location of the establishment. Agent variables included manufacturing standard industrial classification codes, establishments producing durable goods, and establishments producing non-durable goods. Utilizing the constructs of the Traditional Epidemiological Model, the agent, host, and environment variables of the study were organized according to construct.

Operational Definitions

Dependent Variables

Occupational Injury Rate =

$$\frac{\text{fatality/injury with lost workday/injury without lost workday} \times 200{,}000}{\text{total hours worked (estimated at 2,000 hours per employee per year)}}$$

Occupational Injury With a Lost Workday Rate =

$$\frac{\text{injury with lost workday/fatalities x 200,000}}{\text{total hours worked (estimated at 2,000 hours per employee}}$$

Occupational Illness –

taken from the OSHA 200 log, dichotomized to any versus none

Occupational injury rates and the presence of occupational illness were the dependent variables of the study. Injury and illness data were collected using the OSHA Form 200. For purposes of this study, this form was used to determine injury rates and illness frequencies for specific manufacturing establishments. OSHA requires all "recordable occupational injuries and illnesses" to be recorded on the OSHA Form 200. OSHA defines a "recordable occupational injury" as any injury that results from an instantaneous event and that results in "death and injuries other than minor injuries requiring only first aid and which involve loss of consciousness, restriction of work or motion, medical treatment, or transfer to another job". Recordable occupational illnesses are non-instantaneous events and are defined as "all diagnosed (recognized) occupational illnesses, regardless of severity". Because more than fifty percent of the establishments included in the sample reported no illnesses, occupational illnesses were dichotomized.

Environmental Variables

Labor union- defined as any organization in which any of the facility's employees participate as members, which exists for the purpose of dealing with the employer concerning grievances, wages, working hours, and conditions.

Industrial hygiene services- defined as occupational health services conducted to monitor the presence of physical agents such as heat, vibration, radiation, noise, and magnet fields and chemical agents such as fumes, gases, mists, dusts, and vapors.

Full-time, on-site occupational health professional- defined as an individual whose major responsibilities are in the area of occupational illness prevention.

Full-time, on-site occupational safety professional- defined as an individual whose major responsibilities are in the area of occupational injury prevention.

Industrial hygienist – defined as an individual whose major responsibilities are in the area of occupational illness prevention and who has the competence and ability to recognize and evaluate the hazard potential of environmental factors and stresses associated with work operations and to understand their effect on people and their well-being.

Host Variables

Gender composition- defined as percentage of male versus female employees in the manufacturing establishment.

Occupational composition- defined as percentage of employees working in the work area versus employees working in administrative or other low potential for hazardous exposure positions.

Geographical location- defined as region of the United States in which the establishment is located (Northeast, Midwest, Southeast, Southwest).

Company size- defined as number of full-time workers employed to work in the establishment.

Number of years of establishment operation- defined as total number of years that the manufacturing establishment has been in existence.

Agent Variables

SIC codes- Standard Industrial Classification codes as defined by the United States

Department of Labor.

Manufacture of durable goods- defined as establishments classified as producers of durable goods (non-food products); SIC codes 2400-3999.

Manufacture of non-durable goods- defined as establishments classified as producers of non-durable goods (food products); SIC codes 2000-2399.

Study Design

This dissertation study used an observational, cross-sectional design. A phenomena was observed, namely the effect of host, agent, and environment variables on occupational injury and illness rates, but no intervention was performed. Data were collected at one point in time and were used to show the prevalence of occupational injuries and illnesses in manufacturing companies that employ certain health and safety practices as compared to manufacturing companies that do not employ these practices.

Assumptions of the NOES Database

Assumptions of the study included the following:

- OSHA Form 200 was a valid and reliable measure of occupational injury rates and illness frequencies.
- The NOES was a valid and reliable measure of plant-level occupational health and safety programs.
- NOES respondents provided true and accurate responses to survey items.
- Typical daily activities were performed by employees during the time of observation and evaluation of work processes by data collectors.
- Data collector recordings of potential exposures were accurate.
- Linearity, homoscedasticity, independence of the residuals, and normality during

regression analysis.

Limitations

The study design, the age of the data, and the health outcomes used were three limitations of the study. The study used an observational, cross-sectional design. Observational research designs do not lend themselves to formulation of cause and effect relationships based on statistical significance. In this study, a phenomenon, namely the effect of host, agent, and environment variables on occupational injury rates and illness frequencies, was observed. No intervention was used, and no causes of occupational injury or illness could be established. Furthermore, the use of a cross-sectional design makes it difficult to detect changes or trends that may occur over time. Because data were collected at one point in time, the long-term effects of the variables of interest on injury and illness prevalence may be difficult to assess. The study design did not allow for measurement of long-term problems such as disability and its health effects that occur later in life.

The age of the data may have also served as a limitation of the study. Data were collected from the 1981 to 1983 time period. The NOES does, however, provide the most current occupational injury and illness data in existence. No more current data on occupational injury and illness prevalence within certain industry types exists. In fact, data contained in the NOES continues to be examined and used to create occupational health and safety policies. Even though the NOES is the most current data available, there is no information available on the quality of the services questioned in the survey.

Weaknesses of the particular health outcomes examined in this study include the following: (1) failure of injury and illness data to measure worker perception of safety;

(2) failure of injury and illness data to holistically present employee health and well-being; (3) failure of injury and illness data to reveal specific causes of injury or illness; and (4) failure of injury and illness data to quantify injuries or illnesses that are progressive in nature. Use of injury and illness rate data as health outcomes of the model does not take into account worker perceptions of work environment safety. Workers who perceive their work environment to be safe are likely to have higher morale and be more productive. The health outcomes examined in this study are indicators of the physical health of employees but fail to present employee health in a holistic manner by not including information concerning the mental, social, or spiritual health of employees. Furthermore, use of the particular health outcomes examined in this study does not allow for the examination of specific causes of occupational injury or illness. Injury and illness data present an overview of establishment injury and illness prevalence but fail to reveal explanations for occurrences. Injury and illness data provide a general indication of employee safety and health but fail to include information regarding progressive injuries or illnesses in which symptoms take years to surface.

Additional study limitations related to generalizability of the results exist. Results of the study may not be applicable to industries that fall under different SIC codes or to establishments located in rural areas. Furthermore, there are numerous factors affecting an establishment's occupational injury rates and occupational illness frequency. Additional research investigating company practices that aid in reduction of hazardous exposure risk must be conducted in order to get a more accurate picture of occupational injuries and illnesses.

Hypotheses

Agent-Related Hypothesis

Hypothesis 1a:

Manufacturing establishments that are classified as producers of durable goods (SIC codes 2400-3999) will have higher total occupational injury rates than manufacturing establishments classified as producers of non-durable goods (SIC codes 2000-2399).

Hypothesis 1b:

Manufacturing establishments that are classified as producers of durable goods (SIC codes 2400-3999) will have higher occupational injury with a lost workday rates than manufacturing establishments classified as producers of non-durable goods (SIC codes 2000-2399).

Hypothesis 1c:

Manufacturing establishments that are classified as producers of durable goods (SIC codes 2400-3999) will a have higher presence of occupational illness than manufacturing establishments classified as producers of non-durable goods (SIC codes 2000-2399).

Host-Related Hypotheses

Hypothesis 2a:

Manufacturing establishments that employ a larger percentage of female employees will have lower total occupational injury rates than manufacturing establishments that employ a lower percentage of female employees.

Hypothesis 2b:

Manufacturing establishments that employ a larger percentage of female employees will have lower occupational injury with a lost workday rates than manufacturing establishments that employ a lower percentage of female employees.

Hypothesis 2c:

Manufacturing establishments that employ a larger percentage of female employees will have a lower presence of occupational illness than manufacturing establishments that employ a lower percentage of female employees.

Hypothesis 3a:

Manufacturing establishments that employ a larger percentage of administrative employees will have lower total occupational injury rates than manufacturing establishments that employ a lower percentage of administrative employees.

Hypothesis 3b:

Manufacturing establishments that employ a larger percentage of administrative employees will have lower occupational injury with a lost workday rates than manufacturing establishments that employ a lower percentage of administrative employees.

Hypothesis 3c:

Manufacturing establishments that employ a larger percentage of administrative employees will have a lower presence of occupational illness than manufacturing establishments that employ a lower percentage of administrative employees.

Hypothesis 4a:

Manufacturing establishments that employ a greater number of employees will have lower total occupational injury rates than manufacturing establishments employing a fewer number of employees.

Hypothesis 4b:

Manufacturing establishments that employ a greater number of employees will have lower occupational injury with a lost workday rates than manufacturing establishments employing a fewer number of employees.

Hypothesis 4c:

Manufacturing establishments that employ a greater number of employees will have a lower presence of occupational illness than manufacturing establishments employing a fewer number of employees.

Hypothesis 5a:

Manufacturing establishments located in certain regions of the United States will have higher total occupational injury rates than manufacturing establishments located elsewhere in the United States.

Hypothesis 5b:

Manufacturing establishments located in certain regions of the United States will have higher occupational injury with a lost workday rates than manufacturing establishments located elsewhere in the United States.

Hypothesis 5c:

Manufacturing establishments located in certain regions of the United States will have a higher presence of occupational illness than manufacturing establishments located elsewhere in the United States.

Hypothesis 6a:

Manufacturing establishments that have been in operation for a greater number of years will have higher total occupational injury rates than manufacturing establishments that have not been in operation for as long.

Hypothesis 6b:

Manufacturing establishments that have been in operation for a greater number of years will have higher occupational injury with a lost workday rates than manufacturing establishments that have not been in operation for as long.

Hypothesis 6c:

Manufacturing establishments that have been in operation for a greater number of years will have a higher presence of occupational illness than manufacturing establishments that have not been in operation for as long.

Environment-Related Hypotheses

Hypothesis 7a:

Manufacturing establishments that have a labor union will have lower total occupational injury rates than manufacturing establishments that do not have a labor union.

Hypothesis 7b:

Manufacturing establishments that have a labor union will have lower occupational injury with a lost workday rates than manufacturing establishments that do not have a labor union.

Hypothesis 7c:

Manufacturing establishments that have a labor union will have a lower presence of occupational illness than manufacturing establishments that do not have a labor union.

Hypothesis 8a:

Manufacturing establishments that have received industrial hygiene consultation services within the last twelve months will have lower total occupational injury rates than manufacturing establishments that have not received industrial hygiene services within the last twelve months.

Hypothesis 8b:

Manufacturing establishments that have received industrial hygiene consultation services within the last twelve months will have lower occupational injury with a lost workday rates than manufacturing establishments that have not received industrial hygiene services within the last twelve months.

Hypothesis 8c:

Manufacturing establishments that have received industrial hygiene consultation services within the last twelve months will have a lower presence of occupational illness than manufacturing establishments that have not received industrial hygiene services within the last twelve months.

Hypothesis 9a:

Manufacturing establishments that employ a full-time, on-site occupational safety professional will have lower total occupational injury rates than manufacturing establishments that do not employ a full-time, on-site occupational safety professional.

Hypothesis 9b:

Manufacturing establishments that employ a full-time, on-site occupational safety professional will have lower occupational injury with a lost workday rates than manufacturing establishments that do not employ a full-time, on-site occupational safety professional.

Hypothesis 9c:

Manufacturing establishments that employ a full-time, on-site occupational safety professional will have a lower presence of occupational illness than manufacturing establishments that do not employ a full-time, on-site occupational safety professional.

Hypothesis 10a:

Manufacturing establishments that employ a full-time, on-site occupational health professional will have lower total occupational injury rates than manufacturing establishments that do not employ a full-time, on-site occupational health professional.

Hypothesis 10b:

Manufacturing establishments that employ a full-time, on-site occupational health professional will have lower occupational injury with a lost workday rates than manufacturing establishments that do not employ a full-time, on-site occupational health professional.

Hypothesis 10c:

Manufacturing establishments that employ a full-time, on-site occupational health professional will have a lower presence of occupational illness than manufacturing establishments that do not employ a full-time, on-site occupational health professional.

Hypothesis 11a:

Manufacturing establishments that employ an industrial hygienist will have lower total occupational injury rates than manufacturing establishments that do not employ an industrial hygienist.

Hypothesis 11b:

Manufacturing establishments that employ an industrial hygienist will have lower occupational injury with a lost workday rates than manufacturing establishments that do not employ an industrial hygienist.

Hypothesis 11c:

Manufacturing establishments that employ an industrial hygienist will have a lower presence of occupational illness occurrence than manufacturing establishments that do not employ an industrial hygienist.

Multivariate Hypotheses

Hypothesis 12a:

In the manufacturing industry, when agent, host, and environment characteristics are considered together, it is expected that companies that employ a full-time, on-site occupational safety professional will have significantly lower total occupational injury rates. It is expected that companies that have a full-time on-site occupational health professional will have a weaker significance, and the other predictors will not be significant.

Hypothesis 12b:

In the manufacturing industry, when agent, host, and environment characteristics are considered together, it is expected that companies that employ a full-time, on-site occupational safety professional will have significantly lower occupational injury with a lost workday rates. It is expected that companies that have a full-time, on-site occupational health professional will have a weaker significance, and the other predictors will not be significant.

Hypothesis 12c:

In the manufacturing industry, when agent, host, and environment characteristics are considered together, it is expected that companies that employ an industrial hygienist will have significantly lower presence of occupational illness. It is expected that companies that have a full-time, on-site occupational health professional will have a weaker significance, and the other predictors will not be significant.

Data Analysis Procedures

Data analysis was conducted using the SPSS version 9.0 software program. SPSS is a robust statistical software package that enables researchers to perform the necessary data analysis. A data dictionary describing the characteristics of the dependent and independent variables used in this study is included in Appendix D.

Estimates for the number of employees and the number of establishments conducting business nationwide in the SIC ranges used in the NOES were calculated by assigning appropriate weighting factors to establishments included in the sample. The weighting factors were used to ensure that the NOES sample represented the national makeup of employees and establishments. Although data obtained from this study was weighted in order for the estimates of injury and illness rates to be generalized to the population, it was not necessary to weight the data in order to examine relationships between variables.

Univariate frequencies were run on the variables. The data were analyzed for out-of-range codes, outliers, missing variables, and skewness. The variables were recoded as necessary. Bivariate analyses were conducted to determine if relationships between the variables existed. Assumptions concerning normal distribution, linearity, multicollinearity, independence of residuals, and homoscedasticity were examined. In order to predict occupational injury rates and illness presence based on the independent variables, linear and logistic regression models were used for multivariate analyses. Linear regression was used, after the injury variables were logarithmically transformed to produce normality, to determine statistical significance between specific independent variables and the injury-related health outcomes, while controlling for the effects of other independent variables. Logistic regression was used to calculate the odds-ratio of having occupational illness presence based on specific independent variables. Information on the specific tests used for bivariate and multivariate analyses is illustrated in Table 3-2.

Hypothesis	Dependent Variables	Independent Variable	Non-Parametric Test
Bivariate Hypotheses			
Agent – H1	Injury rate Illness presence	Manufacture of Durable or Non-Durable Goods	Mann-Whitney U Chi-Square
Host – H2	Injury rate Illness presence	Gender Composition	Spearman's Rho Mann-Whitney U
Host – H3	Injury rate Illness presence	Occupational Composition	Spearman's Rho Mann-Whitney U
Host – H4	Injury rate Illness presence	Number of Employees	Spearman's Rho Mann-Whitney U
Host – H5	Injury rate Illness presence	Geographical Area- NE, MidW, SE, SW	Kruskal-Wallis Chi-Square
Host – H6	Injury rate Illness presence	Years of Operation	Spearman's Rho Mann-Whitney U
Environment - H7	Injury rate Illness presence	Labor Union	Mann-Whitney U Chi-Square
Environment - H8	Injury rate Illness presence	Industrial Hygiene Consulting Services	Mann-Whitney U Chi-Square
Environment - H9	Injury rate Illness presence	Safety Professional	Mann-Whitney U Chi-Square
Environment - H10	Injury rate Illness presence	Health Professional	Mann-Whitney U Chi-Square
Environment - H11	Injury rate Illness presence	Industrial Hygienist	Mann-Whitney U Chi-Square

Table 3-2. Tests used for bivariate and multivariate analysis according to hypothesis.

Hypothesis	Dependent Variables	Independent Variables	Parametric Test	Non-Parametric Test
Multivariate Hypotheses				
Multivariate H12	Injury rate Illness presence	labor union, IH services, safety professional, health professional, industrial hygienist, gender, # years operation, geographical area, occupational composition, # of employees, type of manufacturing industry	Multiple Linear Regression	Logistic Regression

Table 3-2. Continued.

Hypotheses concerning the effects of each individual environment-related independent variable (labor unions, industrial hygiene consulting services, safety professionals, occupational health professionals, industrial hygienists) on occupational injury rates and presence of occupational illness were tested using the Mann-Whitney U and Chi-Square tests.

Hypotheses concerning the effects of each individual host-related independent variable (gender composition, occupational composition, company size, number of years of establishment operation, geographical location) on occupational injury rates and occupational illness presence were tested using the Spearman's Rho, Mann-Whitney U, Chi-Square, and Kruskal-Wallis tests.

The hypothesis concerning the effects of each individual agent-related independent variable (type of manufacturing industry, durable goods or non-durable goods, as defined by SIC code) on occupational injury rates and occupational illness presence were tested using the Mann-Whitney U and Chi-Square tests.

The alpha level, or p-value, is the statistical significance set by the researcher and is used to determine whether hypotheses are statistically significant. Statistical tests used during analyses were used to determine p-values, which were set at $p \leq 0.05$ for this study.

Descriptive Statistics for Independent Variables

Descriptive statistics were calculated for each of the independent variables included in the study. Tables presenting descriptive statistics for each of the agent, host, and environment variables have been provided in order to illustrate the distribution of these variables among the manufacturing establishments included in the study.

Agent Variables

Descriptive statistics for the agent variables included in the study are presented in Table 3-3. Almost seventeen percent of the manufacturing establishments included in the sample produced durable goods, while approximately eighty-three percent produced non-durable goods.

Variable	Frequency	Percent of Sample
Manufacture of Durable Goods	54	16.9
Manufacture of Non-Durable Goods	266	83.1

Table 3-3. Descriptive statistics for agent-related independent variables.

Host Variables

Descriptive statistics for the host variables analyzed in the study are presented in Tables 3-4 and 3-5. Frequencies and percents for each survey response option for each host variable examined in the study have been included. As illustrated in Table 3-4, the majority of the manufacturing establishments included in the sample were located in the Midwestern region of the United States. The fewest number of establishments included in the sample were located in the Southwestern region. Because the Northwestern region of the United States was not included in the original NOES sample, relationships between the dependent and independent variables of the study in manufacturing establishments located in this region of the country could not be examined. As illustrated in Table 3-5, the mean percent of male workers in the manufacturing establishments included in the sample was approximately sixty-eight. Nearly thirty-two percent of the manufacturing establishment workforces were made up of female employees. There was a mean of approximately seventy percent of employees working in the "work areas" of manufacturing establishments rather than in the administrative areas. The average company size of manufacturing establishments included in the sample was 1,084 employees (median = 942 employees). The mean number of years of establishment operation was thirty-seven (median = 30 years).

Variable	Frequency	Percent of Sample
Geographical Area		
1 Northeast	73	22.8
2 Midwest	135	42.2
3 Southeast	76	23.8
4 Southwest	36	11.2

Table 3-4. Descriptive statistics for host-related independent variables (nominal).

Variable	Mean	Median	Mode
Percent Male Employees	68.4%	71.4%	40.0%
Percent Female Employees	31.6%	28.6%	50.0%
Percent Employees Working in the Work Area	70.1%	75.0%	67.0%
Total Number of Employees	1084.3	942.0	1100.0
Number of Years of Establishment Operation	37.1	30.0	20.0

Table 3-5. Descriptive statistics for host-related independent variables (ratio).

Environmental Variables

Descriptive statistics for the environmental variables examined in the study are presented in Table 3-6. Of the 316 manufacturing establishments included in the sample, 196, or approximately sixty-one percent of the establishments had received industrial hygiene consultation services during the past twelve months. Almost sixty-four percent (204) had some form of organized labor union in place. While nearly sixty-seven percent (214) of the 320 establishments included in the sample had a full-time, on-site safety professional on staff to assist with occupational injury prevention, only twenty-seven percent (86) of the establishments had an industrial hygienist on staff to assist with occupational illness prevention. Most of the manufacturing establishments, approximately eighty-two percent (261), had some type of occupational health professional on staff. Nearly forty-five percent had at least one nurse on staff, while approximately thirty-seven percent had at least one doctor and one nurse on staff. Only eighteen percent of the sample had only a doctor on staff or no doctor or nurse at all.

Variable	Frequency	Percent of Sample
Labor Union		
0 No	116	36.2
1 Yes	204	63.8
Industrial Hygiene Consulting		
0 No	124	38.7
1 Yes	196	61.3
Safety Professional		
0 No	106	33.1
1 Yes	214	66.9
Health Professional		
0 None	59	18.4
1 Nurse(s)	142	44.4
2 Doctor(s) and nurse(s)	119	37.2
Industrial Hygienist		
0 No	234	73.1
1 Yes	86	26.9

Table 3-6. Descriptive statistics for environmental-related independent variables.

CHAPTER IV: RESULTS

The results of bivariate analyses between each of the three dependent variables and the eleven independent variables investigated in this research are presented in this chapter. More specifically, this chapter illustrates the major environment-related hypotheses tested by multiple regression analyses. Results of the study are organized into the agent, host, and environment constructs of the Traditional Epidemiological Model (Fox, Hall, & Elveback, 1970).

Of the thirty-three bivariate hypotheses developed for the study, six were supported. Results of the analyses are organized into the relevant constructs of the Traditional Epidemiological Model.

Bivariate Analyses

Results of bivariate analyses of the relationship between specific agent, host, and environment characteristics and occupational injury rates and presence of occupational illness in manufacturing establishments have been organized according to construct. Tables illustrating descriptive statistics for the dependent variables as well as the analyses of bivariate hypotheses concerning the relationship between specific agent, host, and environment variables and occupational injury rates and presence of occupational illness in manufacturing establishments have been included.

Dependent Variables

Tables 4-1 and 4-2 provide illustrations of the descriptive statistics for the dependent variables of the study. Table 4-1 illustrates the descriptive statistics for the injury-related dependent variables of the study, while Table 4-2 illustrates the descriptive statistics for the illness-related dependent variable.

Descriptive Statistics for Dependent Variables – Occupational Injury

Variable	n	Mean (SD)	Median	Range-Minimum	Range-Maximum
Total Occupational Injury Rate	316	7.69 (8.08)	5.63	0.00	83.63
Occupational Injury With a Lost Workday Rate	316	3.02 (4.09)	1.87	0.00	47.87

Table 4-1. Descriptive statistics for injury-related dependent variables.

Descriptive Statistics for Dependent Variable – Occupational Illness

Occupational Illness	Frequency	Percent
Yes	130	41.1
No	186	58.9
Total	316	100.0

Table 4-2. Descriptive statistics for illness-related dependent variable.

As illustrated in the tables above, the mean occupational injury rate for the 316 manufacturing establishments included in the sample was 7.69 (SD = 8.08), with a median of 5.63. The mean occupational injury with a lost workday rate was 3.02 (SD = 4.09), with a median of 1.87. An incident of occupational illness occurred in 130 (41.1 percent) of the establishments included in the sample. No reports of occupational illness were found in 186 (58.9%) of the establishments.

Agent Variables

Tables 4-3 and 4-4 provide illustrations of the results of bivariate analyses of the relationship between the dependent variables and the agent-related independent variables. The Mann-Whitney U test was used to examine the relationship between the injury-related dependent variables (total occupational injury rate, occupational injury with a lost workday rate) and the agent variable (manufacture of durable versus non-durable goods).

The Chi-Square test was used to examine the relationship between presence of occupational illness and the manufacture of durable goods. The tables have been organized according to occupational injury-related dependent variables and the occupational illness-related dependent variable. As illustrated in the tables, no agent-related hypotheses were supported during bivariate analyses.

Results of Mann-Whitney U Bivariate Analyses for Significance

Independent Variable	Dependent Variable	N	Mean (SD)	Significance p =
Manufacture of Durable Goods	Total Occupational Injury Rate			
Yes		262	7.54 (8.30)	0.153
No		54	8.35 (6.92)	
Manufacture of Durable Goods	Occupational Injury With a Lost Workday Rate			
Yes		262	2.94 (3.97)	0.969
No		54	3.46 (4.66)	

Table 4-3. Results of bivariate analyses for injury-related dependent variables and the agent-related indendent variable.

Note: Total occupational injury rate equals [(fatalities+injuries with lost workdays+injuries without lost workdays) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year); occupational injury with a lost workday rate equals [(injuries with lost workdays/fatalities) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year).

Results of Chi-Square Bivariate Analysis for Significance

Independent Variable	Dependent Variable	Significance p =
Manufacture of Durable Goods	Occupational Illness (percent with an occupational illness)	
Yes	33.3	0.200
No	42.7	

Table 4-4. Results of bivariate analyses for illness-related dependent variable and the agent-related independent variable.

During bivariate analyses, no significant relationships between the production of durable goods and the dependent variables were found. The production of durable goods was not found to be significantly related to total occupational injury rate, occupational injury with a lost workday rate, or presence of occupational illness. Although not proven significant during analyses, relationships between the manufacture of durable goods and total occupational injury rate ($p=0.15$) and presence of occupational illness ($p=0.20$) approached statistical significance.

Host Variables

Tables 4-5, 4-6, 4-7, and 4-8 show the results of bivariate analyses of the relationship between the dependent variables and the host-related independent variables. The Spearman's Rho test was used to examine the relationship between the injury-related dependent variables (total occupational injury rate, occupational injury with a lost workday rate) and four of the five host variables (percentage of female employees, percentage of work area employees, company size, years of establishment operation), while the Mann-Whitney U test was used for examination of the illness-related dependent variable. The Kruskal-Wallis test was used to examine the relationship between the two injury-related dependent variables and the geographical area independent variable, while the Chi-Square test was used for examination of the illness-related dependent variable. Of the fifteen host-related bivariate hypotheses for occupational injury and illness tested in the study, three proved significant. There were, however, two host-related hypotheses, one for occupational injury with a lost workday rate and one for the presence of occupational illness, which showed relationships that approached significance.

Results of Spearman's Rho Bivariate Analyses for Significance

Independent Variable	**Dependent Variable**	
	Total Occupational Injury Rate	Occupational Injury With a Lost Workday Rate
Percentage of Female Employees	r =-0.123 r^2=0.015 Sig=0.37	r =-0.008 r^2=0.000064 Sig=0.83
Percentage of Work Area Employees	r =0.012 r^2=0.000144 Sig=0.83	r =-0.063 r^2=0.003969 Sig=0.27
Company Size	**r =-0.138** **r^2=0.019** **Sig=0.01**	**r =-0.144** **r^2=0.021** **Sig=0.01**
Years of Establishment Operation	r =0.004 r^2=0.000016 Sig=0.94	r =-0.070 r^2=0.0049 Sig=0.24

Table 4-5. Results of bivariate analyses for injury-related dependent variables and the host-related independent variables.

Note: Total occupational injury rate equals [(fatalities+injuries with lost workdays+injuries without lost workdays) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year); occupational injury with a lost workday rate equals [(injuries with lost workdays/fatalities) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year).

Results of Kruskal-Wallis Bivariate Analysis for Significance

Independent Variable	**Dependent Variable**	**N**	**Mean (SD)**	**Significance p =**
Geographical Location	Total Occupational Injury Rate			
Northeast		73	6.73 (5.84)	0.258
Midwest		134	7.55 (6.96)	
Southeast		74	6.99 (6.36)	
Southwest		35	11.60 (15.42)	

Table 4-6. Results of bivariate analyses for injury-related dependent variables and the host-related independent variable (geographical area).

Independent Variable	**Dependent Variable**	**N**	**Mean (SD)**	**Significance p =**
Geographical Location	**Occupational Injury With a Lost Workday Rate**			
Northeast		**73**	**3.60 (4.34)**	**0.02**
Midwest		**134**	**2.69 (2.74)**	
Southeast		**74**	**2.19 (2.47)**	
Southwest		**35**	**4.91 (8.14)**	

Table 4-6. Continued.

Note: Total occupational injury rate equals [(fatalities+injuries with lost workdays+injuries without lost workdays) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year); occupational injury with a lost workday rate equals [(injuries with lost workdays+fatalities) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year).

Results of Mann-Whitney U Bivariate Analysis for Significance

Independent Variable	**Dependent Variable**	**N**	**Mean (SD)**	**Significance p =**
Percentage of Female Employees	Occupational Illness			
	Yes	130	0.33 (0.21)	0.394
	No	186	0.33 (0.21)	
Percentage of Work Area Employees	Occupational Illness			
	Yes	130	0.73 (0.18)	0.418
	No	186	0.69 (0.22)	
Company Size	Occupational Illness			
	Yes	130	1103.12 (556.26)	0.975
	No	186	1071.58 (492.39)	
Years of Establishment Operation	Occupational Illness			
	Yes	130	37.02 (28.41)	0.629
	No	186	37.03 (25.53)	

Table 4-7. Results of bivariate analyses for the illness-related dependent variable and the host-related independent variables.

Results of Chi-Square Bivariate Analysis for Significance

Independent Variable	Dependent Variable (percent with an occupational illness)	Significance p =
Geographical Location		
Northeast	39.7	0.106
Midwest	44.0	
Southeast	31.1	
Southwest	54.3	

Table 4-8. Results of bivariate analyses for the illness-related dependent variable and the host-related independent variable (geographical area).

Bivariate analyses turned up no significant relationships between percentage of females on the payroll of manufacturing establishments and total occupational injury rate, occupational injury with a lost workday rate, or presence of occupational illness.

No significant relationships between the occupational composition (workers in "work" areas versus workers in administrative areas) of manufacturing establishments and total occupational injury rate or occupational injury with a lost workday rate were detected during bivariate analyses. In addition, no significant relationship between occupational composition and the presence of occupational illness were revealed.

Significant relationships between company size and total occupational injury rate ($r = -0.138$, $p<0.05$) and between company size and occupational injury with a lost workday rate ($r = -0.144$, $p<0.05$) were detected during bivariate analyses. No significant relationship was detected, however, between company size and the presence of occupational illness.

Bivariate analyses showed no significant relationships between number of years of establishment operation and total occupational injury rate, occupational injury with a lost workday rate, or the presence of occupational illness. Although not significant during analyses, a relationship between years of establishment operation and occupational injury with a lost workday rate ($r = -0.070$, $p<0.05$) approached statistical significance.

The data showed a significant relationship between the geographical location of manufacturing establishments and injury with a lost workday rate ($p=0.02$). The data, however, illustrated no significant relationships between the geographical location of manufacturing establishments and total occupational injury rate or presence of occupational illness. Although bivariate analyses revealed no significant relationship between geographical location and presence of an occupational illness, a relationship that approached statistical significance was detected ($p=0.11$).

Environment Variables

Tables 4-9, 4-10, and 4-11 provide illustrations of the results of bivariate analyses of the relationships between the dependent variables and the environment-related independent variables. The Mann-Whitney U test was used to examine the relationships between the injury-related dependent variables (total occupational injury rate, occupational injury with a lost workday rate) and four of the five environment-related independent variables (labor union, industrial hygiene consulting, occupational safety professional, industrial hygienist). The Kruskal-Wallis test was used to examine the relationship between the injury-related dependent variables and the occupational health professional independent variable. The Chi-Square test was used to examine the relationship between the dependent variable, presence of occupational illness, and the five environment-related independent variables. Of the fifteen environment-related bivariate hypotheses for occupational injury and illness, three were supported. There were, however, seven hypotheses that were not supported but approached statistical significance.

Results of Mann-Whitney U Bivariate Analysis for Significance

Independent Variable	**Dependent Variable**	**N**	**Mean (SD)**	**Significance p =**
Labor Union	Total Occupational Injury Rate			
Yes		201	8.26 (9.14)	0.297
No		115	6.65 (5.68)	
Labor Union	Occupational Injury With a Lost Workday Rate			
Yes		201	3.32 (4.72)	0.340
No		115	2.52 (2.59)	
Industrial Hygiene Consulting	Total Occupational Injury Rate			
Yes		194	7.26 (6.17)	0.740
No		122	8.33 (10.42)	
Industrial Hygiene Consulting	Occupational Injury With a Lost Workday Rate			
Yes		194	2.95 (3.30)	0.454
No		122	3.15 (5.12)	
Safety Professional	Total Occupational Injury Rate			
Yes		210	7.47 (8.64)	0.143
No		106	8.08 (6.85)	
Safety Professional	Occupational Injury With a Lost Workday Rate			
Yes		210	2.94 (4.31)	0.107
No		106	3.21 (3.62)	

Table 4-9. Results of bivariate analyses for the injury-related dependent variables and the environment-related independent variables.

Independent Variable	Dependent Variable	N	Mean (SD)	Significance p =
Industrial Hygienist	Total Occupational Injury Rate			
Yes		83	7.98 (11.60)	0.08
No		233	7.57 (6.41)	
Industrial Hygienist	**Occupational Injury With a Lost Workday Rate**			
Yes		**83**	**2.78 (5.74)**	**0.01**
No		**233**	**3.12 (3.32)**	

Table 4-9. Continued.

Note: Total occupational injury rate equals [(fatalities+injuries with lost workdays+injuries without lost workdays) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year); occupational injury with a lost workday rate equals [(injuries with lost workdays+fatalities) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year).

Results of Kruskal-Wallis Bivariate Analysis for Significance

Independent Variable	Dependent Variable	N	Mean (SD)	Significance p =
Health Professional	Total Occupational Injury Rate			
None		58	3.52 (2.80)	0.08
Nurse		142	2.86 (2.92)	
Doctor + Nurse		116	2.99 (5.60)	
Health Professional	**Occupational Injury With a Lost Workday Rate**			
None		**58**	**8.50 (6.76)**	**0.003**
Nurse		**142**	**7.41 (6.39)**	
Doctor + Nurse		**116**	**7.59 (10.28)**	

Table 4-10. Results of bivariate analyses for the injury-related dependent variables and the environment-related independent variable (health professional).

Note: Total occupational injury rate equals [(fatalities+injuries with lost workdays+injuries without lost workdays) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year); occupational injury with a lost workday rate equals [(injuries with lost workdays+fatalities) x 200,000] / total hours worked (estimated at 2,000 hours per employee per year).

Results of Chi-Square Bivariate Analysis for Significance

Independent Variable	Dependent Variable	Significance p =
Labor Union	Occupational Illness (percent with an occupational illness)	
Yes	37.8	0.11
No	47.0	
Industrial Hygiene Consulting	Occupational Illness (percent with an occupational illness)	
Yes	44.8	0.09
No	35.2	
Safety Professional	**Occupational Illness (percent with an occupational illness)**	
Yes	**45.7**	**0.02**
No	**32.1**	
Health Professional	Occupational Illness (percent with an occupational illness)	
None	36.2	0.31
Nurse	45.8	
Doctor + Nurse	37.9	
Industrial Hygienist	Occupational Illness (percent with an occupational illness)	
Yes	39.8	0.77
No	41.6	

Table 4-11. Results of bivariate analyses for illness-related dependent variable and the environment-related independent variables.

Hypotheses concerning the relationship between the presence of a formal labor union and the total occupational injury rate and the occupational injury with a lost workday rate dependent variables were not supported during bivariate analyses. A relationship that approached statistical significance (p=0.11) was found between presence of a union and presence of occupational illness.

No significant relationships between industrial hygiene consultation within the past twelve months and the injury-related dependent variables (total occupational injury rate, occupational injury with a lost workday rate) were detected during bivariate analyses. A relationship that approached statistical significance (p=0.09) was found between the industrial hygiene consulting and the occupational illness variables during bivariate analyses.

Presence of a full-time, on-site occupational safety professional was found to have a significant relationship with the occupational illness dependent variable (p=0.02). However, safety professional was not found to be significantly related to total occupational injury rate or to occupational injury with a lost workday rate during bivariate analyses. Relationships approaching statistical significance were detected between safety professional and total occupational injury rate (p=0.14) and occupational injury with a lost workday rate (p=0.11).

A significant relationship (p=0.003) between presence of a full-time, on-site health professional and occupational injury with a lost workday rate was detected during bivariate analyses. Although not statistically significant, a relationship approaching statistical significance (p=0.08) was detected between health professional and total occupational injury rate. No significant relationship between health professional and presence of occupational illness was found.

Bivariate analyses supported a relationship between having an industrial hygienist on staff and occupational injury with a lost workday rate (p=0.01). Although no significant relationship between industrial hygienist and total occupational injury rate was detected, a relationship approaching statistical significance (p=0.08) was found. No significant relationship between industrial hygienist and presence of an occupational illness was found during bivariate analyses.

Multivariate Analyses

Results of multivariate analyses of the interrelationships among multiple variables are contained in this section. The effects of multiple agent, host, and environmental variables on occupational injury and illness health outcomes in manufacturing establishments have been organized according to the dependent variables of interest.

Total Occupational Injury

Tables 4-12 and 4-13 provide illustrations of the significance of occupational injury according to independent variable. Table 4-12 illustrates the significance of occupational injury when controlling for agent, host and environmental independent variables. Table 4-13 illustrates the significance of occupational injury with a lost workday when controlling for agent, host and environmental independent variables.

Total Occupational Injury

Independent Variable	**Significance p =**
Gender Composition (percent female employees)	**0.02**
Company Size (number of full-time employees)	**0.04**
Manufacture of Durable Goods	0.15
Occupational Composition (percent work area employees)	0.30
Years of Establishment Operation	0.96
Geographical Location	0.19
Presence of a Labor Union	0.16

Table 4-12. Linear regression with occupational injury and all independent variables.

Independent Variable	Significance p =
Use of Industrial Hygiene Consultation Services Within the Past 12 Months	0.75
Full-Time, On-Site Safety Professional on Staff	0.26
Full-Time, On-Site Occupational Health Professional on Staff	0.23
Industrial Hygienist on Staff	0.40

Table 4-12. Continued.

As illustrated in Table 4-12, results of multiple linear regression analyses reveal statistical significance between the gender composition host-related independent variable and total occupational injury rate (p = .02) as well as between the company size host-related independent variable and the total occupational injury rate dependent variable (p = .04).

Occupational Injury With a Lost Workday

Occupational Injury With Lost Workday

Independent Variable	Significance p =
Company Size (number of employees)	**0.02**
Full-Time, On-Site Occupational Health Professional on Staff	**0.04**
Gender Composition (percent female employees)	0.06
Manufacture of Durable Goods	0.63
Occupational Composition (percent work area employees)	0.99
Years of Establishment Operation	0.42
Geographical Location	0.69

Table 4-13. Linear regression with occupational injury with lost workday and all independent variables.

Independent Variable	Significance p =
Presence of a Labor Union	0.15
Use of Industrial Hygiene Consultation Services Within the Past 12 Months	0.79
Full-Time, On-Site Safety Professional on Staff	0.77
Industrial Hygienist on Staff	0.12

Table 4-13. Continued.

Results of multiple linear regression analyses illustrated in Table 4-13 reveal statistical significance between the company size (number of employees) of manufacturing establishments and occupational injury with a lost workday rates ($p < 0.02$). Additionally, the presence of a full-time, on-site occupational health professional on staff in manufacturing establishments was found to be significantly related to lower total occupational injury with a lost workday rates ($p = 0.04$).

Presence of Occupational Illness

Table 4-14 provides an illustration of the adjusted odds of the presence of occupational illness when controlling for agent, host, and environmental independent variables.

Adjusted Odds Ratio - Occupational Illness

Independent Variable	Adjusted Odds	95% CI (U, L)
Geographical Location (Southeast)	**0.35**	**(0.86, 0.14)**
Safety Professional	**2.16**	**(3.90, 1.20)**

Table 4-14. Logistic regression with occupational illness and all independent variables.

Independent Variable	**Adjusted Odds**	**95% CI (U, L)**
Labor Union	**0.55**	**(0.96, 0.32)**
Industrial Hygiene Consulting services within past 12 months	1.37	(2.27, 0.83)
Industrial Hygienist	0.84	(1.55, 0.46)
Geographical Location		
1	0.57	(1.38, 0.23)
2	0.75	(1.75, 0.33)
Health Professional		
1	0.93	(2.12, 0.41)
2	1.30	(2.36, 0.72)
Percent Female	1.07	(2.02, 0.57)
Percent of workers working in work areas	1.21	(2.00, 0.74)
Durable Goods	0.80	(1.63, 0.39)
Payroll (Company Size)		
1	0.82	(1.49, 0.45)
2	0.75	(1.44, 0.39)
Years of Operation		
1	0.59	(1.08, 0.33)
2	0.79	(1.50, 0.42)

Table 4-14. Continued.

Results of logistic regression analyses illustrated in Table 4-14 reveal statistical significance ($p<=0.05$) between the geographical location of manufacturing establishments and the presence of occupational illness. In addition, statistical significance ($p<=0.05$) was found between presence of a safety professional and presence of occupational illness and presence of a labor union and presence of occupational illness in manufacturing establishments during multivariate analyses. Manufacturing establishments located in the southeastern region of the United States were found to have a lower odds ratio of occupational illness than establishments located in other regions. Establishments located in the Southeast were found to be less likely (odds ratio of 0.35) to have a higher presence of occupational illness.

Furthermore, manufacturing establishments employing a full-time, on-site safety professional were at higher risk for presence of occupational illness than establishments without a safety professional on staff. The adjusted odds ratio of having the presence of occupational illness was 2.16 in manufacturing establishments employing a safety professional as compared to establishments not employing a safety professional.

The adjusted odds ratio of having a presence of occupational illness was 0.55 in manufacturing establishments with a labor union as compared to establishments without a labor union. Manufacturing establishments with a labor union were more likely to have a lower presence of occupational illness.

Relationships Between Independent and Dependent Variables

Relationships Between Agent Variables and Occupational Injury Rates/Presence of an Occupational Illness

Hypotheses 1a, 1b, 1c. The data did not support agent hypotheses 1a, 1b, or 1c which stated that manufacturing establishments that produced durable goods would have higher total occupational injury rates, occupational injury with a lost workday rates, and occupational illness than non-durable goods manufacturers. No statistically significant relationships were found between the production of durable goods and total occupational injury rate (hypothesis 1a), occupational injury with a lost workday rate (hypothesis 1b), or occupational illness (hypothesis 1c).

Relationships Between Host Variables and Occupational Injury Rates/Presence of an Occupational Illness

Hypotheses 2a, 2b, 2c. The data supported hypotheses 2a and 2b which stated that there would be lower total occupational injury rates and occupational injury with a lost workday rates in manufacturing establishments with a higher percentage of female employees. The data did not support, however, hypothesis 2c which stated that there would be a lower presence of occupational illness in manufacturing establishments that had a greater number of female employees on staff.

Hypotheses 3a, 3b, 3c. The data did not support hypotheses 3a, 3b, or 3c which stated that there would be lower total occupational injury rates, occupational injury with a lost workday rates, and occupational illness in manufacturing establishments with a higher percentage of employees working in administrative areas. No significant relationships were found between the percentage of work area employees and the dependent variables [total occupational injury rate (hypothesis 3a), occupational injury with a lost workday rate (hypothesis 3b), occupational illness (hypothesis 3c)].

Hypotheses 4a, 4b, 4c. The data supported hypotheses 4a and 4b which stated that there would be lower total occupational injury rates and occupational injury with a lost workday rates in manufacturing establishments with a greater number of employees. Significant relationships were found between company size and the injury-related dependent variables [total occupational injury rate (.045, $p<.05$), injury with a lost workday rate (.011, $p<.05$)]. The data did not, however, support hypothesis 4c which stated that there would be lower occupational illness occurrence in manufacturing establishments with a greater number of employees.

Hypotheses 5a, 5b, 5c. The data did not support hypotheses 5a, 5b, or 5c which stated that there would be lower total occupational injury rates, occupational injury with a lost workday rates, and presence of occupational illness in manufacturing establishments located within certain geographical areas of the United States.

Hypotheses 6a, 6b, 6c. The data did not support hypotheses 6a, 6b, and 6c which stated that there would be higher total occupational injury rates, occupational injury with a lost workday rates, and occupational illness in manufacturing establishments that have been in operation for a greater number of years. No significant relationships were found between years of establishment operation and the dependent variables (total occupational injury rate, occupational injury with a lost workday rate, occupational illness).

Relationships Between Environment Variables and Occupational Injury Rates/Presence of an Occupational Illness

Hypotheses 7a, 7b, 7c. The data did not support hypotheses 7a, 7b, or 7c which stated that there would be lower total occupational injury rates, occupational injury with a lost workday rates, and occupational illness in manufacturing establishments with a labor union. No significant relationships were found between presence of a labor union and the dependent variables [total occupational injury rate (hypothesis 7a), occupational injury with a lost workday rate (hypothesis 7b), occupational illness (hypothesis 7c)].

Hypotheses 8a, 8b, 8c. The data did not support hypotheses 8a, 8b, or 8c which stated that there would be lower total occupational injury rates, occupational injury with a lost workday rates, and occupational illness in manufacturing establishments that had received industrial hygiene consulting services within the past twelve months. No significant relationships were found between industrial hygiene consulting and the dependent variables [total occupational injury rate (hypothesis 8a), occupational injury with a lost workday rate (hypothesis 8b), occupational illness (hypothesis 8c)].

Hypotheses 9a, 9b, 9c. The data supported hypothesis 9c which stated that there would be lower occupational illness occurrences in manufacturing establishments that employed a full-time, on-site occupational safety professional (p=0.02). The data did not, however, support hypotheses 9a or 9b which stated that there would be lower total occupational injury rates and occupational injury with a lost workday rates in manufacturing establishments that employed a full-time, on-site occupational safety professional.

Hypotheses 10a, 10b, 10c. Hypothesis 10b, which stated that manufacturing establishments that employed a full-time, on-site health professional were more likely to have lower occupational injury with a lost workday rate was supported (p=0.003). The data did not support hypotheses 10a or 10c which stated that there would be lower total occupational injury rates and occupational illness in manufacturing establishments that employed a full-time, on-site occupational health professional.

Hypotheses 11a, 11b, 11c. The data did not support hypotheses 11a, 11b, or 11c which stated that there would be lower total occupational injury rates, occupational injury with a lost workday rates, and occupational illness presence in manufacturing establishments that employed an industrial hygienist.

Multivariate Relationships Between Independent and Dependent Variables

Hypotheses 12a, 12b, 12c.

The data did not support hypotheses 12a, 12b, or 12c which stated that in manufacturing establishments, when agent, host, and environmental characteristics are considered together, it is expected that companies that employ a full-time, on-site safety professional will have significantly lower total occupational injury rates, occupational injury with a lost workday rates, and presence of occupational illness.

In the overall explanatory model, two host characteristics were significantly related to lower total occupational injury rates: gender composition ($p = 0.02$) and company size ($p = 0.04$). One host characteristic, company size, was significantly related ($p = 0.02$) to lower occupational injury with lost workday rates. In addition, one environmental characteristic, health professional, was found to be significantly related ($p = 0.04$) to lower occupational injury with lost workday rates.

One host characteristic was significantly related to the presence of an occupational illness: Southeast region dummy variable. Relative to the reference region (the Southwest region of the United States), lower occupational injury with lost workday rates were associated with the Southeast region ($p<=0.05$).

Two environmental characteristics were significantly related to the presence of occupational illness: the presence of a full-time, on-site safety professional and the presence of a union. Having a full-time, on-site safety professional was significantly related with having occupational illness ($p<=0.05$). This finding is thought to be due, in part, to the "artifact" concept, which suggests that establishments with a safety professional on staff are more likely to report occupational injury and illness than establishments without this type of professional on staff. Having a union was significantly related with not having occupational illness ($p<=0.05$).

CHAPTER V: CONCLUSIONS

Summary Overview

This study does not support the use of the Traditional Epidemiological Model to explain differences in overall occupational injury rates across a wide range of industries. Findings of this study, however, support the results of previous research in occupational health. This study also provides new information in areas in which there has been limited examination. To date, there have been few studies examining the impact of health professionals, labor unions, and industrial hygiene consultation services on occupational injury and presence of occupational illness in manufacturing establishments, especially studies using multivariate analyses.

This study involved the examination of the effects of five environment-related independent variables (labor unions, industrial hygiene consultation services, safety professionals, occupational health professionals, industrial hygienists) on occupational injury rates and occupational illness presence in manufacturing establishments. In contrast to previous studies, this research examined the effects of work environment characteristics on employee safety in manufacturing establishments. Agent factors have been the primary focus of much of past research related to the manufacturing industry. One limitation of this study is that other independent variables which might affect workplace injury and illness were not examined.

Seven relationships were found to be significant predictors with occupational injury and illness during multivariate analyses. Companies with a higher percentage of females had lower occupational injury rates, as did larger companies. Companies with a labor union, and those located in places other than the Southwest, had lower rates of occupational illness. Companies with a health professional on staff had lower rates of occupational injury with a lost workday, and companies with a safety professional on staff reported higher rates of occupational illness.

Traditional Epidemiological Model

The results of this study do not support the use of the Traditional Epidemiological Model for modeling occupational illness and injury across a wide array of illness and injury types. Previously, the model has been primarily used as a theoretical framework for study of disease causation, with specific agent exposures being considered the "causes" and specific diseases being considered the "effects". Occupational injury and illness rates can be affected by a variety of different variables, internal or external to the host's environment. This study sought to test the model's usefulness in modeling occupational injury and illness as a general construct across a wide array of manufacturing industries. However, the model, when tested, failed to explain much of the variance in occupational illness and injury. The multivariate analyses used to test the Traditional Epidemiological Model explained less than eight percent of the variance. In summary, the use of the model to examine occupational illness and injury from a holistic approach is not supported by the results of this study.

The Traditional Epidemiological Model may be more applicable for use in occupational health/industrial hygiene studies that are more specific in nature, where more control of the variables exists. The way the model was employed in this study did not allow for the identification of specific agents as the "cause" of occupational injury or illness. Furthermore, specific types of injury or illness occurrence could not be identified. The model built from the data in this study allowed for calculation of overall occupational injury and illness occurrence, rather than specific types of injury or illness. The Traditional Epidemiological Model has been widely accepted as a theoretical framework for health-related epidemiological research, and has been well supported in studies that examined specific disease processes. It may be appropriate for use in future occupational health/industrial hygiene studies when examining specific injuries or diseases.

Other Findings

Impact of Agent Variables on Health Outcomes

Results of bivariate and multivariate analyses of agent variables and health outcomes of this study provided little support and clarification to past research. No statistically significant relationships were found between the agent variables (manufacture of durable goods versus non-durable goods) and the health outcomes of the study during either bivariate or multivariate analyses. Findings of this study do not support past research conducted by the NTOF (1999) and the BLS (2000) which suggests that establishments that produce durable goods (non-food products) are likely to have higher occupational injury and illness rates than establishments that produce non-durable goods (food products). It should be noted, however, that much of past research related to occupational injury and illness in the manufacturing industry has not been based on the distinction between the manufacture of durable goods and the manufacture of non-durable goods. Traditionally, all types of manufacturing establishments have been grouped together during analyses, making it difficult to distinguish between establishments producing durable goods and those producing non-durable goods. As a result, an accurate comparison of findings of this study with findings of past research would be difficult. In addition, much of past research has been descriptive in nature and has failed to apply multivariate statistics to examine the impact of type of goods manufactured on occupational injury and illness.

Impact of Host Variables on Health Outcomes

Results of bivariate and multivariate analyses of host variables and health outcomes of this study provided some support and clarification to past research. Analyses provided support for five of the relationships examined in the study.

Findings of this study did not show significant relationships between percentage of female employees and the occupational injury rates and illness presence in manufacturing establishments during bivariate analyses. During multivariate analyses, however, a significant relationship was found between gender composition (percentage of female employees) of manufacturing establishments and the total occupational injury rate health outcome of the study. Findings during multivariate analyses were consistent with past research conducted by Forst, Hryhorczuk, and Jaros (1999); McCaig, Burt, and Stussman (1998); and Islam et al. (2000), which suggests that males have higher rates of occupational injury than females.

During bivariate and multivariate analyses, no significant relationships were found between the occupational composition of manufacturing establishments and occupational injury rates or occupational illness presence. Findings of this study were inconsistent with a study conducted by the NTOF (1999), which reported that during the 1980 to 1995 time period, workers within administrative support occupations had the lowest average annual rate of fatal occupational injuries. It should be noted, however, that the NTOF conclusions were based on descriptive statistics rather than multivariate statistical tests. In addition, the NTOF study examined occupational injury and illness rates among employees with certain occupations working in different industry types rather than among employees working in the manufacturing industry.

Consistent with past research, significant relationships between manufacturing company size (number of employees) and occupational injury rates were found during bivariate and multivariate analyses. Manufacturing establishments with a greater number of employees were found to have lower occupational injury rates than establishments with a fewer number of employees. Results of this study support the findings of past research conducted by Leigh (1989), Jones (1997), Seligman et al. (1988), and the CFOI (1999), which suggest that establishments employing a greater number of workers are more likely to have lower occupational injury and illness rates because larger companies tend to have a greater awareness of risks and safety measures. Results of this dissertation study suggest that larger companies are more likely to have labor unions, use industrial hygiene consultation services, and have safety professionals, health professionals, and industrial hygienists on staff. As a result, larger establishments are likely to have more resources for the identification of hazards as well as for the development and implementation of prevention strategies. Furthermore, there is likely to be a greater number of injury and illness cases (although a lower rate) in larger companies because of the greater number of employees on staff. Employers of larger companies may be more aware of the problem because of the number of employees affected and, therefore, may be more likely to implement prevention strategies. Also, large companies may have more money to spend on safety and health programs.

The data illustrated significant relationships between the geographical location of manufacturing establishments and occupational injury with a lost workday rates during bivariate analyses and between location and illness presence during multivariate analyses. Results of this study supported the findings of research on the effects of geographical location of establishments on occupational injury and illness rates conducted by the NTOF (1999). The NTOF found higher fatal occupational injury rates in establishments located within certain geographical locations of the United States. It should be noted, however, that the NTOF study was based on survey data where there was no control for independent variables. This dissertation study found the highest incidence of injury and illness in establishments located in the southwestern region of the United States. This finding may be due, in part, to the larger number of immigrant workers employed in this region, who may have less access to health care services.

Bivariate and multivariate analyses showed no significant relationships between number of years of manufacturing establishment operation and total occupational injury rates, occupational injury with a lost workday rates, or presence of occupational illness. Findings of this study do not support the findings of past research conducted by the NSC (1983) and Hoekstra, Hurrell, and Swanson (1994). The NSC proposed that there would be higher occupational injury and illness rates in establishments with older facilities, where older equipment is likely to be housed and where working conditions are less likely to be ergonomically optimal. Hoekstra, Hurrell, and Swanson (1994) found higher incidence rates of work-related musculoskeletal disorders in workers in older facilities, which had older furniture and equipment as well as suboptimal ergonomic conditions. The inconsistent findings of this dissertation study, however, may be due, in part, to the timeframe in which NOES data were collected. Ergonomic injuries were not reported or recognized in the early 1980s as they are today. Technological advances have led to the evaluation of work equipment and processes and to the creation of safer and more ergonomically appropriate equipment and processes.

Impact of Environment Variables on Health Outcomes

The results of bivariate and multivariate analyses of environmental variables and health outcomes provided some support for and clarification of past research. In particular, analyses provided support for three of the environment-related relationships examined in the study.

Manufacturing establishments employing a full-time, on-site safety professional were over twice as likely to report at least one incidence of occupational illness than establishments without this type of professional on staff. This finding is likely an artifact due to the increased likelihood of safety professionals to report occupational injuries and illnesses. Safety professionals are trained to recognize and identify hazardous conditions and the effects of those hazards on employees. As a result, establishments with a formal safety professional on staff are more likely to have detailed, accurate reports of occupational injury and illness than establishments who rely on the reports of employees who are responsible for reporting on workplace safety as a collateral duty. The findings of this study are inconsistent with research conducted by Quinn et al. (1998), Levy and Wegman (1995), and the National Safety Council (1983). Those findings indicate that because primary activities of safety professionals are to improve prevention strategies, make changes in materials used, and alter process design to create a safer work environment for employees, establishments with access to this type of professional are more likely to have lower agent exposure levels and, therefore, lower injury and illness rates.

The presence of a labor union significantly decreased the odds of having one or more incidents of occupational illness. Findings of this study are similar to those of past research conducted by Baker and Scherer (1997) and Baugher and Roberts (1999) which reported that lower occupational injury and illness rates were found in establishments with a labor union. During a study assessing job safety in the construction industry, Baker and Scherer (1997) found that establishments with labor unions were more likely to have lower rates of safety violations and lost workdays from injury. Baugher and Roberts (1999) found that injury and illness rates were likely to be lower in establishments with unions since union workers were found to be more conscious of exposure risks and safety measures. Findings of this dissertation study are thought to be due, in part, to the greater likelihood that hazardous conditions will be reported in establishments that have a labor union. Employees may feel more comfortable reporting hazards to union officials, where there may be more support and less fear of job loss or coworker criticism.

This study did not find a significant relationship between the use of industrial hygiene consultation services during the past twelve months and occupational illness or injury. Findings of this study are inconsistent with past research conducted by Cohen (1992), Schlecht and Cassinelli (1997), and Miller (1977), which suggests that establishments that utilize industrial hygiene consulting services, including the recognition of potential health hazards and the design of hazard control programs, are likely to provide safer work environments for employees. It should be noted, however, that the studies conducted by these researchers were descriptive in nature and did not use multivariate analyses to examine the impact of industrial hygiene services on occupational injury and illness. Future research that is more quantitative in nature may be necessary to gain a better understanding of the effects of industrial hygiene consultation use on occupational injury and illness.

This study found that having a full-time, on-site occupational health professional was significantly associated with fewer days lost due to occupational injury. Findings of this study provide additional support to research conducted by Anton (1989), who suggested that primary responsibilities of occupational health professionals include the identification of potential exposures and the creation of exposure control programs. Study findings also provide additional support to the results of research conducted by Pedersen, Venable, and Sieber (1990), which suggest that on-site care is more comprehensive than off-site care, and by Aday and Andersen (1975) and Shi and Singh (1998), which suggest that individuals having more access to on-site health care are more likely to utilize services. Although occupational health professionals are unable to aid in the prevention of all injuries, they may have an impact on the rate of more serious injuries requiring days missed from work. As a result, findings of this study related to lower injury with lost workday rates are thought to be due, in part, to the notion that health professionals aid in the prevention of more serious injuries.

Although bivariate analyses showed support for a relationship between having industrial hygienists on staff and occupational injury with a lost workday rates in manufacturing establishments, multivariate analyses did not reveal such support. Results of multivariate analyses are inconsistent with information reported by the NSC (1983), Levy and Wegman (1995), and Miller (1997), which suggest that industrial hygienists are an integral part of occupational health and injury prevention programs and that the major responsibilities of industrial hygienists include recognizing and evaluating potential hazards, understanding the effects of stressors on employees, and specifying corrective measures for safety hazard control. These studies, however, failed to use statistical tests to examine the effects of industrial hygienists on occupational injury and illness. These studies, which were descriptive in nature, reported on the major responsibilities of industrial hygienists but failed to provide a multivariate analysis of their effects. Future research using multivariate analyses is needed to examine the impact of use of industrial hygienists at the worksite on occupational injury and illness.

Implications

Industry-Related Policy

Findings of this research may be used to most appropriately allocate resources into the safety and health measures found to be most beneficial in reducing occupational injury and illness in the manufacturing industry. Factors influencing injury and illness occurrence in manufacturing establishments are likely to be different than those influencing occupational injury and illness occurrence in establishments of other industry types. Furthermore, new studies of the manufacturing industry, based on the distinction between the production of durable goods (non-food products) versus the production of non-durable goods (food products), may yield different results concerning factors which affect occupational injury and illness occurrence.

Past research has shown higher rates of occupational injury and illness in the manufacturing industry than in other industry types. In addition, manufacturing workers make up a considerable portion of the workforce. These two factors make occupational injury and illness a major issue for manufacturing employers, employees, and policymakers.

Although this study supports past research which suggests that male employees have higher rates of occupational injury and illness, this study did not examine the specific types of work processes carried out by male and female employees. Male employees may carry out the more "hazardous" job processes. Additional research comparing occupational injury and illness rates in male versus female employees holding equivalent positions, with equivalent potential for the same hazardous exposure agents, in manufacturing establishments may provide more accurate information to be used in evaluating current policies and in developing more effective prevention programs.

Urban Health Services

Occupational injury rates in manufacturing establishments located in the southwestern region of the United States were more than double those in the southeastern region. This finding may be due, in part, to the large number of immigrant workers in this region of the United States and to the limited access to health care services for these immigrant workers. Information gained in this study provides additional evidence of the impact of occupational injury and illness and the burden that injury and illness place on health services, especially in certain geographical locations and in urban areas where more immigrants are gathered. This research supports the concept of a greater need for health services for immigrants, legal and illegal, particularly in the southwestern region of the United States.

This research did not specifically explore the occurrence of occupational injury and illness in urban versus rural settings. Although past research has revealed that the majority of manufacturing establishments are located in metropolitan areas, where more businesses are located and where there is more access to potential workers, comparisons between occupational injury and illness rates in metropolitan-based establishments and establishments located in rural areas have yet to be made. New research concerning the impact of urban versus rural location of establishments on occupational injury and illness rates is needed to better ascertain the effects of establishment location on health services provision.

Workplace Health and Safety Practices

Although multivariate analyses uncovered a positive statistical significance in only two of the environment-related independent variables (occupational health professionals and labor unions), bivariate analyses also linked several of the environmental variables with lower occupational injury rates and occupational illness presence in manufacturing establishments. The information on the effects of certain health and safety practices on occupational injury and illness gained in this study may be used in implementing new, more effective health and safety practices in the workplace as well as in evaluating the effectiveness of the health and safety practices currently in use.

One finding, that the presence of a full-time occupational health professional on site was found to be a significant predictor of lower occupational injury with lost workday rates, has critical implications for policy. Although it is impossible to prevent all accidents in the workplace, a company can minimize the severity of those accidents that do occur, such that a healthier workforce will be maintained and the costs associated with injuries will be reduced. Because more severe injuries requiring time away from work are the primary type of injury a company wants to minimize, companies may find it more cost-effective to allocate resources toward hiring health professionals to work on-site to combat and reduce the occurrence of the more severe injuries.

Findings of this study concerning the positive effects of labor unions and health professionals on occupational injury and illness in manufacturing establishments may be used in the creation of strategies for increasing establishment access to these environment-related factors. Safety cooperatives, especially among establishments classified in the same SIC codes, could be established to pull together resources in ways which maximize small company access to various injury and illness prevention programs. Smaller companies, which are less likely to have labor unions or safety and health professionals on staff, could benefit from the sharing of resources, since smaller companies typically have fewer economic resources available.

Future Research

The data used in this study provide baseline information for occupational safety and health research. Findings of this study add valuable information to the body of knowledge in the occupational safety and health field. This study lays the foundation for future occupational safety and health research and may be used in comparison with future studies to ascertain changes in occupational injury and illness since the early 1980s.

The NOES data set, collected from 1981 to 1983, continues to be used as the most current information regarding workplace safety and health practices. New research is necessary to gain more current data to use as a comparison to existing data. For example, employee safety training programs that were in effect during the time of NOES data collection were very subjective, with few measurable objectives. More effective employee safety training is likely to be conducted in the workplace today than in the past because of the 1992-94 OSHA written interpretations of safety training programs. This information must be taken into account when judging the effects of employee safety training on occupational injury and illness. More current data would likely yield different results concerning the effects of workplace health and safety practices, such as the implementation of employee safety training programs, on occupational injury and illness prevalence.

Although the presence of occupational safety professionals and industrial hygienists were not found to have a positive effect on occupational injury or illness in this study, these professionals are extremely valuable to industry safety and health programs. Since the early 1980s, the occupational safety and health profession has evolved such that undergraduate and graduate level degree programs in occupational safety and industrial hygiene are offered at the university level. Furthermore, board certifications now exist for safety and industrial hygiene programs in order to ensure adequate training of the personnel holding these positions. In the past, safety professionals were trained primarily through use of "on the job" training. Now these professionals are formally educated and trained in the elements of occupational safety and health. Future research would likely yield a more significant impact of these professionals on injury and illness rates and provide a more accurate picture of current workplace factors which influence occupational injury rates and illness presence.

Future studies which use smaller sample sizes may allow for the collection of additional data regarding the effectiveness of specific safety and health practices. Furthermore, future research that utilizes observational techniques rather than only responses to questionnaire items may provide more detailed information regarding evaluation of existing safety programs and practices.

Recognizing the need for more up-to-date information regarding workplace safety and health practices and factors influencing occupational injury and illness, the NIOSH has planned collection of a new NOES data set in the near future (W.K. Sieber, personal communication, October 22, 2002). The new NOES questionnaire should include items concerning specific injuries and illnesses as well as information regarding who keeps injury and illness records if no safety or health professional is present in the workplace. More detailed survey items concerning safety training in the workplace should also be included in the new NOES questionnaire in order to gain additional information regarding the effects of safety training on occupational injury and illness rates.

The Occupational Safety and Health Administration is unable to keep up with employer compliance to workplace safety and health standards imposed by the OSHAct of 1970. Previously, many companies viewed compliance with OSHA standards as a hindrance to production. The NOES data set, which was collected only eleven years after implementation of the OSHAct, may not provide an accurate picture of workplace safety and health practices of today. Changes in technology, in conjunction with increased employee demands for safe work environments and greater employer realization of the financial benefits of keeping employees safe, have necessitated implementation of new safety and health measures. Research regarding the creation, implementation, and evaluation of new programs is necessary in order to establish and maintain the safest work environments possible.

New research needs to be disease and injury specific, since the work environment continues to evolve. Changes in agent characteristics since the collection of NOES data include increases in the types and number of products being produced by manufacturers.

Differences in host characteristics of today's manufacturing establishments include the following: (1) a greater number of female employees in the workplace; (2) an increase in the number of administrative workers, which poses different ergonomic issues; (3) the development of manufacturing establishments in new geographical locations due to urban sprawl; (4) an increase in company sizes, with a greater number of people working outside of the home; and (5) the maintenance of establishments such that companies have been in existence for a greater number of years. Changes in characteristics of today's work environments include the following: (1) a decline in the number of labor unions in establishments because of the implementation of new federal laws covering agendas typically bargained for by unions; (2) an increase in the use of industrial hygienists and industrial hygiene consultation services to aid in illness prevention and OSHAct compliance; (3) an increase in the use of occupational safety and health professionals in the worksite to aid in injury and illness prevention and OSHAct compliance; and (4) the implementation of new and more effective employee safety training programs to reduce hazardous exposure risk, decrease absenteeism rates, and increase productivity.

Conclusions

Results of this study indicate that certain environmental characteristics aid in lowering occupational injury and illness risk in manufacturing establishments. However, application of the Traditional Epidemiological Model as the theoretical framework for modeling the effects of agent, host, and environmental factors on occupational injury and illness may have not been the most effective means for illustrating the effects of these factors on the health outcomes in question. Future research related to other agent, host, and environmental factors that affect occupational injury and illness occurrence in manufacturing establishments is warranted. Worker age, ethnicity, and length of service are host factors that may be examined in future research. Examination of environmental factors such as safety training programs, safety inspections, and on-site health units may be useful in expanding the body of knowledge related to occupational safety and health. Application of this model may be more effective in future occupational health research related to direct causes of occupational injuries and illnesses in the manufacturing industry as well as in other types of industry.

The presence of an occupational health professional in manufacturing establishments was found to be a significant predictor of lower occupational injury with a lost workday rates. Having this type of professional on staff may mitigate the severity of injuries, such that more serious and more costly injuries can be minimized or prevented. The hiring of an occupational health professional is one of the proactive safety practices that employers may implement to reduce the risk of injury to employees.

More current data must be collected and used in order to better reflect the impact of occupational injury and illness on the manufacturing industry. A more continuous method of data collection may be warranted because of changes in the work environment and technological advances. Prevention strategies must be continuously evaluated for effectiveness, and new strategies must be developed in order to combat the human and economic cost associated with occupational injury and illness.

This study provides baseline occupational safety and health data for manufacturing establishments during the 1981 to 1983 timeframe. Findings of this study, may be used by researchers to compare the effectiveness of current occupational safety and health practices with those examined in the original NOES data set. Future studies will allow researchers to illustrate the progression of occupational safety and health, to identify trends, and more importantly, to provide direction regarding the identification of the most effective measures for reducing occupational injury and illness.

REFERENCES

Aday, L.A. & Andersen, R. (1975). Development of Indices of Access to Medical Care. Health Administration Press.

Anton, T.J. (1989). Occupational Safety and Health Management. McGraw-Hill.

Baker, B. & Scherer, R.F. (1997). Construction project management and safety: Do labor unions have an effect? *Project Management Journal, 28 (3),* 6-10.

Baugher, J.E. & Roberts, J.T. (1999). Perceptions and worry about hazards at work: Unions, contract maintenance, and job control in the U.S. petrochemical industry. *Industrial Relations, 38(4),* 522-541.

Behrens, V.J. & Brackbill, R.M. (1993). Worker awareness of exposure: Industries and occupations with low awareness. *American Journal of Industrial Medicine, 23(5),* 695-701.

Bhopal, R.S. (1991). A framework for investigating geographical variation in diseases, based on a study of Legionnaires' disease. *Journal of Public Health Medicine, 13(4),* 281-289.

Boden, L.I. & Cabral, H. (1995). Company characteristics and workplace medical testing. *American Journal of Public Health, 85(8),* 1070-1075.

Bureau of Labor Statistics. (2000). Census of Fatal Occupational Injuries, 1995-2000. U.S. Department of Labor, Bureau of Labor Statistics. (Online). Available: http://stats.bls.gov/news.release/cfoi.t01.htm.

Bureau of Labor Statistics. (2001). Consumer Price Indexes. (Online). Available: http://www.ble.gov/cpi/cpi1998d.htm.

Census of Fatal Occupational Injuries (CFOI). (1999). Census of fatal occupational injuries 1992-1997. U.S. Department of Labor, Bureau of Labor Statistics. Database. Available: (stats.bls.gov/oshhome.htm).

Cohen, A., Colligan, M.J., Sinclair, R., Newman, J., & Schuler, R. (1998). Assessing occupational safety and health training: A literature review. *NIOSH*, June 1998, 1-174.

Cohen, B.S. (1992). Industrial hygiene measurement and control. *Environmental and Occupational Medicine,* 1389-1404.

Cohen, H.H. & Jensen, R.C. (1984). Measuring the effectiveness of an industrial lift truck safety training program. *Journal of Safety Resources, 15(3),* 125-135.

Cook, C.K. & Kovein, R.J. (1995). HHE Report No. HETA-94-0220-2526, Exxon Company USA, Houston, Texas. *NIOSH 1995 Report.*

Cullen, M.R. (1996). Epidemiologic methods for the study of occupational asthma. *The American College of Chest Physicians, 109(3),* 1-7. (Online). Available: http:// home.mdconsult.com/das/article/body/2/jorg=journal&source=HS,MI&sp=68.../ 1.htm.

Current Population Survey. (1999). Current population survey of 1999. U.S. Department of Labor, Office of Employment and Unemployment Statistics. Database.

Department of Consumer and Employment Protection, Government of Western Australia. (2002). Manual Handling Injuries. (Online). Available: http://www.safetyline. wa.gov.au/default.html.

Federal Coal Mine Health and Safety Act, Pub. L. No. 91-173 (1969).

Erlichman, M. (1980). Dyeing and finishing of textiles, plant observation report and evaluation, Carlisle Finishing Plant (Cone Mills Corporation). *Report 1980,* 1-44.

Federal Coal Mine Health and Safety Act of 1969, Pub.L.No. 91-563, Stat. 2917 (1969).

Ford, J.K. & Fisher, S. (1994). The transfer of safety training in work organizations: A systems perspective to continuous learning. *Occupational Medicine, 9(2),* 241-259.

Forst, L.S. , Hryhorczuk, D., & Jaros, M. (1999). A state trauma registry as a tool for occupational injury surveillance. *Journal of Occupational and Environmental Medicine, 41 (6),* 514.

Fox, J.P., Hall, L.E., & Elveback, L.R. (1970). Epidemiology: Man and Disease. Macmillan.

Hawkins, N.C. & Evans, J.S, (1989). Subjective estimation of toluene exposures: A calibration study of industrial hygienists, *Journal of Applied Industrial Hygiene, 4,* 61-68.

Hazy, S.L. (1995). A descriptive study of occupational injuries in a hospital setting. (University of Alaska, 1995). Dissertation Abstracts Online, 3, 1149.

Hoekstra, E.J., Hurrell, J., & Swanson, N.G. (1994). HHE report no. HETA-92-0382 -2450, Social Security Administration Teleservice Centers, Boston Massachusetts, Fort Lauderdale, Florida. *NIOSH 1994*, 1-23.

Islam, S.S., Nambiar, A.M., Doyle, E.J., Velilla, A.M., Biswas, R.S., Radha, S., & Ducatman, A.M. (2000). Epidemiology of work-related burn injuries: Experience of a state-managed worker's compensation system. *The Journal of Trauma, 49(6),* 1045-1051.

Johnston, J.J. & Cattledge, G.T. (1994). The efficacy of training for occupational injury control. *Occupational Medicine, 9 (2),* 147-158.

Jones, J.H. (1997). Partnering for workplace safety in small business. *Safe Workplace,* 11-13.

Karol, M.H. (1991). Allergic reactions to indoor air pollutants. *Environmental Health Perspectives, 95,* 45-51.

Leigh, J.P. (1989). Firm size and occupational injury and illness incidence rates in manufacturing industries. *Journal of Community Health, 14(1),* 44-52.

Leigh, J.P., Markowitz, S.B., Fahs, M., Shin, C., & Landrigan, P.J. (1997). Occupational injury and illness in the United States: Estimates of costs, morbidity, and mortality. *Archive of International Medicine, 157(14),* 1557-1568.

Lentz, T.J., Sieber, W.K., Jones, J.H., Piacitelli, G.M., & Catlett, L.R. (2001). Surveillance of safety and health programs and needs in small U.S. businesses. *Applied Occupational and Environmental Hygiene Journal, 16(11),* 1016-1021.

Levy, B.S. & Wegman, D.H. (1995). Occupational Health: Recognizing and Preventing Work-Related Disease. Little, Brown, & Company.

McCaig, L.F., Burt, C.W., & Stussman, B.J. (1998). A comparison of work-related injury visits and other injury visits to emergency departments in the United States, 1995-1996. *Journal of Occupational and Environmental Medicine, 40(10),* 870-876.

McCaffrey, D.P. (1982). OSHA and the Politics of Health Regulation. Plenum.

McCormack-Brown, K.R. & McDermott, R.J. (1991). Dental caries: Selected factors of children at risk. *The Dental Assistant, 60(4),* 10-14.

McVey, H.D. (1981). Determination and money: A successful foundry safety and health Program. *NIOSH 1981,* 121-135.

Melamed, S., Froom, P., Kristal-Boneh, E., Gofer, D., & Ribak, J. (1997). Industrial noise exposure, noise annoyance, and serum lipid levels in blue-collar workers- the CORDIS Study. *Archives of Environmental Health, 52(4),* 292-297.

Miller, T. (1977). Track the true costs of accidents. *Safety & Health,* 165-166.

Moran and Associates. (1996). The OSHA Answer Book. Moran.

Musacchio, C. (1975). 1850-1900: The Industrial Revolution-What price progress? *Occupational Hazards,* 57-63.

Mori, I. (2002). Cancer mortality among man-made graphite electrode manufacturing workers: Results of a 38-year follow-up. *Journal of Occupational and Environmental Medicine, 59,* 473-480.

National Center for Health Statistics (NCHS). (1999). Mortality data, multiple-cause-of-death public-use data files, 1968-1996. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Safety and Health. Database. Available: (www.cdc.gov/nchs/products/catalogs/subject/mortmed.html).

National Safety Council. (1960). Accident Facts, 1960. NSC.

National Safety Council. (1965). Accident Facts, 1965. NSC.

National Safety Council. (1970). Accident Facts, 1970. NSC.

National Safety Council. (1975). Accident Facts, 1975. NSC.

National Safety Council. (1980). Accident Facts, 1980. NSC.

National Safety Council. (1985). Accident Facts, 1985. NSC.

National Safety Council. (1990). Accident Facts, 1990. NSC.

National Safety Council. (1995). Accident Facts, 1995. NSC.

National Safety Council. (2000). Accident Facts, 2000. NSC.

National Safety Council. (1983). Fundamentals of Industrial Hygiene. NSC.

National Safety Council. (2002). National Safety Council Statistics Glossary. (Online). Available: http://www.nsc.org/lrs/glossary.htm.

National Safety Council. (2001). Report on Injuries in America 2000. Available: http://www.nsc.org/library/rept2000.htm.

NIOSH. (1999). Identifying High-Risk Small Business Industries. U.S. Department of Health and Human Services.

NIOSH. (1999). Sentinel Event Notification System for Occupational Risk (SENSOR), 1993-1995. State Health Departments for California, Florida, Kentucky, Massachusetts, Michigan, Minnesota, New Jersey, New York, Ohio, Oregon, Texas, Utah, and Washington.

NIOSH. (1999). Work-related lung disease surveillance report 1999. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute of Occupational Safety and Health. Publication No. 2000-105. Available: (www.cdc.gov/niosh/pdfs/2000-105.pdf).

NIOSH. (2000). Worker Health Chartbook 2000. U.S. Department of Health and Human Services.

NSSPM. (1999). National Surveillance System for Pneumoconiosis Mortality, 1968-1996. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Safety and

Health. Database.

NTOF. (1999). National traumatic occupational fatalities surveillance system. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute of Safety and Health. Database.

Occupational Health and Safety Act of 1970, Pub.L.No. 91-596, 84 Stat. 1590 (1970).

OMB. (1987). Standard Industrial Classification Manual, 1987. Executive Office of the President, Office of Management and Budget.

Pedersen, D.H., Venable, H.L., & Sieber, W.K. (1990). An examination of occupational medicine practices. *Journal of Occupational Medicine, 32(10),* 1037-1041.

Quinn, M.M., Kriebel, D, Geiser, K, & Moure-Eraso, R. (1998). Sustainable production: A proposed strategy for the work environment. *American Journal of Industrial Medicine, 34(4),* 297-304.

Reifsnider, E. (1995). The use of human ecology and epidemiology in nonorganic failure to thrive. *Public Health Nursing, 12(4),* 262-268.

Rivara, F.P. (1990). Child pedestrian injuries in the United States. *American Journal of Diseases of Children, 144(6),* 692-695.

Rosenman, K.D., Reilly, M.J., Deliefde, B., & Kalinowski, D.J. (1999). 1998 annual report on occupational noise-induced hearing loss in Michigan. Michigan State University, Department of Medicine and Michigan Department of Consumer and Industry Services, Occupational Health Division.

Schlecht, P.C. & Cassinelli, M.E. (1997). Survey of Analytical Methods, Parts I and II. *Synergist,* 26-27.

Schneid, T.D. & Schumann, M.S. (1997). Legal Liability: A Guide For Safety and Loss Prevention Professionals. Aspen.

Seligman, P.J., Sieber, W.K., Jr., Pedersen, D.H., Sundin, D.S., & Frazier, T.M. (1988). Compliance with OSHA record-keeping requirements. *American Journal of Public Health, 78(9),* 1218-1219.

Seta, J.A., Sundin, D.S., & Pedersen, D.H. (1988). National Occupational Exposure Survey Field Guidelines. Department of Health and Human Services, National Institute for Safety and Health.

Shi, L. & Singh, D.A. (1998). Delivering Health Care in America: A Systems Approach. Aspen.

Siebenaler, M.J. & McGovern, P. (1992). Carpal tunnel syndrome: Priorities for prevention. *Journal of the American Association for Occupational Health Nurses, 40(2),* 62-71.

Sieber, W.K., Seta, J.A., & Young, R.O. (1994). A job exposure matrix for identification of potential exposures in occupational settings. *NIOSH 1994,* 351-356.

Smith, R.G. (1978). Contributions of the industrial hygienist. *NIOSH 1978,* 221-230.

SOII. (1999). Survey of occupational injuries and illnesses. U.S. Department of Labor, Bureau of Labor Statistics. Database. Available: (stats.bls.gov/oshhome.htm).

Sullivan, T.F. (1995). Environmental Law Handbook. Government Institutes.

Susser, M. (1973). Causal Thinking in the Health Sciences: Concepts and Strategies of Epidemiology. Oxford.

Wheeler, R.N. (1981). Training and work practices. *NIOSH 1981,* 173-177.

Yacher, J.M., Heitbrink, W.A., & Burroughs, G.E. (1997). In-depth survey report, concentration of metalworking mists before and after installation of a commercial air cleaner, at Sauer-Sundstrand Company. *NIOSH 1997*, 1-20.

Appendices

Appendix A

FIGURE 1A. Preface-Part I-Questionnaire

NATIONAL OCCUPATIONAL EXPOSURE SURVEY

Preface

A — DUPLICATE INTO EACH CARD — ID 0 1 0 (1–4); START DATE M M D D Y Y (5–11); FACILITY ID (12–17)

Facility Name (18–52)

B — Address (18–52)

C — City (18–41); State (42–43); Zip Code (44–48, 49–52)

D — Legal Owner(s) (18–52)

Area Code (53–55) Telephone Number (56–58) — (59–62)

Survey End Date M M (63) D D (65) Y Y (67)

IF MAILING ADDRESS OR PERSON TO CONTACT CONCERNING INFORMATION ABOUT THE SURVEY IS DIFFERENT FROM THAT INDICATED ABOVE, LIST THE CORRECT MAILING ADDRESS AND CONTACT BELOW.

E — Facility Name (18–52)

F — Address (18–52)

G — City (18–41); State (42–43); Zip Code (44–48, 49–52)

H — Attention (18–52)

Area Code (53–55) Telephone Number (56–58) — (59–62)

Definitions

The ID is a single alphabetical character identifying a specific NOES surveyor. The ID is assigned by NIOSH. The start date is the month, day, and year of the facility survey. If the survey takes several days, the first day is to be entered as the date. This sample date should be used on Parts I, II, and III where the date of the survey is to be recorded. The facility ID is the 6-digit unique NOES identification number assigned to the facility by NIOSH. The 6-digit number is used to assure that data from the survey of a specific facility can be tracked to the industrial type, employment size group, and geographical location characteristics of the facility once the Preface narrative information is destroyed. This data field always begins with a "2", to denote a NOES facility number, and the final five digits are sequential across the NOES survey sample universe. Programmed gaps of unassigned numbers allow for the inclusion of "shadow" or "subsample" numbers during the course of the survey. The facility name is the legally accepted name of the facility being surveyed and is supplied to the surveyor by NIOSH.

Inclusions

This data is to be entered for all surveys.

Exclusions

Do not enter the date of initial telephone contact with the facility unless that date is the same as the date the survey started.

Procedure

If, at the time of survey, the facility name supplied by NIOSH is different than the facility name as supplied by facility management, the management response should be entered in item A.

Compatibility With NOHS

Replaces and updates Question #1, #7, and #8 of the NOHS Preface.

B (1) — Address (16–52)

Intent

To describe the geographical location of the facility being surveyed.

Definition

Address refers to the physical location of the facility based on the best available gerographic description.

Inclusions

Use the address supplied by NIOSH.

Exclusions

Do not use the post office box number or other address used primarily as a mail collection point. Do not use the corporate headquarters address unless the headquarters is located at the same site as the facility surveyed.

Procedure

If, at the time of initial telephone contact, the NIOSH-supplied address is incorrect, contact headquarters for a verification of the correct address. If authorized to proceed with the survey, enter the updated address as item [B] of the Preface.

Compatibility With NOHS

Replaces and updates Question #2 of the NOHS Preface.

[C] City (18–41) State (42–44) Zip Code (44–48, 49–)

Intent

To provide further geographic information on the facility being surveyed.

Definitions

City means the municipality, county, township or other specific incorporated or unincorporated area as defined by the state or federal possession. State refers to one of the 50 United States or the District of Columbia. Zip Code is the 5-digit code used by the U. S. Postal Service.

Inclusions

Enter the city and state names as provided by NIOSH.

Exclusions

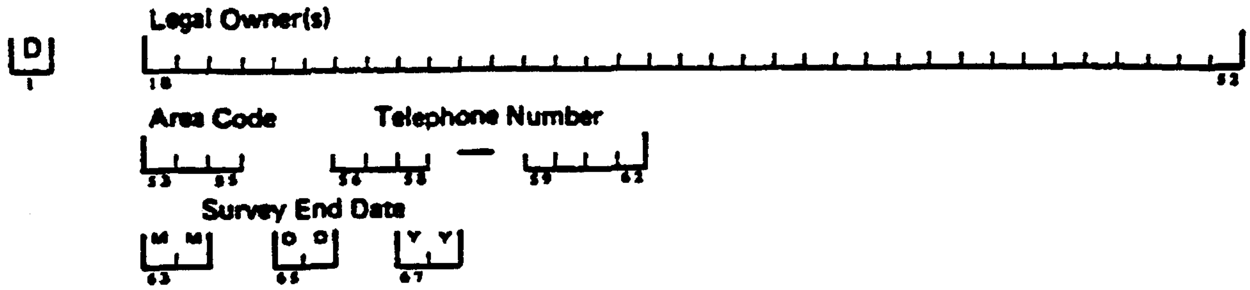
Do not record local descriptors as the city name unless it is commonly used. Evidence of common usage includes the use of the local descriptor by the telephone company, post office, etc. For example, Bethesda, Maryland is a local, unincorporated area of Montgomery County, Maryland which is recognized as an identifier by the telephone company, the post office and businesses.

Procedure

If, at the time of survey, the NIOSH-supplied city and state names and zip code are not accurate, follow the procedure outlined in [B], and if authorized, enter the updated information in [C].

Compatibility With NOHS

Fully compatible with Question #3 of the NOHS Preface.



Intent

To identify the person(s) or organization responsible for the business conducted in the facility, the telephone number (including area code) for the facility, and the date on which the survey was completed.

Definitions

The legal owner(s) is(are) the person(s) or entity who is legally responsible for the operation of the facility. The area code and telephone number are as provided to the surveyor by NIOSH. The survey end date is the date on which the actual on-site survey of the facility and/or its remote components is completed.

Inclusions

As stated above.

Exclusions

Do not enter the date on which encoding of the facility survey data was completed, unless it is the same as the date on which the on-site facility survey was completed.

Compatibility With NOHS

Fully compatible with, and replacing Question #4 and #6 of the NOHS Preface. Survey end date is a new question.

IF MAILING ADDRESS OR PERSON TO CONTACT CONCERNING INFORMATION ABOUT THE SURVEY IS DIFFERENT FROM THAT INDICATED ABOVE, LIST THE CORRECT MAILING ADDRESS AND CONTACT BELOW.

E (1) — Facility Name: ______________________________ (18–52)

F (1) — Address: ______________________________ (18–52)

G (1) — City: ____________________ (18–41) State: ____ (42–44) Zip Code: ______ (44–48) ____ (49–52)

H (1) — Attention: ______________________________ (18–52)

Area Code: ____ (53–55) Telephone Number: ____ (56–58) — ____ (59–62)

Intent

To identify the facility representative who was the contact person for the survey, in case it may be necessary to contact the facility for further information, or to supply the facility with information regarding the NOES survey.

Definitions

Facility name, address, city, state, zip code, area code, and telephone number are as previously defined, except that they refer to the contact person rather than the facility being surveyed. Attention provides space for the recording of the name of the person primarily responsible for providing answers to the Part I quesionnaire.

Inclusions

Utilize items E, F, G, and the area code and telephone number portions of H only if this information is different from that recorded in A through D. Always provide the date requested in H (Attention).

Compatibility With NOHS

Fully compatible with Question #9, #10, #11, #12, and #13 of the NOHS Preface, and an update of Question #5 of the NOHS Preface.

1. Part I - Survey Form Instructions

The pages of Part I contain 66 questions relating to General Facility Information, Medical Services, Industrial Hygiene and Safety Practices and General Recordkeeping Information. Figure 1B displays the Part I form.

The following instructions are keyed to question numbers on the Part I form.

Part I — Management Interview

1.	Card Code	[1] (1)	
2.	Revision Code	0 1 0 (2–4)	
	Surveyor ID	_ (5)	
3.	Date Survey Started	_ _ / _ _ / _ _ (6 7 / 8 9 / 10)	(mo/day/yr)
4.	Facility Number	_ _ _ _ _ _ (12–17)	

Intent

To specifically identify the NOES surveyor, the date that the survey began, and the unique facility identifier.

Definitions

The card code is pre-printed in item number 1, and identifies the record format to be used in computer processing of the Part I questionnaire. The revision code is pre-printed in item number 2, and identifies the Part I questionnaire as a NOES form. The surveyor ID, date survey started, and facility number (Facility ID) are as previously defined.

Inclusions

This data is entered for all facilities surveyed.

Compatibility With NOHS

Fully compatible with NOHS, Part I Questions #1, #2, and #4.

Question:

5. **What is you major activity?** ______________________________

____

Intent

To describe the general activity of the facility from the viewpoint of the management personnel being interviewed. This response also serves as a verification of the SIC code established for the facility in the sample screening process.

Definitions

SIC means Standard Industrial Classification and includes the codes contained in the Standard Industrial Classification Manual 1972 prepared by the Executive Office of the President - Office of Management and Budget.

Inclusions

Such general terms as construction, manufacturing, furniture manufacturing, chemical production, transportation equipment, transportation, wholesale trade, retail trade, etc. should be used.

Exclusions

Do not describe the specific product(s). This is done in Question #6.

Procedure

Print the response given by management in reply to this question.

Compatibility With NOHS

Fully compatible with Question #5.

Question:

CARD [2]

6. What are your chief products, services, lines of trade, etc? ____________________

____

Intent

To describe the product(s) or service(s) which is (are) produced or provided.

Definition

The products, services, or lines of trade refer to the major outputs of normal business operation.

Inclusion

Include all major product or service lines.

Procedure

Print major products or service lines in list form in the space provided (i.e. fiberglass batting and loose-fill insulation materials).

Compatibility With NOHS

This is compatible with the description portion of Question #56.

Question:

CARD [3]
1

7. SIC codes (observed) __ __ __ __
18 21

__ __ __ __
22 25

__ __ __ __
26 29

Intent

To classify the activity(ies) of the facility by the SIC codes derived from management response to Questions #5 and #6 and surveyor observation of the facility.

Definitions

SIC has been previously defined.

Inclusion

Include all (up to three) major product or service line SIC codes at the 4-digit level. A 4-digit SIC code describing the major activity will be provided for each facility by NIOSH. After the survey is complete, refer to the 1972 Standard Industrial Classifications Manual to determine if the brief description of the given SIC code corresponds with the observed major activity of the facility. If in agreement, the NIOSH-provided SIC code should be entered in the first of the lines provided. Where multiple SIC code-definable activities are observed, appropriate codes should be entered in the spaces provided, rank-ordered to correspond with surveyor observations, and management response to this question and Questions #5 and #6.

Ideally, the principal product or service and/or a rank-ordering of multiple activities should be determined by reference to "value added." In practice, however, it is rarely possible to obtain this information for individual products or services, and other criteria which approximate the same results must be used. It is recommended, therefore, that, when possible, the following characteristics be used for major economic sectors in determining an appropriate rank-ordering of SIC code-defined activity.

Economic Sector	Characteristics
Agriculture forestry, and fisheries	Value of production
Mining	Value of production
Contract construction	Value of work done
Manufacturing	Value of production
Transportation, communication, electric, gas, and sanitary services	Value of receipts
Wholesale and retail trade	Value of sales
Finance, insurance, and real estate	Value of receipts
Services	Value of receipts

Occasionally, in cases of mixed businesses, the above characteristics cannot be determined or estimated for each product or service, and less frequently a classification based upon the recommended characteristic will not adequately represent the process or activity of the establishment. In such cases the primary activity should be determined by the activity in which the greatest number of employees work.

The chief product or service of an organization may have changed from that which had been reported earlier or the reporting may have been incorrect. In cases where there is disagreement between the description of the product or service and the SIC code given, a new SIC code will be assigned by the surveyor in consultation with survey Headquarters.

Exclusions

A facility is out-of-scope of the survey and should not be visited if the major activity(ies) cannot be defined within the listed SIC codes in Appendix B. When the surveyor becomes aware of this possibility during the initial telephone contact, he/she should immediately consult with the team leader or survey Headquarters for further instructions.

Procedure

Enter the SIC codes in 4-digit form in the spaces provided and rank-order from greatest to smallest proportion of the facility business activity. In most cases, business activity can be adequately defined using one 4-digit code.

Compatibility With NOHS

Replaces the SIC code portion of Question #5b.

Question:

8. **Approximately how many years has this facility been involved in this activity?**

___ ___ **Years (If "unknown" code "UK")**
30 32

Intent

To determine the length of time that this facility has been used for the same basic type of work.

Definitions

"Activity" is not restricted to that item specified as the major activity in response to Question #5, but refers to all activities at the facility.

Inclusions

In the situation where information is not available as to how long this activity has been carried out in this facility, use the earliest date indicated by the person who is being interviewed.

This is a multiple part question and should be answered by considering a series of decisions. First, a determination should be made as to the inception of the activity; then it should be determined from what date that activity has been carried out at the facility. If they are different, the latter is to be recorded. For example, if the New York Central Iron Works has been manufacturing seamless train wheels since 1911 but the facility itself was completed in 1947, the date to use is 1947. On the other hand, if the facility was built in 1900, and in 1949 the current production activity was initiated, the 1949 date should be recorded. In those instances where the individual buildings at the facility were constructed during different periods, the date recorded should be that date which represents the initiation of products or services at the facility where the major production work is taking place. For example, if an office building has been in continuous use from 1874, but a new plant was opened in 1955 and the production takes place in that plant, use the 1955 date since it best represents the production facility. Changes in legal ownership or name of the organization should be disregarded unless there is an associated change in product or service.

Procedures

Enter the response, in years, to the nearest year. When midway between two years, round off to the even year. For example, if the response is given as 3-1/2 years, enter the number "4."

Compatibility With NOHS

Fully compatible with Question #6.

Question:

9. **How many shifts do you have at present?** ___

Intent

To determine the number of employees engaged in production activities at different times in the facility. The purpose is to bring this fact to the surveyor's attention to ensure that all potential employee exposures are surveyed.

Definition

Shift is defined as the working period for the employees and may be more or less than eight hours in length per day.

Inclusions

Include the total number of shifts. For example, in continuous process industries, five shifts may exist to operate the facility.

Exclusions

Do not included shifts when no production employees are present. For example, if all production work is performed on the first shift and if the second and/or third shifts of a facility is composed entirely of maintenance or janitorial personnel, enter the number "1."

Procedure

For those facilities that have unusual shifts (e.g. four-day work week or three-day work week) enter the number of shifts, but explain irregularities in the comments in Part III. If shift schedules are so varied that the number of shifts cannot be easily determined, the total number of people on the payroll should be divided by the average number of people in the facility at any given time.

Compatibility With NOHS

Fully compatible with Question #9.

Question:

10. **How many hours per shift?**

__ __ (If irregular, code "99").
34 35

Intent

To determine the number of hours per shift in this facility at the time of the survey. There may be regional differences in shift lengths, or some facilities may be working four-day weeks. The purpose of this question is to bring the number of hours per shift to the surveyor's attention, since he must account for all employees (regardless of shift) on the Part II form.

Inclusions

Include all shifts in considering this question.

Procedure

For those facilities which have shifts of varying lengths, code "99."

Compatibility With NOHS

This is a new question.

Question:

11. **How many people are on your payroll for all shifts at the present time?**

Males _ _ _ _ _

Females _ _ _ _ _

Total _ _ _ _ _

Intent

To determine the total number of employees working in the facility being surveyed, and to determine the number of males and females.

Definition

People, as used in this question, refers to the term "employees".

Inclusions

Include full-time and part-time personnel who are paid directly by the facility. Include maintenance and repair personnel and janitorial staff. Include individual consultants working directly for the facility. Include those personnel who may work solely on a commission basis.

In the special case of a survey in the construction industry involving a construction job site, the question above should be understood to read, "How many people in the direct employ (even if temporarily) of the firm being surveyed are on this job site today?" In this special case, only persons being paid directly by the surveyed facility are to be included. Include construction workers who are retained on a job-specific basis, such as carpenters hired through contact with their local union for the duration of a construction job. Include office personnel, if any, but exclude truck drivers who are merely making deliveries, and inspectors employed by governmental agencies.

Exclusions

Do not include contract or sub-contractor personnel employed by another enterprise, even if they are continually on site. For example, the maintenance or cleaning services provided by a contract organization or temporary secretaries hired from an agency on a short-term basis, or construction workers employed by a sub-contractor are excluded.

Compatibility With NOHS

Fully compatible with Question #7. Number of males and number of females has been added for two purposes:

(1) To validate the surveyor's Part II observations.

(2) To preserve the capability to develop estimates of the number of women potentially exposed to occupational health hazards, and the number of men potentially exposed. Many chemical and physical agents are suspected of having different effects on the two sexes.

Question:

12. **Of this total number, how many are normally in the work areas as opposed to the administrative or other areas?**

_ _ _ _ _
51   55

Intent

To determine the number of employees in the facility working in those locations where production or service work is conducted.

Definition

Work area is defined as service area or areas where major activities are conducted.

Inclusions

Include personnel clerks, secretaries, maintenance people, etc. who are located in the production or service areas or areas where the major activity is being conducted. Examples are: Iron works - those people who work in the raw material storage, fabricating, and warehouse areas; transportation - those who maintain and repair equipment within the facility. Include a cab driver in a cab company and a truck driver in a trucking company. Include field service personnel in a service industry.

Exclusions

Do not include outside salesmen, erectors, administrative personnel and clerical personnel whose place of work is outside the production or service area. An example is: wholesale and retail -- those clerical, administrative, or sales personnel who are geographically separated form the area where the wholesale and/or retail trade occurs. Example: traveling salesmen. Exclude truckers in manufacturing.

Compatibility With NOHS

Fully compatible with Question #8.

Question:

13. **Are there any labor unions operating in this facility?** 16

1 No

2 Yes; list complete union names and acronyms (initials)

CARD [4]

Union Names	Acronym
______________________	_ _ _ _ _ _ _ (18–24)
______________________	_ _ _ _ _ _ _ (25–31)
______________________	_ _ _ _ _ _ _ (32–38)
______________________	_ _ _ _ _ _ _ (39–45)
______________________	_ _ _ _ _ _ _ (46–52)
______________________	_ _ _ _ _ _ _ (53–59)
______________________	_ _ _ _ _ _ _ (60–66)

Intent

To determine the prevalence of unions in the facilities included in the survey population.

Definition

A union is any organization in which any of the facility's employees participate as members, which exists for the purpose of dealing with the employer concerning grievances, wages, working hours, and conditions. Unions are voluntary organizations and need no license from the government to operate.

Inclusions

Any organization which may be called a trade union, labor union, labor organization, etc., whose purpose is as defined above.

Exclusions

Organizations such as credit unions, fraternal associations, or social groups which may consist solely of the facility's employees, but whose purpose is not as stated in the above definition.

Compatibility With NOHS

Compatible with Question #40.

Question:

CARD [5]

14. Is there a formally established health unit at this facility? 18

1 Yes, physician in charge

2 Yes, registered nurse in charge

3 Yes, licensed practical nurse in charge

4 Yes, other in charge

5 No

Intent

To determine if there is a company policy to provide basic health resources or capabilities at the facility site.

Definitions

Health unit suggests that a specific work area or portion of the facility has been reserved solely for the examination and/or treatment of employees and that there is a permanent staff (either full-time or part-time) responsible for operating this unit.

Physician refers to a person who possesses a state or federal government-recognized medical degree, such as an M.D. or D.O., and is licensed to diagnose and treat diseases and disorders of the human body or a particular disease, age, or occupation group.

Registered Nurse (RN) is a person meeting the educational, legal, and training requirements to practice as required by a state board of nursing.

Licensed Practical Nurse (LPN) is a person who meets the requirements of the state for such a designation, and is licensed by the state.

Inclusions

When more than one response applies, use the lowest applicable code number. For example, if a physician is in charge two days a week and a nurse is in charge the other days, code the response as "1".

Exclusions

Do not count, as a health unit, a resting room that is reserved for female employees as required under certain Federal and/or state regulations. Exclude the situation where a room is used to store first-aid supplies and no one is assigned the responsibility for providing health care to employees. Do not include situations where rooms are reserved for specific purposes other than basic health care (for example, a room used only for audiometric testing).

Procedures

If a "paramedic" is in charge, then "4" should be coded.

Compatibility With NOHS

Fully compatible with Question #15.

Question:

15. Do you have an employee at this facility with formal first-aid training, who has been formally designated to provide emergency medical treatment?

1 Yes, full-time

2 Yes, part-time

3 No

Intent

To determine if a specific individual (or individuals) who is not a physician or nurse has been formally assigned the responsibility for providing emergency first-aid to the employees.

Definitions

Physician: See Question #14.

Nurse: See Question #14.

Full-time: At least one individual on duty at all times during which the facility is operating.

Part-time: At least one individual is designated, but such individuals are not on duty during all hours of operation of the facility.

Inclusions

Include paramedics and other employees (who are not physicians or nurses) who have been formally assigned this responsibility.

Exclusions

Exclude physicians and nurses. Exclude all informal arrangements.

Compatibility With NOHS

Fully compatible with Question #21.

Question:

16. Do you have on your payroll one or more on-site physicians to give your employees medical care?

1 Yes, full-time

2 Yes, part-time

3 No

Intent

To determine if the facility employs a physician for the purpose of providing the employees with access to the care of a physician.

Definitions

Physician: See Question #14.

Full-time: Defined in Question #15.

Part-time: Defined in Question #15.

Exclusions

Exclude all physicians who are not engaged in the direct provision of medical services to the employees. Do not include any physicians whose primary responsibility is research. Exclude all physicians provided by a third-party provider under contract to the facility.

Compatibility with NOHS

Partially compatible with Question #16.

Question:

17. **Do you have a formal arrangement with any outside source (physicians or clinics) to give your employees access to the care of a physician?**

21

- **1** **Yes, physician will travel to this facility on call**
- **2** **Yes, at clinic (not at this facility)**
- **3** **Yes, physician is based at this facility either full or part-time**
- **4** **No**

Intent

To determine if formal arrangements for medical care are provided for facility employees and the type of arrangements used in the provision of such care.

Definition

Physician: See Question #14.

Inclusions

Include only those arrangements made by the facility's management. If more than one arrangement was made, use the arrangement with the lowest coding number. For example, if it is determined that a physician will travel to the facility on call and that formal arrangements exist with an outside clinic, the proper response is "1." A medical center should be considered a clinic.

Exclusions

Do not include medical service arrangements provided by unions, associations or other groups unless a formal arrangement exists with the facility's management. Exclude third-party payment plans, e.g., Blue Cross/Blue Shield insurers.

Procedure

If the facility has no direct formal arrangement with a physician (codes 1, 2, or 3), but does, as a policy, pay medical bills incurred by employees at a physician of the employee's choice, then code "2" (yes, at clinic) is the proper response.

Compatibility With NOHS

Partially compatible with Question #16.

Question:

18. Estimate the average number of physician hours that are devoted to your facility per week.

___ ___ ___ hours per week

Intent

To determine the aggregate level of physician effort provided to the facility.

Definition

Physician: See Question #14.

Inclusions

When Question #16 is answered by code 1 or 2, include an average weekly figure based upon the last 12 months or the best available estimate.

Include the physician hours, if available, spent with the employees when the response to Question #17 is either code 1, 2, or 3. If the response to Question #17 is code 2 due to a facility policy of paying the medical bills incurred by an employee with a physician of the employee's choice, the company is at least indirectly aware of physician hours devoted to the employees of the facility, and should be able to provide an estimate in response to this question.

Exclusions

Do not include time spent by physicians in the facility, other than time spent caring for the employees. For example, physicians involved in medical research would not be counted.

Compatibility With NOHS

Fully compatible with Question #17.

Question:

19. Does this facility have one or more nurses on the payroll to provide care for employees?

1 Yes

2 No (Skip to Question 21)

Intent

To determine if nursing services are available to employees on a regular basis through direct employment of a nurse or nurses.

Definitions

Nurse (RN and LPN): Defined in Question #14. Regular basis refers only to situations where a nurse is scheduled to be on duty at periodic intervals throughout the week.

Inclusions

Include registered and licensed practical nurses specifically assigned to provide nursing services to the facility's employees on a regular basis.

Exclusions

Do not include nurses on the facility's payroll whose job function does not involve taking care of the facility's employees. Example: Nurses working in a hospital or research capacity; or as medical secretaries or receptionists.

Do not include student nurses, or other paramedic personnel undergoing on-the-job training. Do not include visiting nurses from corporate headquarters even if "detailed" or "assigned" to this facility for long periods of time. Do not include visiting nurses from city, county, state, and other government agencies.

Compatibility With NOHS

Fully compatible with Question #18.

Question:

20. How many registered nurses and licensed practical nurses are on the payroll at this facility?

RN ___ ___ (27–29)

LPN ___ ___ (30–32)

Intent

To determine the number of nurses employed at this facility.

Definition

Nurses (RN and LPN): Defined in Question #14.

Inclusions

Include all categories specified in Question #19.

Include all nurses and supervisory nurses who are employed by the facility and are giving nursing aid to employees. This also includes nurses who may not be present at the facility.

Exclusions

Do not include nurses who may be employed by the facility but do not perform nursing services for employees.

Do not include visiting nurses from city, county, state, and other government agencies. Do not include visiting nurses from corporate headquarters even in those circumstances where the nurses have been "detailed" or "assigned" to this facility for long periods of time.

Do not include nurses supplied under contract with a third party provider, or through an arrangement not made by management.

Compatiblity With NOHS

Fully compatible with Question #19.

Question:

21. **Estimate the average number of nursing hours that are devoted to your facility per week.**

_ _ _ _ **hours**

Intent

To determine the aggregate level of medical nursing effort provided to the facility.

Definition

Nurse: Defined in Question #14.

Inclusions

Include the hours spent by all categories of nurses. Include nurses who provide nursing services on a contract basis. Include nurses from corporate headquarters who are assigned to provide nursing services to this facility.

Include other nurses providing care to employees if the facility, as a policy, pays for such nursing service. This may occur regardless of the response to Question #19.

Exclusions

Do not include nursing hours that may be devoted to facility employees by nurses employed by a government agency.

Exclude nurses who do not spend time in the provision of medical care. Example: full-time nurse who is assigned to teach sanitation techniques to neighborhood improvement group.

Do not include visiting nurses from city, county, state, and other government agencies.

Compatibility With NOHS

Fully compatible with Question #20.

Question:

22. **Do you provide the following examinations or tests to all or to selected groups of employees on a periodic basis?**

	No	Yes, All	Yes, All Exec. & Mgmt Only	Yes, All Production Workers Only	Yes, for Selected Mgmt and/or Production Workers
Opthalmology 37	1	2	3	4	5
Audiometric 38	1	2	3	4	5
Blood tests 39	1	2	3	4	5
Urine tests 40	1	2	3	4	5
Pulmonary function 41	1	2	3	4	5
Chest X-rays 42	1	2	3	4	5
Allergy/Sensitization 43	1	2	3	4	5
Immunizations (flu, etc.) 44	1	2	3	4	5

Intent

To determine the number of facilities that have a preventive medical program for their employees, and the types of examinations or test provided.

Definitions

All: When an employer provides an examination to each employee of a designated type (every employee, executive and management, production workers) without regard to that employee's exposure to potential occupational safety and health hazards.

Selected: When an employer provides an examination to some, but not all of the employees.

NOTE that these definitions apply equally to the responses for Question #22 through #26.

Inclusions

As listed.

Procedure

Facilities employing truck drivers in interstate commerce and operating under Interstate Commerce Commission (Department of Transportation) regulations pay for, but may not be aware of the exact nature of the examination provided. Review of the pertinent examination form and Department of Transportation requirement indicated that these drivers minimally receive opthalmology, audiometric, urine, and pulmonary function tests or examinations. At the doctor's discretion, they may also receive blood tests and x-ray examinations. Therefore, Question #22 should be coded 2 or 5 (as applicable) for all the tests or examinations listed here for truck drivers subject to this Department of Transportation medical examination.

Compatiblity With NOHS

Question #22 replaces and supplements Question #25 through #32. The question remains fully compatible with NOHS.

Question:

23. **Before new employees are hired or placed, are they required to take a medical examination?** 46 1 2 3 4 5

Intent

To determine the number of facilities that examine the status of a new employee's health when hired or placed in a new position.

Definitions

Medical examination means those tests, procedures, and observations of an employee's health status that are performed by, or under the supervision of, a physician. Physician is defined in Question #14.

Inclusions

Include all types of examinations. Examinations could range from a basic interview session with a physician to a comprehensive physical examination involving X-rays, blood, urine, other laboratory tests, etc.

Include examinations performed by an employee's private physician when the results of the examination are submitted to the facility's management.

Sight screening tests, color blindness tests, and/or audio screening tests are to be included when the results are reviewed or evaluated by a physician.

Exclusions

Do not include health examinations which are not performed by or under the supervision of a physician.

Procedures

When the response refers to employees in certain occupations (e.g., maintenance personnel) and also managers, use the code "5".

Compatibility With NOHS

Fully compatible with Question #23.

Question:

24. **Do you record health information about a new employee on some regular form?**₄₆   1   2   3   4   5

Intent

To determine if the facility records health information about new employees and to determine for which types of new employees such information is recorded.

Definitions

Health information refers to any data regarding an employee's health. Regular form is any type of standardized documentation that is retained as part of the employee's file or as part of his medical history.

Inclusions

Include all written records of information, including responses to questions pertaining to employees' health as long as the recording process is consistent for the designated employee group.

Information that is obtained from pre-employment physicals or detailed medical histories should be included.

Include any kind of information that is retained concerning employee's health. For example, a recorded question which asks: "How is your health?" and to which the reply is "good, fair, or poor" should be included.

Include instances where any information about physical defects of a new employee is recorded.

Exclusions

Do not include situations where medical information is obtained from employees, but is not retained in the files as a permanent record. Exclude information on physiological tests when obtained for other that health purposes.

Compatibility With NOHS

Fully compatible with Question #22.

Question:

25. **Do you require medical examinations of your employees who return to work after an illness?** 47 | 1 | 2 | 3 | 4 | 5

Intent

To determine if the facility requires medical examinations to assess the level of fitness of an employee returning after sick leave, and to determine for which type(s) of employees such examinations are required.

Definitions

Medical examination is defined in question #23.

Inclusions

Include situations where company policy may not cover all employees. For example, if the facility requires special medical examinations only for employees in certain occupations, or for only certain categories of absences, a positive response should be recorded.

Include those situation where the examination is not performed at the facility but the employee submits a written statement that his personal physician considers the employee fit to return to work.

Exclusions

Do not include situations where the returning employee may voluntarily visit the facility's medical unit or his own physician. Required is the key word.

Compatibility With NOHS

Clarification of Question #24.

Question:

26. **Do you require medical examinations of your employees when their employment is terminated? (Exit examination)** 1 2 3 4 5

Intent

To determine if the facility requires exit medical examinations, and to determine for which type(s) of employees such examinations are required.

Definition

Exit Examination: A medical examination that is performed by or under the supervision of a physician when the employee's employment is terminated.

Inclusions

Include all examinations, partial or complete, performed by or under the supervision of a physician.

Exclusions

Do not include situations where the terminating employee may voluntarily visit the facility's medical unit or his own physician. Require is the key word.

Compatibility With NOHS

Clarification with Question #24.

Question:

27. **How long are medical records and other health information records retained?**

___ ___ **Years (If "forever" code "999")**
49 51 **(If "unknown" code "UK")**

Intent

To determine the facility's policy with respect to the retention of personnel health and medical records.

Exclusions

Exclude personnel record systems and timekeeping systems unless they make specific provision for the inclusion of medical and health-related records.

Compatibility With NOHS

New question.

Question:

28. **Do you employ full-time individuals at this facility whose major responsibilities are in the area of <u>prevention</u> of occupational injuries or illnesses?**[53]

   1. **Yes, injury prevention**
   2. **Yes, illness prevention**
   3. **Yes, both injuries and illnesses**
   4. **No (Skip to Question 30).**

<u>Intent</u>

To determine if the facility employs individuals whose primary responsibilities are to <u>prevent</u> injuries and illnesses.

<u>Definition</u>

<u>Injury Prevention</u>: That art which is devoted to the recognition, evaluation, and control of occupational safety hazards. Injury prevention activities include, but are not limited to: Periodic inspection of the facility for fire hazards and adequacy of fire protection; the inspection of machinery for safety guards over moving parts, wheels, pulleys, etc.; planning and developing safety programs; conducting safety and first-aid classes for employees; and evaluating the facility for compliance with OSHA regulations.

<u>Inclusions</u>

Include in the "injury prevention" category, all personnel with job titles such as Safety Man, Safety Inspector, Safety Supervisor, Industrial Engineer, Safety Director, or Safety Professional or Safety Engineer <u>if</u> the individual is responsible for performing safety-related duties for more than 50% of the time.

<u>Exclusions</u>

Exclude all federal, state, and local government officials; they are not full-time employees of the facility. Exclude all visiting corporate headquarters personnel, even in those situations where such personnel have been "detailed" or "assigned" to work at the facility for long periods of time.

<u>Definition</u>

<u>Illness Prevention</u>: That art which is devoted to the recognition, evaluation, and control of occupational <u>health</u> hazards. Illness prevention activities include, but are not limited to: Recognition of environmental conditions and stresses associated with work and work operations, the evaluation of, on the basis of training and experience and with the aid of quantitative measurements, the magnitude of these stresses in terms of potential impairment of the employee's health and well-being; prescribing methods to control, eliminate, or reduce such stresses, collecting samples of dusts, gases, and other potentially toxic materials for analyses; evaluating the adequacy of ventilation in the work areas; and developing educational programs for employees.

Inclusions

Include in the "illness prevention" category, all persons with job titles such as Industrial Hygienist, Industrial Health Engineer, Environmental Health Engineer, Health Specialist, etc. if that person is responsible for performing health related duties more than 50% of the time.

Exclusions

Exclude all personnel involved in the direct delivery of medical care. Do not include doctors, nurses, or paramedics who spend less than 50% of their time in the illness prevention activities described above. Exclude all federal, state, and local government officials; they are not full-time employees of the facility. Exclude all visiting corporate headquarters personnel, even in those situations where such personnel have been "detailed" or "assigned" to work at the facility for long periods of time.

Procedure

The thrust of this question is to determine if such personnel are employed at the facility. If none are employed, circle "no" (code response "4") and skip to Question #30. If the answer is "yes," determine in which category ("safety" or "health") the company employs individuals. If unable to classify, or if the facility employs people in both categories, circle "yes, both injuries and illnesses," (code response "3") and proceed to Question #29.

Compatibility With NOHS

Consolidates responses from Questions #10, #11, and #13.

Question:

29. **How many full-time occupational health and safety specialists are employed at this facility?**

$\overline{}_{53}\overline{}_{54}$ **Safety (injuries)**

$\overline{}_{55}\overline{}_{56}$ **Health (illnesses)**

For each of those individuals, please write in the appropriate activity number from the activity clusters listed below:

CLUSTER NO.

Individual #1$_{57}$ —	**#1: Administers (directs, manages). Plans and develops programs. Advises top level management.**
Individual #2$_{58}$ —	**#2: Inspects work place to identify hazards. Investigates to determine the cause of injuries/illnesses.**
Individual #3$_{59}$ —	**#3: Analyzes plans or specs. to identify hazards, develops operating procedures to control hazards.**
Individual #4$_{60}$ —	**#4: Provides education and training.**
Individual #5$_{61}$ —	**#5: Performs and analyzes tests to monitor for the presence of dusts, gases, etc.**
Individual #6$_{62}$ —	**#6: Performs engineering design to control hazards.**
Individual #7$_{63}$ —	
Individual #8$_{64}$ —	
Individual #9$_{65}$ —	
Individual #10$_{66}$ —	
Individual #11$_{67}$ —	
Individual #12$_{68}$ —	

Intent

To determine the number of individuals involved in occupational safety and health at this facility, to categorize them in general terms, and to describe their major duties.

Definitions

For definitions of safety (injuries) and health (illnesses) professionals see Question #28.

Inclusions

Inclusions are the same as in Question #28.

Exclusions

Exclusions are the same as in Question #28.

Procedure

Categorize each individual according to the area (safety or health) which encompasses more than 50% of his/her time. Enter the total number of persons on the appropriate line. For each individual enter the cluster number which best describes the major portion of his or her duties.

Compatibility With NOHS

New question; asked only of those who respond affirmatively to Question #28.

Question:

30. Has your facility received industrial hygiene services on a consulting basis during the past 12 months?[69]

1 Yes, from government sources

2 Yes, from non-government sources

3 No

Intent

To determine if the facility has received industrial hygiene services or consultation from outside sources during the past 12 months.

Definitions

Industrial Hygiene: See Question #28.

Consulting Basis: Advice, consultation, or services obtained from persons not employed at the facility.

Inclusions

Include visits from federal, state, and local government authorities where the consultation was provided as a service and was not for reasons of compliance or enforcement of health standards. Include visits from corporate headquarters personnel if they conducted an industrial hygiene walk-through investigation or on-site inspection. Include consultation from specialists employed by insurance companies.

Exclusions

Exclude visits from federal, state, and local government agencies made for the purpose of compliance or enforcement. Exclude all inspections and visits not conducted on the behalf of facility or corporate management such as those conducted on the behalf of the unions.

Compatibility With NOHS

Rewording of Question #10 and #11. Compatibility maintained; government aid and assistance separated from corporate or private outside assistance.

Question:

31. **Has your facility received occupational safety services <u>on a consulting basis</u> during the past 12 months?** 70

    1. **Yes, from government sources**
    2. **Yes, from non-government sources**
    3. **No**

<u>Intent</u>

To determine if the facility has received occupational safety services or consultation during the past 12 months.

<u>Definition</u>

<u>Occupational Safety</u>: See Question #28, Injury Prevention

<u>Inclusions</u>

Include visits from federal, state, and local government authorities where the consultation was provided as a service and was not for reasons of compliance or enforcement of safety standards. Include visits from corporate headquarters personnel if they conducted a safety survey walk-through investigation or on-site inspection. Include visits from specialists employed by insurance companies.

<u>Exclusions</u>

Exclude visits from federal, state, and local government agencies made for the purpose of compliance or enforcement. Exclude all inspections and visits not conducted on behalf of facility or corporate management such as those conducted on the behalf of the unions.

<u>Compatibility With NOHS</u>

Rewording of Question #10 and #13. Compatibility maintained; government aid and assistance separated from corporate or private outside assistance.

Question:

32. Do you have a program under which you regularly or periodically monitor the presence of physical agents such as heat, vibration, radiation, noise, and magnetic fields? 71

1. No (Skip to Question 34)
2. Yes (Circle yes or no for each physical agent listed below:)

		Yes	No
1.	Heat 72	1	2
2.	Vibration 73	1	2
3.	Radiation 74	1	2
4.	Noise 75	1	2
5.	Magnetic fields 76	1	2
6.	Other 77	1	2

Intent

To determine the existence of a company program of monitoring for certain physical agents as a part of its occupational health program.

Definitions

Regularly or periodically monitor applies only to established programs which monitor environmental levels of physical agents on a regular and/or predictable basis. Heat, vibration, noise, and magnetic fields are defined in Section VII.

Inclusions

Include tests using instrumentation only when the intent of the tests are to determine if employee health is potentially at risk.

Include contract monitoring performed by outside consultants at the request and direction of management.

Exclusions

Do not include any measurements that are simply measuring process conditions or any environmental measurements which are taken where no employee exposures could potentially exist. For example, the measuring of temperature and humidity inside a sealed vessel in a process loop should not be counted.

Do not include those monitoring tests that are not routinely performed. For example, special monitoring of new machines during the start-up and initial use stages should not be included.

Exclude monitoring tests where industrial hygiene is not part of the rationale for the conduct of the tests (i.e., monitoring of process conditions, for economic reasons only).

Compatibility With NOHS

Rewording of Question #42. Separates monitoring of physical agents.

Question:

33. How long do you retain the records of the monitoring program?

__ __ Years (If "forever" code "99")
(If "unknown" code "UK")

Intent

To determine the length of time that the company retains the records from its program of monitoring physical hazards.

Compatibility With NOHS

New question; asked only of those who responded affirmatively to Question #32.

Question:

34. **Do you have a program under which you regularly or periodically monitor the presence of fumes, gases, mists, dusts, or vapors?** 18

1. **Yes**
2. **No (Skip to Questions 38)**

Intent

To determine the existence of a company program to monitor certain conditions for the protection of the employees.

Definitions

Regularly monitor applies only to established programs which monitor levels of chemical materials on a regular, predictable basis. Fumes, gases, mists, vapors, and dusts are defined in Section VII.

Inclusions

Include tests taken with instruments only where the intent of the tests is to determine if the employee's health is potentially at risk.

Include situations where the monitoring is performed by someone other than the facility's management, such as monitoring by contract. Include monitoring programs established and/or conducted by or for the facility's insurance carriers provided that they are performed regularly or periodically. NOTE: A "Yes" response should be coded if the program includes any part of the facility.

Exclusions

Do not include any measurements that are simply measuring process conditions or any environmental measurement which are done where no employee exposures could potentially exist. For example, the measuring of temperature and humidity inside a sealed vessel in a process loop should not be counted. Exclude measurements that are taken for the sole purpose of determining if a fire or explosion potential exists in an area where no employees are at risk.

Do not include those monitoring tests that are not routinely performed. For example, special monitoring of new machines during the start-up and initial use stages should not be included.

Exclude monitoring tests where industrial hygiene is not part of the rationale for the conduct of the tests, such as monitoring of process conditions for economic reasons only.

Exclude all programs conducted by federal, state, or local government agencies and officials; exclude any one-time studies of the facility or areas within the facility. Exclude all non-periodic consultations by consultants, insurance carriers and others.

Compatibility With NOHS

Rewording of Question #42. Separates monitoring of chemical agents.

Question:

35. How is this monitoring conducted? ₁₉

1. **Sample collection with laboratory analysis (Skip to Question 37)**
2. **Direct reading instruments**
3. **Both**

Intent

To categorize the method of monitoring for this facility.

Inclusions

Inclusions are noted in Question #34.

Exclusions

Exclusions are noted in Question #34.

Compatibility With NOHS

New question; asked only of those who responded affirmatively to Question #34.

Question:

36. **Which types of direct reading instruments are used in the monitoring program? Circle "yes" or "no" for each type listed below:**

		Yes	No
1.	Direct mass measurement tests $_{20}$	1	2
2.	Fibrous aerosol monitors $_{21}$	1	2
3.	Detector tubes $_{22}$	1	2
4.	Infrared (I.R.) gas monitors $_{23}$	1	2
5.	Ultraviolet (U.V.) gas monitors $_{24}$	1	2
6.	Gas chromatograph monitors $_{25}$	1	2
7.	Electrochemical monitors $_{26}$	1	2
8.	Other "wet" chemical methods $_{27}$	1	2

Intent

To categorize the current practices of the facility with regard to direct-reading instrumentation.

Procedure

Either "yes" or "no" (code response "1" or "2") is circled for each applicable instrument type.

Compatibility With NOHS

New question; asked only of those who responded affirmatively to Question #34 and #35.

Question:

37. How long do you retain the records of the monitoring program?

__ __ Years (If "forever" code "99")
(If "unknown" code "UK")

Intent

To determine the length of time that the company retains records from its program of monitoring fumes, gases, mists, dusts, etc.

Compatibility With NOHS

New question; asked only of those who responded affirmatively to Questions #34 and #35.

Question:

38. Have any substitutions of chemical materials been made within the last 5 years? 30

1. Yes
2. No (Skip to Question 41)

Intent

To determine if there have been any substitution of chemical materials in the facility.

Definition

Substitution means to cease the use of one chemical material and initiate use of an alternative.

Exclusions

The substitution of one tradename product for another unless it was done for reasons related to the chemical content of both tradename products is not considered to be a substitution.

Procedure

If the response to the question is "2", skip to Question #41.

Compatibility With NOHS

New question.

Question:

39. Were any of these substitutions made for the primary purpose of reducing employee exposures?

1. **Yes**
2. **No**

Intent

To determine if the chemical substitution made was for the purpose of reducing or eliminating worker exposure to specific chemical agents.

Definition

See Question #38.

Inclusions

Include substitution of raw materials, ingredients, intermediates or finished products primarily for the purpose of protecting employee health and/or required because of a federal, state or local government ban on the production, trade, or marketing of specific chemicals.

Exclusions

See Question #38. Substitutions for economic or other reasons not dealing expressly with employee health should be coded "2" or "no".

Procedure

Chemical substitution for employee health reasons or due to regulatory requirements should be coded "yes" or "1".

Compatibility With NOHS

New question.

Question:

40. **Were any of these substitutions made as a result of inspections of this facility by federal, state, or local authorities?** 38

1. Yes
2. No

Intent

To determine if chemical substitutions have been made as a result of government inspection activity.

Inclusions

Include only those substitutions of chemicals made as a direct result of government inspection(s) of the facility.

Exclusions

Do not include substitutions made as the result of consultation and/or advice from consultants, corporate staff, or insurance carriers.

Procedure

Ask Question #40 without regard to the response received to Question #39.

Compatibility With NOHS

New question.

Question:

41. Have any major equipment or process modifications been made within the last 5 years? ₃₃

1. Yes
2. No (Skip to Question 45)

Intent

To determine if any major equipment or process modifications have been made during the past 5 years at the facility being surveyed.

Definition

Major Modification is a change in machinery, process, equipment, or physical layout which was significant enough to change the potential exposure of employees to chemical, physical or biological agents; or to fumes, dusts, mists, vapors, or particulates.

Inclusions

Include changes in machinery, equipment, process, physical layout and plant design or process modification.

Exclusions

Exclude any changes made to protect against injuries, such as machine guarding.

Procedure

If the response to Question #41 is "no," skip to Question #45.

Compatibility With NOHS

New question.

Question:

42. Were any of these modifications made for the primary purpose of reducing employee exposures? 34

1. Yes
2. No

Intent

To determine if the reason for the modification(s) cited in response to Question #41 was primarily for the purpose of reducing or eliminating employee exposure to chemical, physical, or biological agents.

Definition

See Question #41.

Inclusions

See Question #41.

Exclusions

See Question #41.

Procedure

All modifications performed primarily for economic or other reasons not dealing directly with occupational health should be coded "2." (No)

Compatibility With NOHS

New question.

Question:

43. **Were any of these modifications made as a result of inspections of this facility by federal, state, or local authorities?** 35

1 Yes

2 No

Intent

To determine if any of the modifications were made as the result of an inspection by government agencies.

Inclusions

Include only those modifications made as a direct result of inspections of this facility by government authorities.

Exclusions

Exclude modifications made as the result of consultation and/or advice given by consultants, corporate staff, or insurance carriers.

Procedure

Ask and record the response to Question #43 without regard to the response received on Question #42.

Compatibility With NOHS

New question.

Question:

44. **What was the nature of the modification?**[34]

1. **A redesign of the process**
2. **Enclosing the process**
3. **Equipment substitution**
4. **A redesign of the equipment**
5. **Combination of the above**
6. **Not listed here**

Intent

To categorize the nature of the modification(s) performed at this facility within the last 5 years.

Inclusions

As in Questions #41 and #42.

Procedure

If more than one of the coded responses is appropriate, the proper code response is "5." If none of the coded responses are accurate, code a "6."

Compatibility With NOHS

New question.

Question:

45. **Does this facility recirculate exhaust air from any process or plant area?**,,

1. **Yes**
2. **No (Skip to Question 47)**

Intent

To determine if exhaust air is recirculated within the facility. Also to alert the surveyor to this fact prior to the walk-through portion of the survey.

Definition

Recirculate exhaust air refers to the practice of capturing exhaust air from a process or work area and subsequent re-introduction of the exhaust air into the facility, usually following treatment to remove contaminants.

Exclusions

Air handling systems such as facility heating or cooling systems are not considered recirculation systems. Catalytic converters and other scrubbing devices attached to internal combustion engines (as used in air compressors, welding generators, forklifts, etc.) are not to be considered recirculation systems.

Procedure

If the response is negative, skip to Question #47.

Compatibility With NOHS

New Question.

Question:

46. What processes or areas are involved?

______________________ ______________________

______________________ ______________________

______________________ ______________________

Intent

To determine the areas or processes within the facility where exhaust air is recirculated.

Inclusions

Any process or area which recirculate air as defined in Question #45.

Procedure

Asked only of those responding affirmatively to Question #45. Descriptive terms given by the person(s) interviewed are to be entered in the spaces provided.

Compatibility With NOHS

New question.

Question:

47. **Are there areas in this facility in which personal protective devices or equipment are required or recommended?**

   1 Yes, required
   2 Yes, recommended
   3 Yes, both
   4 No (Skip to Question 53)

Intent

To determine the company management's policy regarding the use of personal protective devices and equipment.

Definitions

Required means that there is a formal company policy that some or all employees must use personal protective devices as a condition of employment. This policy may or may not be enforced. Recommended indicates that management encourages employees to use personal protective devices but it is not a condition of employment. Personal protective devices and equipment include, but are not limited to, safety glasses, goggles, ear plugs, face shields, hard hats, gloves, steel-toed shoes, rubberized clothing, welding helmets and/or goggles, and respirators.

Inclusions

If only one work area or department requires or recommends the usage of personal protective devices, the response should be coded "1" or "2," as applicable. If a facility has some areas that recommend usage and some areas that require usage, the response should be coded "3."

Exclusions

Exclude cases where individual employees want to use personal protective gear and the use of protective devices is not required or recommended by the employer. The response in such cases should be coded "4."

Procedure

If the response to Question #47 is "no," skip to Question #53.

Compatibility With NOHS

Fully compatible with Question #36.

Question:

48. **Who provides personal protective devices?**

  1 individual employees
  2 employer
  3 both
  4 other (specify)________________________________

Intent

To determine who is financially responsible for the purchase of personal protective equipment.

Definitions

Personal protective devices and equipment are defined in Question #47.

Inclusions

Include reimbursement plans. For example, if employees purchase their own equipment and are reimbursed by the company, the response should be coded "2." Include in the "other" response situations where union, state or local government organizations provide the equipment. In situation where employees and the company share the cost, code "3," for "both."

Procedure

Asked only of those who respond affirmatively to Question #47.

Compatibility With NOHS

Fully compatible with Question #37.

Question:

49. **Who has been designated to see to it that personal protective devices and equipment are serviced and maintained?**[48]

 1 **individual employees**
 2 **employer representative**
 3 **both**
 4 **no one**
 5 **other Specify**____________________________________

Intent

To determine if formal responsibility has been assigned to an individual or individuals for maintaining personal protective devices and equipment in proper operating condition.

Definitions

Servicing and/or maintaining refers to such activities as cleaning or changing filters or cartridges in respirators, repairing straps on safety goggles or face shields, filling air tanks, repairing broken lenses, etc. Personal protective devices are defined in Question #47.

Inclusions

"Designated" is the key word in Question #49. If the employer has directed the employees to maintain their own equipment and provides cleaning apparatus and work space, the response is coded "1." If the employees normally maintain their own equipment, but they have not been specifically charged or directed to do so by management, the response should be coded "4." If the employer has established procedures whereby a union or a governmental agency maintains the equipment, the response should be coded "5" with an explanation entered on the "specify" line.

Compatibility With NOHS

Fully compatible with Question #38.

Question:

50. In those instances where employees refuse to wear protective devices or fail to wear them properly, are corrective measures taken? 41

1. Yes
2. No (Skip to Question 53)

Intent

To determine if the employer has a functioning system of corrective actions for improper usage of protective devices, equipment or clothing.

Definitions

Corrective action is formal action by plant management against the individual involved. Improper means wearing of inappropriate clothing or devices, including respirators rendered non-functional due to improper facial fit.

Inclusions

Include such actions as personnel actions (transfer, removal, suspension, etc.) and fines levied by management.

Exclusions

Exclude non-formal actions such as verbal notification of wrong doing, etc. Exclude labor union sanctions against the employee.

Procedure

If the response to Question #50 is "no," skip to Question #53.

Compatibility With NOHS

New question.

Question:

51. Do those corrective measures involve economic penalties?[43]

1 Yes

2 No (Skip to Question 53)

Intent

To determine the extent to which employees are penalized by the employer because of failure to comply with company requirements for proper wearing of protective clothing, devices, and equipment.

Definitions

Economic penalties are defined as official disciplinary actions taken by management which result in a financial loss to the affected employee, either directly or indirectly.

Inclusions

Includes all official disciplinary actions which result in financial penalities to the employee. Such actions include fines, dismissal, reduction in work hours, reassignment or transfer (at a lower wage rate), suspension, loss of seniority credits, loss of shift differential, etc.

Exclusions

Exclude all actions which are not taken on behalf of plant management, such as labor union sponsored sanctions or fines against the employee.

Do not include medical or related costs incurred by the individual as a consequence of the improper wearing of protective devices, clothing or equipment, i.e. the costs to the employee of having metal chips removed from an eye because he was not wearing goggles.

Procedure

This question is asked only if the response to Question #50 is "yes." If the response to Question #51 is "no," skip to Question #53.

Compatibility With NOHS

New question.

Question:

52. **Have any economic penalties been assessed in the past 12 months?**[43]

1. **Yes**
2. **No, we know of no instances where violations of company policy have occurred within the last 12 months.**
3. **No, although we know that there was a minimum of one violation of company policy within the last 12 months.**

Intent

To determine whether formal corrective actions involving economic penalties have been taken in the last 12 month period as a result of employee refusal to wear protective devices, or employee failure to wear such devices properly.

Definitions

Economic penalties are defined in Question #51.

Inclusions

As in Question #51.

Exclusions

As in Question #51.

Procedure

This question is asked only of those who respond affirmatively to Question #51.

Compatibility With NOHS

New question.

Question:

53. **Do you have a program under which you regularly or periodically conduct safety inspections of this facility?**[44]

   1. **Yes**
   2. **No (Skip to Question 56)**

Intent

To determine if the facility is inspected regularly or periodically for potential safety hazards.

Definitions

Regularly or periodically applies only to established programs which provide inspections on a regular, predictable basis.

Inclusions

Include only regular or periodic safety inspections of the facility performed as a result of management policy. Include regular or periodic inspections performed by consultants, insurance carriers and others at the request of management or with management participation.

Exclusions

Exclude any ad-hoc inspections. Also exclude any safety inspections precipitated by a mishap or injury. Exclude all inspections conducted by a government agency or authority. These are not facility management programs. Exclude all one-time studies of the facility or areas within the facility. Exclude all non-periodic inspections by consultants, insurance carriers and others.

Procedure

If the response to this question is negative, skip to Question #56.

Compatibility With NOHS

New question.

Question:

54. **Are written results of these safety inspections required?**[48]

1. **Yes**
2. **No**

Intent

To determine if safety inspections must always result in written reports.

Definitions

Written results are defined as reports of the determinations arising from a safety inspection whether the determinations are positive or negative in nature. These reports need not be formal, as long as they represent at least a summation of inspection results.

Inclusions

Hand-written reports made as the result of an inspection should be included, if they are always written as a result of a safety inspection. Include narrative reports if they are transcribed in written form.

Procedure

This question is asked only if there was an affirmative response to Question #53.

Compatibility With NOHS

New question.

Question:

55. **Are the results of the safety inspections posted or otherwise made routinely available to affected employees?**[44]

1. Yes
2. No

Intent

To determine whether or not affected employees are routinely provided the results of safety inspections.

Definitions

Posted is defined as mounted on walls, bulletin boards or other surfaces commonly used in the employee areas. Routinely available is defined as the normal practice, due to management policy, of providing the results of safety inspections to any affected employee. Inspection results can be either verbal or written. Affected employee is defined as a worker whose environment was included in a safety inspection.

Inclusions

Include any system instituted by management which routinely provides the results of safety inspections to the affected employees of the facility.

Exclusions

Exclude any reporting system not initiated and/or maintained by management. Exclude posting of government inspection results or union-sponsored inspection efforts.

Procedure

This question is asked only of those persons responding affirmatively to Question #53.

Compatibility With NOHS

New question.

Question:

56. **Do you have a regularly scheduled preventive maintenance program?** [47]

1 **Yes**

2 **No**

Intent

To determine if the facility has a preventive maintenance program.

Definitions

Preventive maintenance program is defined as a management initiated process of inspection and corrective action undertaken prior to any actual failure of the facility assets, including the physical structure and related equipment.

Inclusions

Include programs in which a limited amount of maintenance and repair work is actually performed but which involves routine and regular inspections of the plant.

Exclusions

Exclude all programs whose frequency of inspection is less than once every three (3) years.

Compatibility With NOHS

New question.

Question:

57. Do you have a regularly scheduled formal safety training program for your employees?

1. Yes
2. No

Intent

To determine if the facility has a regularly scheduled formal program of safety training for its employees.

Definitions

Generally, a safety training program is devoted to the recognition, evaluation, and control of safety hazards. Training programs include, but are not limited to: recognition of safety hazards such as unguarded moving machinery, inadequate fire protection, free-standing compressed gas cylinders, evaluation of potentially dangerous situations, who to contact, and what to do.

Inclusions

Include company-paid training programs that occur off-site if they are provided on a routine, regularly scheduled basis.

Exclusions

Exclude all training programs which are not formal in nature and are not presented by or on behalf of company management. Exclude all first-aid and emergency medical treatment (CPR, etc.) training programs. Exclude from consideration any after-the-accident discussions and safety seminars, as these are not considered "regularly scheduled." Also exclude any training that an employee may take voluntarily.

Compatiblity With NOHS

New question.

Question:

58. **Do you have a program under which you regularly or routinely assess the employee's awareness of safety rules?**

    1 Yes

    2 No

<u>Intent</u>

To determine if the facility management makes periodic assessments of the employee's awareness of safety rules pertinent to facility operations.

<u>Inclusions</u>

Include continual, informal assessment by management representatives if there is evidence that management initiates such assessment, and receives reports of employee awareness of safety rules.

<u>Exclusions</u>

Exclude "voluntary" or "employee-suggestion" input to management by employees concerning safety practices on the job.

<u>Compatibility With NOHS</u>

New question.

Question:

59. In those instances where employees are found to be in violation of the safety rules, are corrective measures taken?[58]

1. Yes
2. No (Skip to Question 62)

Intent

To determine if the employer has a functioning system of corrective actions which can be used when safety rules are violated.

Definitions

Corrective action is defined as a formal action by plant management personnel against the individual involved.

Inclusions

Include personnel actions (transfer, removal, suspension, etc.), and fines levied by management.

Exclusions

Exclude non-formal actions such as verbal notification of wrongdoing. Exclude labor union sanctions against the employee.

Compatibility With NOHS

New question.

Question:

60. Do those corrective measures involve economic penalties?[51]

1. Yes
2. No (Skip to Question 62)

Intent

As in Question #51.

Definitions

As in Question #51.

Inclusions

As in Question #51.

Exclusions

Exclude all actions which are not taken on behalf of plant management, such as labor union sponsored sanctions or fines against the employees.

Do not include medical or related costs incurred by the individual worker as a consequence of safety rule violation.

Procedure

This question is asked only of those responding affirmatively to Question #59. If the response to this question is negative, skip to Question #62.

Compatibility With NOHS

New question.

Question:

61. **Have any economic penalties been assessed in the past 12 months?**[52]

1 **Yes**

2 **No, we know of no instances where violations of company policy have occurred within the last 12 months.**

3 **No, although we know that there was a minimum of one violation of company policy within the last 12 months.**

Intent

As in Question #52.

Definitions

Economic penalties are defined in Question #51.

Inclusions

As in Question #51.

Exclusions

As in Question #60.

Procedure

This question is asked only of those responding affirmatively to Question #60.

Compatibility With NOHS

New question.

Question:

62. How long are personnel records on terminated employees retained?

__ __ Years (If "forever", code "999")
(If "unknown", code "UK")

Intent

To determine the length of time records on terminated employees are kept by the company.

Inclusions

Include all recordkeeping systems which identify an individual and provide personal data on that individual.

Exclusions

Exclude recordkeeping systems that only identify a group of people collectively. Exclude medical recordkeeping systems.

Compatibility With NOHS

New question.

Question:

63. **Do you keep employee absenteeism records?** $_{54}$

1. **Yes, showing specific nature of illness where appropriate**
2. **Yes, showing only the type of absence**
3. **Yes, without showing the type of absence**
4. **No**

Intent

To determine if management keeps any absenteeism records and, if so, at what level of detail.

Definition

Employee absenteeism records refers to that information kept by management concerning the failure of employees to report to work when scheduled.

Inclusions

Include only those records kept by management over and above the records required by law. Use code "4" when the employer keeps only those records required by Federal, State, or local regulations or no records at all. Use code "3" when the employer keeps additional records, but merely indicates "present" or "absent". This occurs in industries such as the construction industry where all or part of the employees are paid only for those days actually worked. Use code "2" when the employer keeps additional records and indicates whether the absence is due to a particular situation such as "illness" or "personal leave." Use code "1" when the employer keeps records which indicate an absence is caused by sickness and, gives the specific nature, type, or symptoms of the sickness.

Exclusions

Do not include those records required by OSHA or State regulations.

Procedure

Ask the management representative the question, "Do you keep employee absenteeism records?" If the response given is not adequate to determine the proper code, additional questioning will be necessary.

For example, the response may simply be "yes." In this case ask, "Do these records show the specific nature of sickness?" If answered "yes," code a "1"; if not, ask, "Do these records show the nature of the absence?" If answered "yes," then code a "2." If answered "no," the proper code will be "3."

Compatibility With NOHS

Fully compatible with Question #33.

Question:

64. What is your rate of unscheduled absenteeism?

__ — __ days per employee per year (If unknown, code "UK")

57 58

Intent

To determine the absenteeism rate for the establishment due to illness or injury.

Definitions

Unscheduled absenteeism is defined as the failure of employees to report to work when scheduled. Rate is defined as the number of days per year per employee.

Inclusions

Include only those days where the absence is due to illness, injury, or failure to report to work.

Exclusions

Do not include those days where the absence is due to vacation, jury duty, pre-arranged personal leave, maternity leave, strikes, layoffs, work cancelled due to the weather, etc.

Procedure

When the interviewee says he does not know the absenteeism rate, the interviewer should ask if the information is available from another individual or from the facility's personnel records. If the information is available from these sources, the interviewer should request that the information be obtained. If the response is given as being from 4.5 to 5.4 days per year the response should be coded "005." If the response is from 5.5 to 6.4 days per year, code "006." Where an employer provides a percentage rate, multiply that percentage by 240 workdays to determine the days per year per employee. If the absentee rate is not known, enter the code "UK."

Compatibility With NOHS

Fully compatible with Question #34.

Question:

65. What is your turnover rate among permanent employees in the nonadministrative areas?

__ __ % per year

Intent

To determine an overall turnover rate for employees engaged in non-administrative jobs.

Definitions

Permanent employees are employees which management expects to retain on a long-term basis (more that 1 year). Non-administrative is defined as those jobs and positions which are directly engaged in the production, packaging, inspecting, and shipping departments of the company. Do not include outside salespersons in this figure.

Inclusions

Include any permanent employee who is not an executive or a manager who works directly in the production, packaging, and shipping/receiving areas of the facility at least 50% of their work day.

Exclusions

Exclude temporary and seasonal employees from this calculation. Also exclude all executives and managers who do not work directly in the production, packaging, or shipping/receiving areas of the facility for at least 50% of their work day.

Compatibility With NOHS

New question.

Question:

66. **May I see the latest Summary of Occupational Injuries and Illnesses Form (OSHA Form 200)? (OSHA regulations provide for inspection by NIOSH).**[18]

1. **Yes**
2. **No (or company does not keep one)**

SURVEYOR: COPY THE FOLLOWING INFORMATION FROM THE OSHA FORM 200

Occupational Injuries

a. **Number of deaths (column 1)**
b. **Number of injuries with lost workdays (column 3)**
c. **Number of injuries without lost workdays (column 6)**

Occupational Illnesses

a. **Skin diseases or disorders (column 7a)**
b. **Dust diseases of the lungs (column 7b)**
c. **Respiratory conditions due to toxic agents (column 7c)**
d. **Poisoning (systemic effects of toxic materials) (column 7d)**
e. **Disorders due to physical agents (column 7e)**
f. **Disorders associated with repeated trauma (column 7g)**
g. **Deaths (column 8)**
h. **Number of illnesses with lost workdays (column 10)**
i. **Number of illnesses without lost workdays (column 13)**

Intent

To determine the incidence of injuries and illnesses among the facility employees.

Definitions

OSHA Form 200 refers to the reporting form issued to industry by the U.S. Department of Labor, Occupational Safety and Health Administration.

Procedure

Code a "1" if the facility keeps, and allows surveyor access to the OSHA 200 Form. If the facility either does not keep, or refuses access to the form code a "2." If the response to the question is "yes," enter the data requested by this question directly from the facility copy of the OSHA 200 Form. Where necessary, total the column entries from the facility copy of the OSHA 200 Form, and enter this total in the appropriate location within the body of Question #66.

Where no data is provided (equivalent to a zero) on the facility OSHA 200 Form, enter a right-justified zero in the appropriate space.

Compatibility with NOHS

Fully compatible with Question #49.

Appendix B

DEPARTMENT OF HEALTH AND HUMAN SERVICES Public Health Service

National Institute for Occupational
Safety and Health
Robert A. Taft Laboratories
4676 Columbia Parkway
Cincinnati OH 45226-1998
Voice: (513) 841-42312
Facsimile: (513) 841-4489
October 22, 2002

Dear Sirs:

Mr. Gary Morris has contacted me concerning use of geographical data collected during the 1981-1983 National Occupational Exposure Survey (NOES) in analyses required for his Ph.D. dissertation. The NOES was conducted by the National Institute for Occupational Safety and Health (NIOSH) in response to its mandate under the Occupational Safety and Health Act of 1969 (OSHAct) to conduct necessary research to protect safety and health of the national workforce. NIOSH was created to provide such research as required for the development of policies and legislation promulgated by the Occupational Safety and Health Administration (OSHA).

NOES data has been and continues to be used for the investigation of OSH policies and practices. Such nationally representative data has not been collected since the 1981-1983 NOES, so this database provides special opportunities to characterize OSH practices across industry. One use has been to investigate the use of personal protective equipment (PPE) in industries with exposure to high noise levels. The use of PPE following promulgation of laws requiring such PPE was analyzed. An example of the use of NOES data for this purpose may be found in recent articles by Pedersen (*American Industrial Hygiene Association Journal*, May/June 2000) and Sieber (*American Industrial Hygiene Association Journal* 59:715-722, 1998). We have also considered the use of safety and health professionals and training by size of establishment (number of employees), since such issues are of much current interest (Lentz T.J. et al, *Surveillance of Safety and Health Programs and Needs in Small U.S. Businesses*, submitted to *Applied Occupational and Environmental Hygiene*). These analyses have not included a geographical component, however, and Gary's proposed dissertation topic would add an additional dimension to such analyses. Such analyses will also be helpful in planning analyses for an updated National Occupational Exposure Survey which NIOSH is currently planning.

I look forward to working with Gary in this exciting area.

W. Karl Sieber Ph.D.
Surveillance Branch, Hazard Section
Division of Surveillance, Hazard Evaluation, and Field
Studies

Appendix C

OLD DOMINION UNIVERSITY

College of Health Sciences
School of Community Health Professions and Physical Therapy
Norfolk, Virginia 23529-0288
Phone: (757) 683-4519
FAX: (757) 683-4410

Old Dominion University College Of Health Sciences
Human Subject Review-Exemption/Expedited Review

Date: May 29th, 2002
Number: SU02-102

Title of Research Project	:Application of the Traditional Epidemiological Model to Predict Occupational Injury and Illness Rates
PI	: Mr. Morris

This project has final approval from the committee chair as 'EXEMPT' under VA Code 32.162.17. It may begin anytime after: May 29th, 2002

At the end of the project, you need to file a Human Subjects Research Close-Out Report. If the project is going to continue beyond one year from the date of approval, you need to also file a Human Subjects Research Progress Report Form to renew the approval. If there are any adverse events experienced by ANY subjects, you need to file an Adverse Event Reporting Form. All of these forms can be found at:

http://www.odu.edu/ao/research/IRB_forms.html.

These forms need to be send hard-copy (with signatures and NOT by e-mail). It is advisable to look at the forms as soon as possible, so that you know what type of information you might need to collect.

Approved George Maihafer

George Maihafer, Ph.D. Co-Chair, College of Health Sciences Human Subject's Committee

Appendix D

DATA DICTIONARY

Label	Computation	Name/Value Label
Dependent Variables		
Occupational injury without lost workday rate	$\frac{\text{INJWOLST X 200,000}}{\text{PAYROLL X 2,000}}$	IJWOLSRT
Occupational injury rate	$\frac{\text{INJDEATH + INJWOLST + INJWLOST X 200,000}}{\text{PAYROLL X 2,000}}$	TOTINRT
Occupational injury with lost workday rate	$\frac{\text{INJWLOST X 200,000}}{\text{PAYROLL X 2,000}}$	IJWLSTRT
Occupational illness without lost workday rate	$\frac{\text{ILLWOLST X 200,000}}{\text{PAYROLL X 2,000}}$	ILWOLSRT
Occupational illness rate	$\frac{\text{ILLDEATH + ILLWOLST + ILLWLOST X 200,000}}{\text{PAYROLL X 2,000}}$	TOTILRT
Occupational illness with lost workday rate	$\frac{\text{ILLWLOST X 200,000}}{\text{PAYROLL X 2,000}}$	ILWLSTRT
Absenteeism rate	Rate of unscheduled absenteeism (days per employee per year); Code UK if unknown	ABSRATE
Turnover rate for non-administrative workers	Percent per year for permanent workers	TURNRATE
Fatal occupational injury	# of deaths	INJDEATH
Nonfatal occupational injury	# injuries w/ lost workdays # injuries w/o lost workdays	INJWLOST INJWOLST
Fatal occupational illness	# of deaths	ILLDEATH
Nonfatal occupational illness	# illnesses w/ lost workdays # illnesses w/o lost workdays	ILLWLOST ILLWOLST

Label	Computation	Name/Value Label
Independent Variables		
Date survey started	(Month/day/year) Date survey of establishment began	
Facility Number	Number identifying the specific establishment	FACNUM
SIC codes observed	List of up to 3 SIC codes describing major activity of establishment; completed by surveyor after observation	SICCODE
Durable goods industry	SIC codes 2400-3999	DURABLE
Non-durable goods industry	SIC codes 2000-2399	NODURABL
# Years in operation	# years, to the nearest year; round up to nearest year in cases of 6+ months; code UK if unknown	YRSOPER
# shifts	Total # shifts where production employees are present	SHIFTS
Hours per shift	# hours per shift; code 99 if irregular	SHFTHRS
Company size		
Males	# full-time/part-time male personnel paid directly by establishment, even if commission	MALEPAY
Females	# full-time/part-time female personnel paid directly by establishment, even if commission	FEMPAY

Label	Computation	Name/Value Label
Total	# full-time/part-time personnel, male or female, paid directly by establishment, even if commission	PAYROLL
Percent male	MALEPAY / PAYROLL	PERCTMAL

Percent female	FEMPAY / PAYROLL	PERCTFEM
# work area employees	Total # employees working in service area (spaces where major activities are conducted); excluding employees in administrative spaces	WANUMBR
Percent service area workers	WANUMBR / PAYROLL	PERCTWA
Labor union	1 No 2 Yes	UNIONS
Labor union	1 Yes 0 No	REUNION
Health unit	1 Yes, MD in charge 2 Yes, RN in charge 3 Yes, LPN in charge 4 Yes, other in charge 5 No	HLTHUNIT
First aid personnel	1 Yes, full-time 2 Yes, part-time 3 No	FIRSTAID
On-site physician	1 Yes, full-time 2 Yes, part-time 3 No	PHYSSITE
On-site physician (recoded)	1 and 2=1 Yes Else =0 No	REPHYSIC
On-site Physician (recoded)	1=2 Else=0	DOCTOR

Label	**Computation**	**Name/Value Label**
Access to physician	1 Yes, physician will travel to establishment on call 2 Yes, at clinic (not on-site) 3 Yes, physician based on-site 4 No	PHYSOUT

Physician hours	Estimate of average # physician hours devoted to establishment per week	PHYSHRS
Nurses	1 Yes 2 No	NURSES
On-site health Professional	DOCTORS + NURSES 1 Nurses 2 Doctors 3 Both 4 None	HLTHPRO
# nurses		
RNs	# Registered Nurses on payroll	NUMBRN
LPNs	# Licensed Practical Nurses on payroll	NUMBLPN
Nursing hours	Average # nursing hours devoted to establishment per week	NURSEHRS
Medical exam before hire	1 No 2 Yes, for all workers 3 Yes, for executives/managers 4 Yes, for production workers 5 Yes, for select workers	PREEXAM
New employee health records	1 No 2 Yes, for all workers 3 Yes, for executives/managers 4 Yes, for production workers 5 Yes, for select workers	HLTHINFO
Medical exam following illness	1 No 2 Yes, for all workers 3 Yes, for executives/managers 4 Yes, for production workers 5 Yes, for select workers	RTRNWORK
Label	**Computation**	**Name/Value Label**
Exit medical exam	1 No 2 Yes, for all workers 3 Yes, for executives/managers 4 Yes, for production workers 5 Yes, for select workers	TERMWORK

Medical records retained	# years medical records/health information retained; Code 999 if forever; Code UK if unknown	MEDRCDS
Full-time staff for prevention	1 Yes, injury prevention 2 Yes, illness prevention 3 Yes, both injury & illness 4 No	RESPPREV
Illness Prevention Professional (Industrial Hygienist)	Recoded RESPPREV 2=1, 3=1, else=0 1 Yes 0 No	IHPRO
Safety Professional	Recoded RESPPREV 1=1, 3=1, else=0 1 Yes 0 No	SFTYPRO
# Full-time health/safety specialists		
Safety (injury)	# full-time, on-site safety specialists	NUMBSFTY
Health (illness)	# full-time, on-site health specialists	NUMBHLTH
Industrial hygiene consulting during past 12 months	1 Yes, from government sources 2 Yes, from non-government sources 3 No	IHCNSLT
Industrial hygiene consulting during past 12 months	Recoded IHCNSLT 1=1, 2=1, else=0 1 Yes 0 No	CNSLTIH

Label	**Computation**	**Name/Value Label**
Occupational safety consulting during past 12 months	1 Yes, from government sources 2 Yes, from non-government Sources 3 No	SFTYCNLT

Occupational safety consulting during past 12 months	Recoded SFTYCNLT 1=1, 2=1, else=0 1 Yes 2 No	CNLTSFTY
Physical agent monitoring	1 No 2 Yes	AGNTMNTR
Physical agent record retention	# years records are retained; Code 99 if forever; Code UK if unknown	AGNTRECDS
Chemical agent monitoring	1 Yes 2 No	FUMEMNTR
Monitoring method	1 Sample collection w/ lab analysis 2 Direct reading instruments 3 Both	CNDTMNTR
Chemical agent record retention	# years records are retained; Code 99 if forever; Code UK if unknown	FUMERCDS
Chemical substitutions during last 5 years	1 Yes 2 No	CHEMSUB
Chemical substitutions for employee safety	1 Yes 2 No	CHEMPRPS
Chemical substitutions after inspection	1 Yes 2 No	CHEMINSP
Equipment/process modifications during last 5 years	1 Yes 2 No	PROCSMOD
Equipment modifications for reducing exposure	1 Yes 2 No	PRCSPRPS

Label	**Computation**	**Name/Value Label**
Equipment modifications after inspection	1 Yes 2 No	PRCSINSP
Nature of equipment modification	1 Redesign of the process 2 Enclosing the process 3 Equipment substitution	PRSCNATR

	4 Redesign of equipment 5 Combination of the above 6 Not listed here	
Air exhaust recirculation	1 Yes 2 No	RECIRAIR
Personal protective devices required or recommended	1 Yes, required 2 Yes, recommended 3 Yes, both 4 No	PROTCODE
Provider of protective devices	1 Individual employee 2 Employer 3 Both 4 Other (specify)	PROTPRVD
Protective device service & maintenance responsibility	1 Individual employee 2 Employer representative 3 Both 4 No one 5 Other (specify)	PROTSVCD
Corrective measures for protective device refusal/failure	1 Yes 2 No	PROTCORR
Economic penalties for refusal/ failure	1 Yes 2 No	PROTPLTY
Economic penalties during past 12 months	1 Yes 2 No, no known violations during past 12 months 3 No, but there has been at least 1 violation during past 12 months	PROTECON
Safety inspection program	1 Yes 2 No	SFTYINSP

<u>**Label**</u>	<u>**Computation**</u>	<u>**Name/Value Label**</u>
Written results for safety inspection	1 Yes 2 No	SFTYREQD
Posting of inspection results	1 Yes 2 No	SFTYAVAL

Regular preventive maintenance	1 Yes 2 No	PREVMAIN
Employee safety training	1 Yes 2 No	SFTYCODE
Employee safety training (recoded)	1 Yes 0 No	SFTYTRAN
Employee safety awareness assessment	1 Yes 2 No	SFTYAWAR
Safety rule violation corrective measures	1 Yes 2 No	SFTYCORR
Economic penalties for safety rule violations	1 Yes 2 No	SFTYPLTY
Economic penalties during past year	1 Yes 2 No, no known violations during past 12 months 3 No, but there has been at least 1 violation during past 12 months	SFTYECON
Record retention for terminated workers	# years personnel records retained; Code 999 if forever; Code UK if unknown	PERSRCDS
Employee absenteeism records	1 Yes, shows specific illness 2 Yes, shows type of absence 3 Yes, does not show type of absence 4 No	ABSCODE
Copy of OSHA Form 200	1 Yes 2 No, company does not keep one	OSHAFORM

Label	**Computation**	**Name/Value Label**
Geographical location	1 Northeast 2 Midwest 3 Southeast 4 Southwest 5 Northwest	AREACODE

CURRICULUM VITAE

March 2003

Name GARY A. MORRIS

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Education

1986-1991
Bachelor of Science (B.S.)
Occupational Safety and Health Engineering
Murray State University
Murray, Kentucky 42071

1994-1997
Master of Science
Environmental Health
Old Dominion University
Norfolk, Virginia 23529

1998-2003
Doctor of Philosophy, Urban Services – Health Services (Ph.D.-ABD)
Old Dominion University, College of Health Sciences
Norfolk, Virginia 23529

Positions

Current
Senior Occupational Health Inspector- President, Board of Inspection and Survey. Inspect occupational safety, environmental protection, and medical department equipment and programs for afloat assets in the United States Navy.

1995-1998
Department Head- Shore Intermediate Maintenance Activity, Norfolk- Responsible for all safety and environmental programs for the largest intermediate ship repair facility in the Navy.

1992-1995:
Assistant Safety Officer- on board the aircraft carrier USS GEORGE WASHINGTON (CVN 73), Norfolk, VA. Responsible for safety and environmental programs on a nuclear power aircraft carrier.

1991-1992: **Industrial Hygiene Officer-** Naval Medical Center, Portsmouth. Portsmouth, VA. Conducted industrial hygiene surveys for Naval facilities in the Hampton Roads area.

Selected Presentations at Professional Conferences

"Safety's Effect on Success: A study to examine if doing well on the NAVOSH section of a ship's INSURV Material Inspection increases the ship's odds of doing well on the other sections of the inspection" (with Stacey Plichta), presented at the Navy Environmental Health Conference, March 2002.

"On-Site Occupational Health Professionals Can Prevent Lost Workdays" (with Stacey Plichta, William Luttrell, and Scott Sechrist), submitted for presentation at the 131st American Public Health Association Conference, November 19, 2003.