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Report on Occupational Safety and Health for FY 1983

UNDER PUBLIC LAW 91–596

NIOSH

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

NIOSH REPORT ON OCCUPATIONAL SAFETY AND HEALTH FOR FISCAL YEAR 1983 UNDER PUBLIC LAW 91-596

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

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A. Introduction

1. Background

Prevention of occupational diseases and injuries is a concern of major importance in protecting the health of all Americans. The approximately 104 million men and women who make up the workforce of this country are subject to occupational injuries and diseases that exact a large toll in human suffering, disability, lost workdays, and premature death as well as in loss of dollars. Most workplace diseases and injuries are preventable.

To deal with these work-related health problems, the U.S. Congress passed the Occupational Safety and Health Act of 1970 (Public Law 91-596). This Act established the National Institute for Occupational Safety and Health (NIOSH) as the Federal organization responsible for research on the health and safety of America's workers. This and several subsequent acts (e.g., the Federal Mine Safety and Health Amendments Act of 1977 [PL 95-164]) charge the Institute with identifying occupational safety and health hazards, developing means of preventing these hazards, and conducting educational and training programs to provide adequate personpower for prevention. The Institute coordinates its comprehensive research program of laboratory investigations, field surveys, and epidemiologic studies so that appropriate standards and control measures can be recommended. NIOSH is a prevention-oriented research institute with goals and objectives in two major areas: 1) producing significant, valid information by identifying occupational safety and health hazards and conducting research and field studies on these problems, and 2) transmitting this information to those who need to know in order to protect the worker and control work-related disease and injury. Section 20 of the Occupational Safety and Health Act of 1970 mandates NIOSH to conduct research; Section 21 mandates NIOSH to conduct training and education. NIOSH is specifically authorized to recommend standards to the Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA), for the protection of workers In all activities, the emphasis is on prevention, intervening before worker exposure occurs.

In 1973, NIOSH became part of the Centers for Disease Control (CDC), the arm of the Public Health Service (PHS) responsible for safeguarding the health of the American people. The operation of NIOSH within CDC provides a framework for cooperation and exchange in activities designed to prevent and control disease, improve occupational health and safety, and foster health promotion and health education.

2. Organization

The headquarters and administrative offices of NIOSH are located in the CDC complex in Atlanta, Georgia. An office is also maintained in Washington, DC. Five divisions are in Cincinnati, Ohio, and two are in Morgantown, West Virginia. They are organized as follows:

Division of Biomedical and Behavioral Science (Cincinnati)
- Applied Psychology and Ergonomics Branch
- Experimental Toxicology Branch
- Physical Agents Effects Branch
- Technical Support Branch

Division of Physical Sciences and Engineering (Cincinnati)
- Engineering Control Technology Branch
- Measurements Research Support Branch
- Methods Research Branch
- Monitoring and Control Research Branch

Division of Standards Development and Technology Transfer (Cincinnati)
- ~~Document Development Branch~~
- ~~Priorities and Research Analysis Branch~~
- Technical Information Branch
- Hazardous Waste Working Group

Division of Surveillance, Hazard Evaluations, and Field Studies (Cincinnati)
- Surveillance Branch
- Industrywide Studies Branch
- Hazard Evaluations and Technical Assistance Branch
- Support Services Branch

Division of Training and Manpower Development (Cincinnati)
- Educational Resource Development Branch
- Curriculum Development Branch
- Direct Training Branch

Division of Respiratory Disease Studies (Morgantown)
- Clinical Investigations Branch
- Environmental Investigations Branch
- Epidemiological Investigations Branch
- Examination Processing Branch
- Laboratory Investigations Branch

Division of Safety Research (Morgantown)
- Accident and Injury Epidemiology Branch
- Safety Surveillance Branch
- Standards and Consultation Branch
- Testing and Certification Branch

NIOSH Regional Program Consultants, located in the ten regional offices of the Department of Health and Human Services, deal directly with workers, employers, and State and local health departments in their regions. They conducted many of the investigations summarized in this report and participated in about 40 percent of the evaluations, conducted by the Institute, of potentially toxic materials used or found in the workplace (Health Hazard Evaluations [HHE]). Currently, 19 officers from CDC's Epidemic Intelligence Service (EIS) are assigned to NIOSH. In FY 1983, the Institute placed its first non-EIS representative within a State health department; more such representatives are planned for the future to help build the capabilities of the States in the field of occupational safety and health.

NIOSH personnel are trained in a wide variety of disciplines and specialties; they perform extensive bench and field research and provide technical support for clinical and statistical activities. The Institute operated with 773 permanent positions and an average of 111 temporary employees in FY 1983.

3. Focus

In 1979, PHS published Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention, 1979 (1) and designated occupational safety and health as one of 15 areas in which efforts could be made through health promotion, health protection, and disease prevention to improve the health of Americans. The next year, in Promoting Health/Preventing Disease: Objectives for the Nation (2), PHS outlined 226 objectives in the 15 priority areas as measurable goals to be achieved by 1990; 20 of these objectives were in the area of occupational safety and health. In responding to the challenge of these objectives, the senior scientists at NIOSH developed a list of the Ten Leading Work-Related Diseases and Injuries (Table 1). This list, produced in 1982 (3), ranked the most important health problems associated with work. It was developed based on the known or suspected frequency of occurrence of each disease or injury, the severity of the condition in individual cases, and its amenability to prevention.

Table 1. The Ten Leading Work-Related Diseases and Injuries

1. Occupational lung diseases, including lung cancer
2. Musculoskeletal injuries
3. Occupational cancers
4. Amputations, fractures, eye loss, lacerations, and traumatic deaths
5. Cardiovascular diseases
6. Disorders of reproduction
7. Neurotoxic disorders
8. Noise-induced loss of hearing
9. Dermatologic conditions
10. Psychologic disorders

This list depicts the Institute's best evaluation of occupational problems and serves as a guide for the NIOSH research program. Efforts are underway to develop a comprehensive control strategy for each problem on the list and to study the need for establishing or modifying standards. In the future, as situations change, the list will be updated.

The Institute monitors and evaluates a wide variety of other occupational conditions beyond those on this list--conditions that are now partially under control or new conditions that have recently emerged. Some of these may eventually be placed among the list of diseases and injuries when conditions now ranked are brought under better control. The emphasis is always on prevention.

In efforts to improve the quality of its programs, NIOSH has recently strengthened mechanisms through peer review to assure excellence in the research and recommendations of the Institute; it has focused the scientific skills and resources of the Institute on the most important diseases and injuries associated with work; and it has improved the access of workers to the benefits of health promotion. In dealing with occupational diseases and injuries, the Institute operates through four applied strategies that follow a logical sequence: 1) identification, 2) evaluation, 3) control, and 4) dissemination of research findings and recommendations. Priorities are set

based on an analysis of current surveillance data, a knowledge of emerging problems, and projected changes in the work force (e.g., a larger, more mature work force with an increasing proportion of women) and the workplace (e.g., a shift in percentage from manufacturing- to service-related jobs).

The same framework for research activities applies to the NIOSH research grants program, which gives funding consideration for extramural research in important topics in occupational safety and health. In FY 1983, the Institute sponsored 87 research and demonstration grants. A small grants program was introduced to stimulate young investigators to develop skills in occupational safety and health research; this resulted in funding 31 grants for approximately $600,000. Under the Request for Applications program in respiratory protection systems, seven grants were funded for more than $400,000. Control technology research was also highlighted in the grants program this year.

In keeping with the emphasis on prevention, NIOSH has begun a program of health promotion (4) and is adapting a health risk appraisal questionnaire to the occupational setting. The interaction between certain behaviors--such as the smoking of tobacco and excessive use of alcohol or other drugs--and occupational exposures can increase the risk of harmful outcomes. By contrast, healthy behaviors reduce the risk of adverse interaction with hazards in the workplace.

The Institute also participates in cooperative projects with Federal, State, and private organizations, at home and abroad. These include such diverse activities, for example, providing technical and scientific review of manuscripts and documents submitted by non-Institute researchers; coordinating efforts with the Environmental Protection Agency (EPA) and CDC's Center for Environmental Health (CEH) in protecting the public from hazards of waste sites; collaborating with the High Institute of Public Health, Alexandria, Egypt, on a study of crystalline silica exposure; co-sponsoring an international workshop with the World Health Organization on respiratory diseases related to vegetable and other natural dusts; and visiting the People's Republic of China to discuss occupational and environmental health problems of mutual interest and to lay plans for future collaboration on these issues. These are only representative of the activities of the Institute.

Much of the Institute's research is of an extended nature, dealing with the etiology of chronic occupational disease. This report cannot include all studies but covers only the highlights of NIOSH activities in FY 1983, with a brief summary of representative work.

B. The Ten Leading Work-Related Diseases and Injuries

1. Occupational Lung Diseases

Occupational lung diseases head the list of the Leading Work-Related Diseases and Injuries. The potential is high for workplace exposure to substances causing such disorders as pneumoconiosis, emphysema, chronic (industrial) bronchitis, and lung cancer. For example, an estimated 1.2 million workers may be exposed each year to silica dust alone, and as many as 18.8 million workers may be exposed to potentially hazardous concentrations of asbestos.

Recognition of occupational lung diseases is often difficult because of the long latency period and because other factors, such as smoking, may contribute to the disease process. Determining the contributing factors and preventing the occurrence of these lung diseases are high priorities of the Institute.

Lung Cancer in United States Coal Miners

Between 1972 and 1980, the National Coal Workers' Autopsy Study performed 3,341 autopsies on former underground coal miners and found that 9.9 percent had lung cancer. This figure is comparable to the incidence in the U.S. population as a whole. Because histologic cell types of lung cancer have been shown to be associated with certain occupational exposures, a selected subgroup of miners with primary lung cancers was assessed to determine the effect of dust exposure (measured by years underground) on the distribution of cell types. The most prevalent cancers in this group were squamous-cell carcinomas (28 percent) and adenocarcinomas (28 percent). However, no significant statistical association or pattern was found between cell type and years underground.

Diesel Engines in Coal Mines

Studies related to the use of diesel engines in coal mines included the effects of exposure to diesel exhaust. Although a five-year follow-up of workers indicates few if any additional risks associated with exposure to diesel exhaust, laboratory studies showed that rodents exposed to low levels of diesel exhaust, coal dust, or a combination of the two, developed pulmonary lesions with altered pulmonary clearance and dust deposition patterns. Exposure of animals to diesel exhaust/coal dust also inhibited metabolism of hepatic and pulmonary drugs. *In vivo* exposure of rat alveolar macrophages to coal dust activated these cells and resulted in hypersecretion, while exposure to diesel emissions in culture deactivated the macrophages. Additional studies are planned to determine the implications of these findings for specific diseases in workers.

Workers Exposed During Production of Phosphate Fertilizer

A retrospective cohort mortality study of 3,199 phosphate-fertilizer production workers was undertaken to determine whether this group is at increased risk of dying from any cause, and particularly from lung cancer. Although no statistically significant elevations in mortality from any specific cause were observed, when the analysis was stratified by duration of employment and length of follow-up, a statistically significant excess mortality from lung cancer was observed among workers with more than 10 years employment and follow-up. These data should be viewed as suggestive until further investigations involving larger populations can be conducted.

Mortality among Cadmium Production Workers

A previous, retrospective mortality study of 292 U.S. cadmium-production workers was extended to include 261 workers with 6-23 months employment and 351 workers who were employed for two or more years. The entire cohort was followed for an additional five years through 1978. Mortality from respiratory cancer and from nonmalignant gastrointestinal disease was significantly greater among the cadmium workers than would have been expected from U.S. rates. All deaths from lung cancer occurred among workers employed for two or more years. NIOSH is now preparing a Current Intelligence Bulletin to advise workers of the carcinogenicity of cadmium; it will be distributed in FY 1984.

Hypersensitivity Lung Disorders

A variety of workplace environments were investigated in which hypersensitivity lung reactions have been documented. These include large office buildings, poultry-confinement houses, insect-rearing facilities, saw mills, and furniture factories.

In building-associated hypersensitivity illnesses, the available data suggested that moisture incursion into occupied space and into components of the ventilation system may be the common feature causing the symptoms.

Allergic reactions at insect-rearing facilities were controlled by the use of vertical, laminar-flow hoods and personal protective equipment for the handling of insects and debris.

In a study of occupational asthma, monkeys were used as the animal model because of their anatomic and immunologic similarities to humans. After baseline testing of pulmonary function, the animals were exposed to substances with the potential to elicit the asthma reaction. Repeat testing after exposure determined the change in pulmonary responsiveness of the animals. Exposure to sodium hexachloroplatinate demonstrated reproducible airway obstruction in the monkeys; the incidence of responders was greater with concurrent ozone exposure, suggesting that pulmonary irritants may exacerbate pulmonary hypersensitivity.

Control Technology for Inorganic Dusts

This research is designed to document, catalog, and disseminate methods and techniques used to control, reduce, or eliminate workplace exposures to chemical dusts that are responsible for a variety of lung diseases. Controls at bagging operations, for such substances as asbestos and diatomaceous earth, were assessed. NIOSH recommended the redesign of work practices to reduce any needless handling or positioning of bags that would generate increased exposure to the contents, the use of personal protective equipment, environmental and medical monitoring, and administrative control programs, such as worker education.

A major hazard in the ceramics industry is exposure to crystalline silica dust in the preparation of raw materials. NIOSH findings indicated that effective dust-control procedures have been developed and are now in widespread use to maintain dust exposures at safe levels.

Research in the crushed-stone industry identified several plant sites where workers are overexposed to dusts. NIOSH has instructed plant operators how to initiate engineering controls to prevent occupational lung disease.

Surveys at a plant where attapulgus clay is mined and processed found that worker exposure to dust from all sources exceeded the MSHA standard at many sites. Engineering measures to reduce worker exposure are being communicated to the plant officials.

Substitutes for Harmful Materials

A study was recently initiated to determine the fibrogenicity of four commercial coal slags that are used as substitutes for silica sand in abrasive-blasting operations. Rats in each treatment group were given a test material by single intratracheal instillation. The effects of these slags on

the animals' pulmonary function and lung histopathology will be determined over a period of two years.

Data from biochemical studies on the cellular basis for irritation seem to indicate that wollastonite (a mineral fiber) is far less toxic to alveolar macrophages than is asbestos. Thus, wollastonite may be a medically acceptable substitute for asbestos.

Cotton Dust

Inhaled cotton dust causes respiratory symptoms and has adverse effects on pulmonary function. The specific agent(s) in this complex mixture of plant products and microbiologic contaminants responsible for the adverse pulmonary effects remains unknown. NIOSH research demonstrated that washing cotton before carding reduces the total amount of dust in the cotton and lowers the potency of the residual dust. In addition, the data indicated that the acute pulmonary effects of cotton dust correlate more closely with the concentration of inhaled endotoxin than with the total weight of inhaled dust. This research has implications for the future setting of standards, not only in the cotton industry, but ultimately for all industries processing vegetable products. Cotton dust extracts were shown to produce acute byssinotic reactions in laboratory animals. Further work is in progress to determine the etiology of these reactions in laboratory animals. Identification and increased knowledge of the etiologic agent(s) in cotton dust may aid efforts to grow cotton that is free of these agents; their elimination may prevent the induction of byssinosis.

Water-soluble extracts of cotton bract were tested on the isolated airway smooth muscle of dogs, guinea pigs, and cats to see whether agents in cotton bracts could be involved in the production of Monday-morning chest tightness reported by byssinotic workers. The pharmacologic effects of the extracts were shown to be species specific. A characterization of the active agents in the extracts is now in progress. Since ashed samples retain full activity, inorganic substances may be involved. A photoaffinity labeling technique was developed to aid further studies.

Immunotoxic Dusts

Workers on farms and at grain terminals, animal handlers, and workers in the compost, sewage, mushroom, wood, insect-rearing, and cotton industries are exposed to dusts that interact with human immune factors and are capable of initiating acute inflammatory reactions in the lung. *In vitro* studies using water-soluble extracts of airborne dusts collected in the workplace have shown that components of the human complement system are activated by these extracts. Understanding the nature of inflammatory mediators produced in response to agricultural dusts may lead to better diagnostic and/or therapeutic procedures for the associated occupational lung diseases. Identification of the inflammatory agents in these dusts may lead to better monitoring of the workplace environment, control technology development, and disease prevention.

Development of Analytical Methods

A new X-ray diffraction method for vanadium oxide was used to evaluate the potential of this compound to produce a hypersensitivity reaction. Vanadium is mined in Colorado and converted to vanadium oxide for use as a catalyst in the manufacture of organic compounds and in metallurgy, specifically the preparation of special steels.

A study evaluating an X-ray diffraction method for lead sulfide established the precision of the method for field samples. Lead, which has a wide variety of uses, is known to be extremely toxic. This analytical tool will permit studies that determine whether lead sulfide is as toxic as other lead compounds.

An electron microscope method for asbestos, which has the advantage of objectively distinguishing asbestos from other fibers, gave quantitative results comparable to the traditional optical microscope method.

Development of Ion Chromatography/Solid Sorbent Methods

A silica gel tube was developed to collect the lung irritant, hydrogen fluoride. These tubes are more acceptable than the liquid impingers or multiple samplers previously used and provide the capacity and stability required for industrial hygiene sampling. This sampler now has the capability of collecting six inorganic acids for simultaneous analysis; ion chromatography is used to separate and measure each acid in a single sample.

Sampling and Analysis for Acrolein

Acrolein, a respiratory-tract irritant, is the basis of several types of plastics, textile finishes, and synthetic fibers; it is also formed during commercial processing of animal fat and occurs as a constituent of diesel-engine exhaust. A personal, sorbent-tube sampler was developed that is specific for acrolein and preserves stable samples.

Alternative Sampler for Isocyanates

Exposure to isocyanates, intermediates in the production of polyurethane coatings and foams, results in an asthma-like syndrome and causes severe eye irritation. Following the successful development of a method to measure total isocyanates in workplace air, the Institute is developing a sampling device more suitable for personal monitoring than the impingers now in use.

Respiratory Mechanics

Studies of gas-trapping in excised lungs have shown that changes in the gas-trapping process could serve as an early indicator of several lung diseases. A high correlation between gas trapping and lung sounds in these excised lungs has raised hopes that the sounds may be used to study living animals and man. The use of mathematical and computer models to describe the process of inflating and deflating lungs indicates that they do not expand and contract uniformly but by sequential opening and closing of individual lung units. This may be responsible for changes in the lung sounds.

Biochemical studies are in progress to determine 1) the cellular basis for the synthesis and reutilization of pulmonary surfactant materials, 2) which component of cotton dust is responsible for the surface-tension effects of the dust, 3) the mechanisms of oxygen release and transport, and 4) to study inflammation.

Diagnosis of Asbestos-Associated Diseases

New diagnostic criteria were developed for asbestos-associated diseases of the lungs and pleural cavities. These criteria, and a system for grading the severity of the disease, will improve the accuracy of diagnosis and permit earlier and more accurate reporting.

Measurement of Toxic Aerosols

An inexpensive cascade impactor ($5-$15 vs. commercial models at $500-$3000) was developed to provide information on the aerodynamic size of aerosols. This information is important for predicting the site of deposition in the respiratory tract. The impactor will improve the dose determination for dose/response studies of workers exposed to various toxic aerosols.

2. Musculoskeletal Injuries

Because many work activities are physical in nature, the musculoskeletal system is highly susceptible to a variety of occupational injuries and illnesses. Back injuries may account for one fifth of all workers' injuries, and repetitive-motion tasks may cause cumulative trauma disorders, such as carpal tunnel syndrome. In 1982, musculoskeletal injuries accounted for 18 percent (580,000) of the occupational injuries treated in U.S. emergency rooms. As the average age of the work force increases over the next several decades, the frequency and impact of these conditions are expected to increase.

Industry- and Occupation-Specific Risks

Data on workers' compensation claims (from the Bureau of Labor Statistics System) were used to assess the incidence, among American industrial workers, of two musculoskeletal problems, repetitive-motion wrist disorders and low-back strains/sprains. The data, presented by age, sex, industry of employment, and general occupation, were coupled with total employment data for industries and occupations to establish industry- and occupation-specific risks for these disorders. The results are being published in labor and occupational medicine journals.

Upper Extremity Disorders

Seven workplace ergonomics investigations were conducted in FY 1983. The jobs, which included electrical-parts assembly, weighing and packaging of chemical powders, food processing and preparation, sewing, and microscopy, were alleged to impose significant risk to the upper extremities of workers due to various forms of postural stress and strain or repetitive, forceful use of arms, wrists, or hands. Medical records of some workers indicated the presence of carpal tunnel syndrome or ganglionic cysts. Data on job-task analyses, evaluation of work-station layout, and tool design were collected to help diagnose the problems and recommend corrective measures. Recommendations for weighing and packaging operations included limiting excessive lifting of loads. For bagging operations, a substitution was recommended of self-sealing bags to eliminate the forceful wrist-flexion movements now required to close the bags by tucking in flaps.

Other studies of these types of injuries included a) developing a computerized, dynamic biomechanical model of pushing and pulling to assess the potential for injury to the lower back in jobs requiring these tasks; and b) reducing risks of injury by identifying design factors for industrial containers that minimize stresses to workers' hands, wrists, shoulders, and backs.

Grocery Warehouse Workers

A contract study completed by the University of Wisconsin investigated physical fatigue and biomechanical stress in grocery warehouse workers. Oxygen uptake and heart rate were recorded as indices of physiologic fatigue

in workers engaged in lifting and handling materials to meet performance standards (based on traditional methods-time-measurement procedures). One-third of the workers had values at or near maximum work capacity. Studies to identify forces at various body joints during lifting tasks suggested that one-third of the workers would not have the strength to do such work without significant risk of overexertion. Thus, added fatigue allowances must be made in the jobs studied to reduce the rate of work-related injuries.

Military Helicopter Pilots

The health records of 3,000 military helicopter pilots were reviewed to determine types of injuries sustained and types of helicopters involved. An increased incidence of back disorders was found for one type of helicopter that has a fixed, nonadjustable seat. However, it was not determined whether ergonomic considerations, whole-body vibration, or a combination of the two was responsible for the back pain. NIOSH recommended that laboratory studies be conducted to determine methods of correcting this problem.

Carpet-Layer's Knee

A study was conducted of knee injuries to carpet layers who use a kicking tool to hold the carpet taut. Measurements of the force and acceleration at the knee showed excessively high impact forces on the joint. Efforts are underway to redesign the tool and thus prevent knee injuries and biomechanical trauma to carpet layers.

Video Display Terminals

A series of laboratory studies isolated ergonomic factors that would ease musculoskeletal and visual discomfort in the operation of video display terminals (VDT). The use of detachable keyboards and adjustable tables and chairs, reducing glare, controlling background lighting, and taking rest breaks all yielded higher performance levels and fewer complaints of muscle strain and eye fatigue.

3. Occupational Cancers

More than 1,000 new chemicals are introduced into the working environment each year; few of these are regulated or controlled in the workplace. As a result, occupational cancer related to exposure to these chemicals may increase in the future. If as few as five percent of all new cancers in the United States annually involved industrial exposure, 20,000 cancer deaths could be considered occupationally related. Some cancers identified as occupationally related are leukemia, mesothelioma, and cancers of the bladder, kidney, lung, liver, nose, skin, and stomach.

Brain Cancers at a Petrochemical Plant

Based on an earlier study that uncovered an excess of neoplasms of the brain at a petrochemical plant, an investigation was conducted to determine the etiology of this excess. The case/control study examined possible associations between brain tumor and job title, departmental employment history, chemical-exposure history, location within the plant, dates of employment, and residence. Among the 33 chemicals to which at least four persons with tumors had been exposed, the greatest risk was associated with carbon dioxide, diethyl sulfate, diethylene glycol, ethanol, ethylene, isopropanol, methane, tetraethylene glycol, and vinyl acetate. Duration of

exposure did not appear to have a significant effect. Although vinyl chloride monomer, previously implicated in the etiology of brain tumors, was produced and used at this plant, no significant association was found in this study between exposure to it and the formation of brain tumors.

Garment Workers Exposed to Formaldehyde

To evaluate the human carcinogenicity of formaldehyde, a proportionate mortality study was conducted of garment workers who make shirts from cloth treated with formaldehyde. Although no deaths from nasal cancer were observed, and the mortality from respiratory cancer was less than expected, statistically significant elevations in proportionate mortality were observed for malignant neoplasms of the buccal cavity, of biliary passages and liver, and of lymphatic and hematopoietic sites. The observed excesses in cancer mortality were most pronounced among white females and workers with more than ten years latency and duration of exposure. Because of the small number of deaths and the lack of consistency with other studies, interpretation should await the outcome of more definitive studies.

Workers Exposed to Dioxin

Since dioxin is a potent carcinogen in laboratory animals, a registry is being assembled of U.S. workers potentially exposed in the manufacture of substances contaminated with dioxins. Workers included in the registry will be the basis for further studies to determine whether an association exists between disease and exposure to dioxin.

Ethylene Oxide

As many as 145,000 workers are potentially exposed to ethylene oxide (EtO), an important chemical intermediate and a disinfectant used to sterilize hospital equipment. Animal studies showed that it induces leukemia, peritoneal mesotheliomas, and gliomas in rats; human studies suggest that it is also a human carcinogen.

For a study of worker exposures to EtO, suitable plants were selected and a study population of 44,000 was identified in large chemical manufacturing plants that produce EtO for hospital supplies. Because previous studies have been hampered by small sample size and mixed exposures, this study will address single exposures and known combinations of exposures.

A study is in progress to examine the effects of low levels of EtO on chromosomes. Such low levels cannot be studied using the traditional epidemiologic methods of examining mortality or morbidity. The association between chromosomal changes and eventual disease outcomes, such as cancer, is not known at present.

Azo Dyes

Two commercial azo dyes, Acid Black 52 and Disperse Yellow 3, were studied for carcinogenicity in rats and hamsters. Acid Black is used to dye wools, silks, and leathers; Disperse yellow is used for dyeing synthetic fibers. In one experiment, the dyes were administered intratracheally; in another experiment, they were consumed in the diet. After a 27-month observation, Acid Black 52 showed no evidence of oncogenicity, while Disperse Yellow 3 produced a significant excess of oncogenic effects in selected organs, regardless of the route of exposure.

Glass Fibers

A study using rats and monkeys for chronic inhalation of four geometrically different glass fibers showed significant group differences for fiber deposition, translocation, and cellular response. Although no significant effects on mortality, hematology, pulmonary function, and ophthalmology were found, a highly significant increase in leukemias was induced in the rats by such treatment.

Immunotoxicology of Isobutyl Nitrite

Volatile nitrites, such as isobutyl nitrite (IBN), have been suspected of suppressing the immune system and thus increasing the risk of Acquired Immunodeficiency Syndrome (AIDS) and cancer. Assisting CDC's Center for Infectious Diseases with its research on AIDS, the Institute undertook an immunotoxicologic evaluation of IBN. Control mice and mice exposed to IBN for various time periods were tested for immunocompetency by several techniques. Results from all procedures were consistent and showed that IBN was not immunotoxic to mice at the concentrations tested. This suggests that volatile nitrites are probably not the cause of basic immunologic defects characteristic of AIDS.

Impact of Coal Dust on Gastric Cancer

Because several studies showed an elevated incidence of gastric cancer among coal miners, NIOSH laboratory research was designed to elucidate the possible risk factor. Using the Ames/salmonella mutagenicity system, high mutagenic activity was found when coal-dust extracts were treated with nitrate under acidic conditions. Since most inhaled coal dust can be swallowed following mucociliary clearance from the lung, and since considerable gastric nitrite can be present in the stomach from ingestion, it was postulated that mutagenic and carcinogenic substances may be generated in the acidic environment of the stomach by nitrosation of coal dust. This postulate is being tested.

Cellular Studies Using the Interferon System

The interferon system was used to study the combined activity of certain metals and fibrous minerals--an example of multiple-factor interaction that results in a high risk of carcinogenesis. The stimulation of interferon production by viruses was inhibited by these minerals. Dose-response measurements showed that admixtures of nickel and chrysotile asbestos more markedly affected interferon production than did either mineral alone.

Deactivation of Waste Chemicals

In a program conducted by the International Agency for Research on Cancer to destroy carcinogens in laboratory wastes, NIOSH is collaborating on studies of polycyclic aromatic hydrocarbons and hydrazines. The Institute is developing methods other than conventional incineration and biologic degradation to dispose of these substances.

4. Amputations, Fractures, Eye Loss, Lacerations, and Traumatic Deaths

Annually, about one of every ten workers employed in the private sector sustains an occupational injury. In 1982, work-related accidents in the United States were responsible for 11,200 deaths, and about 1.9 million workers experienced disabling injuries. Injuries in the workplace in 1982 cost the United States 31.4 billion dollars, or 1.1 percent of the gross national product.

Effects of Hot and Cold Environments on Safe Behavior

Frostbite, heat stroke, heat exhaustion, and heat cramps are the frequent results of temperature extremes in the work environment. The following research broadens the traditional perspective of thermal stress by measuring safety-related behavior under these extremes.

The Institute monitored workers' behavior at two manufacturing plants over a 14-month period under different thermal conditions. Safe behavior was optimal when workers were exposed to conditions in the thermally comfortable range. NIOSH also assessed data from the Bureau of Labor Statistics' Supplementary Data System on the claims experience of 30 states in 1979. Workers' compensation records showed that claims attributed to hot environments were highest in agriculture, construction, and mining industries, with firemen and laborers filing the most claims. Claims attributed to cold environments were highest in mining, construction, agriculture, and transportation industries, with laborers, truck drivers, firemen, policemen, materials handlers, and garbage collectors filing most frequently.

Cataracts

An analysis of data was completed to determine occupational factors associated with the induction of cataracts. A review of scientific literature and an examination of several data bases indicated that ultraviolet radiation may be the single most important cause of increased cataract risk. Since persons who work outdoors may be at increased risk of developing cataracts, further research is addressing the use of protective eye coverings.

Machine Safety

A pilot study was completed on amputations caused by power presses; the study used simulated after-reach conditions to begin developing recommendations on the safe distance for locating two-hand controls. Further research is based on results from the pilot study showing that a significant difference in hand-reach speed exists between two different locations of the two-hand actuators. This research will use actual power-press operators to address the problem of amputations that can occur on industrial machines equipped with two-hand-control palm buttons.

A study of self-tripping press systems evaluated the safety factor of using photoelectronic light curtains to safeguard the press operator and to initiate closure of the press. Results indicated that, under controlled conditions, a press operator can efficiently use the self-tripping mode with no more stress than that experienced using two-hand, palm-button safeguards. This information was submitted to OSHA and voluntary standards committees.

Based on additional research in machine safety, NIOSH recommended computer-related hazard controls for the safe operation of robots and ergonomic-design considerations to protect lathe operators from injury.

Construction of Concrete Structures

A study in the construction industry developed a computerized model to determine the safe loading for concrete structures. NIOSH developing improved test methods to determine the *in situ* strength of concrete and thus prevent structural collapses from insufficient concrete strength.

5. Cardiovascular Diseases

Cardiovascular disease continues as the number one cause of death among U.S. adults. Various substances in the workplace (e.g., carbon disulfide and carbon monoxide) are known to be specifically toxic to the heart and its allied blood vessels, and occupational stress has shown a definite association with cardiovascular disease. Although data are lacking on the extent of an occupational etiology or the role of occupational factors in cardiovascular disease, the magnitude of the problem emphasizes the critical need for research in this area.

Workers Exposed to Nitroglycerine

Exposure to nitroglycerin (NG) in the explosives and munitions industries has been associated with acute cardiovascular mortality. To investigate a recent report of increased risk persisting for extended periods after cessation of exposure, the Institute conducted a cohort study of 5,668 white males exposed to NG. Although fewer deaths than expected were observed for all cardiovascular diseases combined, deaths from ischemic heart were significantly greater than expected. The excess was particularly noticeable in the 40-49-year age group and for employees with ten or more years exposure. With the company's policy of medical screening before hiring and an annual examination thereafter to exclude persons with cardiovascular abnormalities from NG exposure, a marked deficit of cardiovascular mortality would have been expected.

Cardiotoxicology

Rats were exposed by inhalation to subchronic levels of the cardiotoxins, allylamine (a chemical intermediate and solvent used in making polymers and rubbers) and (mono)ethylamine (encountered in the foundry industry). Neither gross pathologic changes in the heart nor effects on the EKG were noted as a result of exposure to ethylamine; both effects were seen in rats exposed to allylamine.

In a separate study, EKG chest leads were used to develop a method of detecting cardiac damage in rats treated with isoproterenol and norepinephrine. These chemicals, found in certain drugs, were used in developing this electrical method because of their known, predictable cardiotoxic effects. The study demonstrated the efficacy of this method for detecting cardiotoxins.

6. Disorders of Reproduction

Although the portion of reported reproductive effects related to occupational exposure cannot be determined at this time, many substances found in the workplace are known to be toxic to the reproductive system. An estimated 3,000,000 married couples have some type of reproductive impairment unrelated to contraceptives, and more than 560,000 infant deaths, spontaneous abortions, and stillbirths occur each year in this country. The March of Dimes estimates that seven percent of all live births annually (200,000 infants) involve some kind of defect, whether benign or totally disabling. Although causes for 65-70 percent of these developmental defects are unknown, a significant percentage may be occupationally related.

National Natality/Fetal Mortality Survey

NIOSH completed a preliminary analysis of data from the 1980 National Natality/Fetal Mortality Survey, which covered a representative sample of births and fetal deaths throughout the United States. A descriptive analysis of the employment characteristics of married mothers of live-born infants was completed, examining maternal labor-force participation, full-time employment, blue-collar employment, occupation, industry, and potential workplace exposures to teratogens during the 12 months before delivery. These and other results of the survey are being used as baseline data for monitoring national trends in parental employment and reproductive outcomes.

Ethylene Dibromide

Ethylene dibromide (EDB), which has been shown to be mutagenic, carcinogenic, and spermatotoxic in animal studies, may also affect the human reproductive system. An estimated 108,000 American workers are potentially exposed to EDB in manufacturing, formulation, and agriculture. A new study of workers who use EDB to fumigate papaya is underway to determine any cytogenetic effects of the chemical or the influence it may have on the reproductive system.

Reproductive Effects of Paternal Exposure to Carbon Disulfide

A possible relationship was studied between exposures of male workers to carbon disulfide and the pregnancy experience of their wives. Using 540 workers (236 exposed and 304 unexposed), patterns of fetal loss, births, and the time between live births were examined. Although fewer births occurred per person-years for the exposed population, these deficits were not significantly different from those in the unexposed population. Differences in intervals between live births for exposed and unexposed groups were minor. The combination of these analyses does not suggest an effect of carbon disulfide on pregnancy outcomes at the levels of exposure in this study.

Adverse Reproductive Outcomes among Women Pharmaceutical Workers

Following a report of increased frequency of perinatal deaths among infants born to women working in a research laboratory, the Institute conducted a telephone survey of 191 female laboratory workers and former workers. The control group consisted of 318 women employed in the administrative areas of the same company. A panel of physicians classified responses to the survey into categories. Although miscarriages and stillbirths did not differ significantly between groups, congenital malformations and such malformations combined with perinatal illnesses were significantly more common among children born to laboratory workers. When stratified by age, parity, or race, the association with work area persisted but was not statistically significant. The only common exposure in the laboratory was organic solvents. This study is consistent with other studies showing increased reproductive risk among laboratory workers but should be viewed with caution since the study population in this report was essentially self-selected.

Organic Oxides

Ethylene oxide (EtO), already mentioned as a possible carcinogen, also produces adverse reproductive effects. Studies using monkeys to determine the toxicity of EtO and propylene oxide (PO) showed toxic effects of EtO on sperm and also increases in chromosomal aberrations and sister chromatid exchanges. Exposure to certain levels of PO resulted in decreased sperm count and motility. About 270,000 workers are potentially exposed to PO, which is used as a fumigant for food stuffs.

Glycol Ethers

An Institute study of the conventional teratogenic effects of four glycol ethers in laboratory animals showed that shorter alkyl chains produced greater embryotoxicity than did longer chains. 2-Methoxyethanol produced behavioral and neurochemical deficits in offspring after exposure of either parent.

The Institute sponsored an international symposium on the reproductive toxicity of glycols and glycol ethers. Reports of laboratory studies indicated that these widely used chemicals cause adverse reproductive effects, including resorption of litters, reduced litter size, stillbirths, development dysfunction in offspring, and male infertility.

Biotransformation of 2-Ethoxyethanol

Male rats were given radioisotope-labeled doses of the known reproductive toxin, 2-ethoxyethanol (2-EE), by gavage. Two major metabolites, ethoxyacetic acid and N-ethoxyacetyl glycine, appeared in the urine. Since ethoxyacetic acid was found in the testes, this may explain the induction of male infertility in rats given 2-EE.

Sperm Analysis

Videographic methods for evaluating the morphologic and morphometric properties of sperm were validated in FY 1983. These methods represent an advance in evaluating the effects of chemicals on sperm. The methods were used in an Institute field study of forestry workers who were exposed to ethylene dibromide, which was being used as a fumigant.

Screening of Teratogens

A Drosophila method was tested for its efficacy in screening chemicals for teratogenesis. All 17 known teratogens tested were positive in the Drosophila screen. These results point to the use of this screening method in setting priorities for screening chemical teratogens. Further evaluations of the method are planned.

Another method for screening reproductive hazards used a modified postnatal mouse test. Thirty compounds, 15 of which were glycols or glycol ethers, were tested with this method in FY 1983. The results are being compiled to show structure/activity relationships of the compounds.

7. Neurotoxic Disorders

Although major episodes of neurotoxicity related to occupational exposures have dramatized the dangers of neurotoxic effects, diverse, minor occurrences throughout industry involve significantly larger numbers of workers. These effects, ranging from mild to severe, include motor changes (inability to walk, tremors, or loss of fine coordination), sensory changes (loss or reduction in vision, hearing, or touch), and cognitive changes (judgmental lapses, personality changes, or loss of alertness). Such effects are particularly serious because of the irreversibility of most damage to the central nervous system and the inability of the nervous system to replace lost functions.

Spray Painting

Laboratory and field studies were conducted to determine the neurotoxic effects of spray-paint constituents. Elements of human performance were tested for effects of exposure to toluene or methyl ethyl ketone (inhalation) or alcohol (ingestion). No effects on memory, cognitive processes, or coordination were found for either toluene or methyl ethyl ketone. In a separate field study of spray painters, no adverse neurologic effects were found for exposures to acetone, methyl ethyl ketone, various alcohols, or toluene in amounts below the standards set for these substances.

Preventing Occupational Neurotoxic Illness

At a workshop held in conjunction with the World Health Organization (WHO), an international consensus was achieved on recommendations for diagnosing, measuring, treating, and preventing neurotoxic illness. A monograph resulting from this workshop will be published by WHO in 1984.

8. Noise-Induced Loss of Hearing

Noise-induced deafness is one of the top occupational health problems worldwide. Census Bureau figures estimate that 14.9 million workers are in industries associated with noise-producing processes. Previous NIOSH research has shown that many workers are receiving less than half the attenuation reportedly provided by their hearing protectors. Noise-induced hearing loss, which isolates workers from their daily contacts, is usually irreversible and cannot ultimately be corrected with hearing aids. The cost of compensation for this disability in the decade of the late 1970's and early 1980's may reach one billion dollars.

Loss of Hearing Among Firemen

Based on a finding of hearing loss among firemen at a small fire department, a follow-up study is now underway at a larger department. The noise levels of sirens and fire engines are being measured at various riding positions on the vehicles, and the length of service of each of the firemen is being tabulated and compared with hearing loss.

Noise Exposures for Airline Maintenance Workers

A preliminary evaluation found high noise exposures for airline maintenance workers at an airport. Further studies will determine the effect of these exposures on the workers' hearing.

Impulse Noise

Surveys of impulse noise, completed in 14 plants during FY 1983, verified the inadequacy of available instrumentation to accurately measure impulse-noise levels. Preliminary estimates indicated that commercial sound-level meters underestimate impulse noise levels by 30 percent-50 percent. Based on these data, NIOSH recommended modifications to the standard noise dosimeter of the American National Standards Institute.

9. Dermatologic Conditions

Skin conditions, including dermatoses, scaldings, chemical burns, and contusions, are common occupational disorders accounting for more than 40 percent of all reported job-related illnesses. Causes of occupational skin

disorders can be chemical, mechanical, or physical, and include plant poisons, biologic agents, or combinations of these; the most frequent cause is chemicals. As many as 25 percent of the job-related skins disorders may result in lost work days. Estimated annual costs of occupationally related skin disorders range from 20-30 million to over 100 million dollars.

Severe Dermatitis from EDB Contact

Forestry workers developed severe dermatitis after removing plastic sheets from pine logs that had been treated with ethylene dibromide (EDB) to kill pine beetles. Workers were warned to wear protective clothing and eye protection, and the public was alerted to the hazards of handling the wood and plastic covers.

Dermatitis Studies in Various Occupations

Several evaluations of occupational skin disease were conducted following exposure to: phenolic cleansing agents at a hospital, formaldehyde during the manufacture of uniforms, pesticides during the cultivation of mushrooms, an amine compound added to the humidification system at a university museum, and outdoor maintenance tasks at a dam.

Dermal Absorption

Preliminary results of dermal-absorption studies recently completed with laboratory animals indicated that benzene is absorbed at a rate comparable to that measured for human skin. Knowledge of the skin-absorption properties of occupational chemicals will aid in establishing more protective chemical-exposure limits and in preventing dermatitis that results from absorption of chemicals through the skin.

10. Psychologic Disorders

Increasing evidence has linked job stress and psychologic impairment. Stress in the workplace may be produced by undue job demands and/or adverse working conditions and may result in emotional/behavioral disturbances, mental illness, increased cardiovascular disease, digestive disorders, and increased incidence of injury. Annual productivity losses from stress-related mental illness are estimated at 17 billion dollars, and projected changes in the workplace and the work force may increase this figure in the future.

Stress Reduction

A study on teaching stress-reduction methods to highway-maintenance workers involved the use of video cassette tapes to demonstrate biofeedback and progressive muscle relaxation. This completes the last of three worksite-intervention studies designed to demonstrate the feasibility and effectiveness of worker training in stress management. As in the previous trials involving nurses and retail sales clerks, the training was effective in reducing the arousal level and feelings of anxiety among workers. These and other results will form the basis of recommendations for establishing stress-reduction programs at the worksite.

C. Program Strategies

To accomplish its mission of protecting the health and safety of American workers through research and implemented research results, the Institute follows a program of four applied strategies to prevent illness and control hazards in the workplace. It seeks 1) to identify work-related diseases and injuries by detecting and defining significant changes and trends, 2) to evaluate work-related diseases and injuries so that causes can be understood and hazards prevented, 3) to control work-related diseases and injuries by developing, assessing, and improving measures to reduce hazards, and 4) to disseminate scientific findings and appropriate recommendations to all organizations and individuals with a need to know, including training and developing field personnel. Studies in this section apply to more than one condition on the list of Ten Leading Work-Related Diseases and Injuries; the strategies involve techniques that may be applied to a wide variety of these conditions.

1. Identification

To identify problems, NIOSH gathers facts from national, State, and local safety and health data bases and from reports of workers and employers. Based on these data, injury and disease trends are monitored, scientific hypotheses are generated, priorities for research and public health action are set, and progress is measured. The goal of an injury and disease surveillance program is to provide an early warning system for workplace hazards and health effects. Perhaps the greatest need in occupational safety and health today is for comprehensive systems of surveillance for occupational diseases and injuries; the many systems that are currently operating provide overlapping and often noncomparable fragments of the epidemiologic situation. Efforts are now underway to develop a national reporting system for some respiratory diseases (e.g., asbestosis, silicosis, and coal workers' pneumoconiosis). As a first step, the process was initiated, in collaboration with the Conference of State and Territorial Epidemiologists, to make silicosis the first reportable, noninfectious occupational disease.

National Occupational Hazard/Exposure Survey (NOHS, NOES)

The National Occupational Exposure Survey (NOES, underway since 1980) and the National Occupational Hazard Survey (NOHS), which preceded it (1972-1974), constitute the center of the hazard surveillance research program. For example, each year the NOHS data base is used to answer many requests for information, and clarification of the ingredients in trade-name products permits the identification of chemical hazards in working environments. A sampling strategy was implemented for NOES; facilities to be included in the survey were selected; surveyors were recruited, trained, and deployed to the survey areas; and data-editing software was developed. By the end of FY 1983, the survey was completed and had included 4,490 facilities employing 1,900,000 workers.

National Occupational Health Survey of Mining (NOHSM)

This survey, mandated by law, will identify potential exposures to at least five of the Ten Leading Work-Related Diseases and Injuries. Over a six-year period, NOHSM will survey about 900 mining and milling operations that are representative of the entire industry. By identifying potential occupational exposures, the number of miners involved, and the conditions of exposure, NIOSH can order the priority of research efforts and respond to inquiries from scientific investigators, MSHA, individual workers, and mining companies. In FY 1983, the first surveyors for NOHSM were recruited and began their orientation and training. The survey questionnaire and protocol were submitted for review and are now in final form. The first survey is scheduled for February 1984.

Priorities and Research Analysis

By integrating the existing current-awareness system for chemical and physical agents with surveillance programs for injuries and illnesses, the Institute initiated a new method of selecting priority issues. This method will identify subjects warranting documentation of hazards and issuance of guidelines or recommendations and will help set priorities for research programs. In FY 1983, the Institute refined the design of the priority system, initiated its operation, and, using information in the system, made recommendations for research and document development in FY 1984.

Health Hazard Evaluations

In response to requests from workers, employers, or their representatives, or Federal, State, and local agencies, NIOSH conducts Health Hazard Evaluations (HHE). These may involve investigation of suspected problems or evaluation of hazardous chemical, biologic, or physical agents used or found in the workplace. The investigators then recommend control procedures, improved work practices, and/or medical screening to reduce exposure levels and subsequent health effects. In FY 1983, NIOSH received 494 requests for HHE's (465 general industry and 29 mining), a 17 percent increase over FY 1982 (Table 2).

Table 2. Comparison of HHE Requests, FY 1982 and FY 1983, by Type of Requestor

Requestor	FY 1982	FY 1983
Employer	80	101
Employee/Union	195	167
Federal agency	52	83
OSHA	7	3
MSHA	23	29
CDC	2	22*
State/local govts.	57	78**
Other	7	11
Total	423	494

* Includes cooperation with Superfund through the Center for Environmental Health

** Includes 35 requests from State and local health departments

In FY 1983, HHE's identified health problems of varying severity related to such hazards as microbiologic aspects of indoor air, toluene diisocyanate in automotive plants, heat stress conditions in heavy-equipment operations, asbestos hazards in public buildings, reported excess of lung cancer among workers in an automobile manufacturing plant, reproductive effects among refinery workers, silicosis in foundry workers, changes in pulmonary function in petroleum coke workers, hazards from PCB transformer fires, roofers exposed to polynuclear aromatic hydrocarbons, plumbers exposed to solvents, road construction workers using asphalt mixed with sulfur, cotton-gin workers exposed to pesticides, museum workers exposed to DDT, formaldehyde exposures of hospital laboratory workers, dermatitis among building cleaners using phenolic cleaners, exposures at several hazardous waste facilities, dioxin contamination at industrial sites, fire fighters exposed to hazardous waste spills or fires, persistent liver-function abnormalities among workers at a chemical plant, exposures to respirable particulates among workers at a facility using refuse-derived fuel, and solvent exposure at a shoe manufacturing facility.

Industrywide Studies

Industrywide studies evaluated the health effects of many agents in various industries and occupations. In FY 1983, the Institute participated in planned studies and initiated feasibility assessments for suspected hazards in such areas as paints, plastics, chemicals, newsprint, dyes, mining, automobile manufacture, commercial diving, VDT's, fumigation, precast concrete, sand, bus driving, office stress, land-based oil and gas wells, construction, petroleum, grain elevators and feed mills, and fertilizers.

National Coal Study

The National Coal Study began in 1969 with surveys at 31 nationally distributed mines; 9,080 coal miners received chest X-rays and ventilatory function tests and were interviewed about chest symptoms, work and smoking history, and other activities. Three rounds of surveys have now been held, with follow-up at about nine-year intervals. Examination of X-ray changes over the nine years indicate that the current standard for coal-dust exposure (2 mg/M^3) appears adequate to protect the miners. Nine-year changes in ventilatory function (forced expiratory volume in one second [FEV_1]) show that both smoking and dust exposure were associated with longitudinal changes in FEV_1 over that period. Improvements in the study, designed to overcome criticisms to this point, will include: observing longer periods of follow-up, surveying former as well as current miners, and encouraging better participation than occurred in the third round.

National Coal Workers Autopsy Study and Disaster Plan

In FY 1983, data were analyzed from the National Coal Workers Autopsy Study, which monitored autopsies from 1972 through 1980. The analysis will assist the Department of Labor in awarding black lung claims and will permit research into the epidemiology and pathogenesis of coal workers' pneumoconiosis (CWP). Because of the latency period for the disease, the high prevalence of CWP (64 percent) found in this study is reflective of exposures received in earlier years when dust levels in mines were much higher, i.e. before the introduction in 1972 of the current respirable coal-dust standard of 2 mg/M^3. Mortality and morbidity from CWP will likely decrease in future decades, and this autopsy program will be valuable in monitoring these changes.

Environmental Mining Surveillance

For several years, NIOSH has conducted environmental surveillance activities in the mining industry. The ongoing effort is designed to collect, store, and evaluate mine environmental data for research. In FY 1983, this survey provided data to the Mine Safety and Health Administration (MSHA) on hearing loss among miners and respiratory exposures among crushed-stone, cement, kaolin, uranium, silica-flour, and coal workers. It also examined worker exposures in the diatomite, taconite, and coal-preparation industries, and mining exposures to water-gel explosives, xanthates, and by-products of selected blasting agents. Environmental research data from the Institute and other sources are being compiled for incorporation into a computer data base, Mine Environmental Data Analysis Library (MEDAL).

Surveillance Cooperative Agreements Between NIOSH and States (SCANS)

The Institute seeks to develop the capabilities of State health agencies in reporting occupational safety and health problems, with the goal of achieving the same competence that is now available in the states for monitoring other diseases. The Surveillance Cooperative Agreement between NIOSH and States (SCANS) was set up to stimulate this capability. A two-year pilot demonstration program, involving Maine, New York, Rhode Island, and Utah, is complete, and final reports submitted by the states are being analyzed. A second round of agreements is being implemented, and five states have been selected, Maine, New York, North Carolina, Pennsylvania, and Rhode Island. They are undertaking activities in the areas of safety and respiratory disease.

Computer-Generated Maps

Computer-generated maps give a visual representation of the geographic distribution and patterns of occupational exposures and health problems; they permit researchers to develop hypotheses, establish baseline measures, and monitor disease changes. The maps are generated on a continuing basis in a cooperative exchange of information through State representatives and SCANS. They are a means of coordinating activities with other government and private organizations to plan strategies for combating occupational health problems.

Industry and Occupation Coding for Vital Statistics

Courses were held in FY 1983 to train vital statistics personnel from 29 states in the coding of industry and occupation on vital records. In addition, the Institute funded the preparation and publication of "Guidelines for Reporting Occupation and Industry on Death Certificates." This will help funeral directors obtain information to complete the occupation and industry items on death certificates.

Sentinel Health Events (Occupational)

A Sentinel Health Event (SHE) is a preventable disease, disability, or untimely death, which, when it occurs, is a warning signal that the quality of preventive and/or therapeutic medical care may need to be improved. A SHE(Occupational) is an occupationally related condition that serves the same purpose. The present SHE(O) list (5) includes 50 disease conditions linked to the workplace. This list will constitute a framework for developing a national system of occupational health surveillance that can be applied at the State and local level and used as a guide for practicing physicians caring for patients with occupational illnesses. The list will be updated periodically to accommodate new occupational disease events that meet the criteria for inclusion.

National Electronic Injury Surveillance System (NEISS)

In conjunction with the Consumer Product Safety Commission, the Institute completed its second full year of monitoring daily reports of all occupational injuries treated at 66 hospital emergency rooms. The selected hospitals are statistically representative of all U.S. hospital emergency rooms. This system provides information on the types and estimated numbers of occupational injuries treated in U.S. hospital emergency rooms, including treatment date, age and sex of patient, type of accident, cause of accident, and disposition of case. Two analyses of data based on these case reports were completed. Weekly surveillance reports of NEISS cases, by diagnosis and accident types, are sent to all Institute Divisions to help them monitor trends and measure improvement.

Fatal Accident Circumstances and Epidemiology (FACE)

This pilot study is designed to collect epidemiologic data from a sample of fatal incidents. Analyses of these data will allow the identification and ranking of factors and exposures that increase the risk of total injury for selected employees. Based on this risk assessment, corrective actions can be initiated to prevent or lessen the occurrence of these incidents. Rather than seeking to control individual situations, this strategy aims to eliminate recurring factors or exposures. To date, ten fatal accidents in West Virginia and Pennsylvania were studied in collaboration with the State medical examiners.

2. Evaluation

Evaluation is the core of the Institute's scientific research. The hypotheses formed after identification are tested through epidemiology, toxicology, and kinesiology. As cause-and-effect relationships are identified, intervention strategies can be implemented to prevent the problems. The majority of the Institute's work in this area has been described earlier under the Top Ten.

Evaluation may include such widely diverse topics as on-site inspections of suspected problems, sampling for toxic substances, improvement of sampling techniques, analyzing samples, developing and improving analytical methods for detecting or measuring contaminants, statistical analysis of data on the incidence of disorders, and laboratory studies to determine toxic effects in experimental animals. Biologic monitoring, (e.g., examining the effects of low levels of toxic agents on chromosomes) will provide information on the effects of exposures that cannot be studied using traditional epidemiologic methods. Such biologic monitoring is expected to become an important new tool.

Potential Hazards in Rhode Island Jewelry Industry

A survey was conducted of health problems in the costume jewelry industry in Rhode Island to provide a preliminary evaluation of the prevalence and severity of occupationally related diseases in this industry. The Rhode Island jewelry industry consists of many small shops with transient workers. Investigations of 15 facilities ranged from brief walk-through inspections to detailed studies involving environmental and biologic monitoring. The processes of casting, soldering, and electroplating received the most attention. No patterns of acute or chronic illnesses were found except for dermatitis in electroplaters, probably caused by nickel dust; some excessive

exposures to silica, lead, and cadmium were also found. This study indicated that exposures in this industry involve only well-recognized hazards and can be reduced by education programs, engineering controls, and the occasional use of personal protective equipment.

Studies in Emerging Energy Technologies

Occupational health studies for emerging energy technologies are designed to prevent occupational illness in synfuel and other new energy industries. This will be accomplished by identifying potential hazards and health problems in pilot plants and pioneer commercial plants for oil shale, coal gasification, fluidized bed combustion, and urban waste utilization. FY 1983 accomplishments include:

Peer review of two reports, one providing most of the information available today on worker exposures in modern synfuel plants and the other involving resource-recovery processes (waste preparation and combustion);

Field industrial hygiene characterizations of a modified, *in situ* shale oil retorting facility and a U.S. Department of Energy coal gasifier;

Initiation of an Institute-supported study by the Scottish Institute of Occupational Medicine to determine if surviving Scottish, oil-shale workers show abnormal levels of respiratory or dermal disease; more than 1,000 persons were X-rayed in 1983 to detect respiratory disease; and

Explorations for the design and operation of registries for oil shale and synfuel workers, which will help identify any work-related diseases that may become manifest.

Commercial Diving

A five-year study identified several hazards associated with commercial diving. 1) Although mortality from deep-sea diving is decreasing, harbor and inland diving is associated with increased mortality. 2) Laboratory animals were used to demonstrate that the pharmacokinetic properties of prescription drugs are modified by hyperbaric pressure. The drugs' pharmacologic properties were unchanged, but hyperbaric pressure delayed their time course. 3) Research identified the need to modify the current OSHA decompression schedules for caisson/tunnel workers; NIOSH recommendations have been submitted to OSHA.

Laboratory Studies in Mutagenicity

Mycotoxins, which are known to occur in various organic dusts including respirable airborne corn and peanut dust particulates, produced acute toxicity following intratracheal instillation in rats. *In vitro* studies showed these substances to be toxic to rat alveolar macrophages. The most recent work with the mycotoxin, patulin, demonstrated potent inhibition of protein and RNA synthesis in rat alveolar macrophages.

A study is in progress to evaluate and/or develop suitable assay systems to detect the potential genetic, carcinogenic, and reproductive hazards of chemicals and complex mixtures present in the workplace. The mutagenic sensitivity of the Salmonella/arabinose-resistant assay system was evaluated with 26 compounds. A urine mutagenesis assay was evaluated and improved for use in determining whether workers have been exposed to genotoxic agents.

Genotoxicity studies with mice and/or rats were conducted to evaluate the potential mutagenic hazard associated with exposures of coal miners to diesel emission particulates (DEP) and/or coal dusts (CD). The results indicated that solvent extracts of DEP are mutagenic, but no mutagenic activity was found for the CD extracts.

Attempts are underway to establish a sensitive and reliable on-site test system for mutagenicity that can be used to routinely monitor airborne mutagens in occupational settings. New strains of bacteria applicable to field conditions were developed, and a fritted air impinger was selected as the sampling instrument because it generates small bubbles that can increase the trapping efficiency for chemicals. Following refinement in the laboratory, the system will be validated under field conditions.

Field Sampling and Monitoring Techniques

Because sampling and monitoring must be done under many different workplace conditions, new and improved techniques for these operations continue to be developed.

Diffusive samplers, small badge-like devises worn by workers to sample a wide variety of gases and vapors, are more convenient than conventional samplers and are rapidly increasing in use. This year NIOSH proposed protocols for testing these samplers in the field and laboratory to help assure uniform and well-characterized samplers. Samplers of different geometry, sorbent configuration, sorbency and sorbent response were examined. Detailed information was obtained on how sampler performance is influenced in environments with varying concentrations of hazardous materials.

Three portable gas chromatographs were tested for their value in providing immediate feedback and detailed information on a variety of organic exposures.

Ozone, formed by UV radiation (welding) or electrical discharge (machinery), is also a major photochemical air pollutant. To provide a better personal ozone sampler, iodometric methods are being modified to make use of new liquid media samplers; spill-proof impingers and passive and active samplers are being developed to use specific ozonolysis reactions.

Reduced oxygen levels in confined spaces is a threat to worker health. The performance of 20 portable, direct-reading oxygen-deficiency monitors was completed, and a report is being prepared.

To help eliminate new cases of four preventable occupational diseases--asbestosis, byssinosis, silicosis, and coal worker's pneumoconiosis--the GCA MiniRAM personal dust-exposure monitor was evaluated, using different concentrations and size distributions of coal dust. The accuracy of the monitor was shown to be dependent on the median diameter of the dust.

The working range of the TSI Aerodynamic Particle Sizer is being extended. It has been used in such diverse studies as characterizing the respirable fraction of coal dust and evaluating the size of water droplets to determine whether mists at health spas can support bacteria.

Measurements Research Support

Chemical analysis of samples obtained by field workers provides laboratory support for all Institute programs and allows implementation of control measures to reduce the exposure of workers. The Institute regularly develops new analytical methods to detect, identify, and measure substances that workers may encounter. Quality assurance and quality control were expanded in FY 1983; a consultant was retained to improve operating and quality-assurance procedures; an interlaboratory exchange of samples was successfully completed for control-technology assessment. Many thousands of samples were analyzed--some requiring as many as seventeen separate steps--in support of research in such diverse areas as safety, mining, energy, respiratory disease, inhalation toxicology, and including the building of glass-fiber-reinforced plastic boats, the manufacture of oral contraceptives, and the handling of solid materials. New analytical methods were developed and existing methods were modified to meet the needs of bench research and field problems; regular meetings were held to communicate these new and improved methods to research staff.

Multi-element Analysis

The Institute is developing new methods for multi-element analysis of biologic materials. A method, using inductively coupled plasma-atomic emission spectroscopy to analyze trace elements in urine, permits 17 elements to be quantitatively determined simultaneously from a single urine sample. This will allow investigators to determine which of several elements a worker has been exposed to.

Analytical Methods Development

A new method for measuring concentrations of polynuclear aromatic hydrocarbons (PNA)--many of which are carcinogenic--was tested in a study of the biologic effects of coal dust and diesel exhausts. This method uses high-pressure, liquid chromatography to separate the components in acetonitrile extracts of respirable dust samples; the PNA's are then detected by fluorescence.

Revision of NIOSH Manual of Analytical Methods

The NIOSH Manual of Analytical Methods contains more than 520 methods that NIOSH has developed in the past ten years, including methods for agents that cause occupational lung diseases (e.g., silicosis, asbestosis), cancers, neurotoxic illnesses, and dermatologic problems. The Manual, used by over 6,000 industrial, governmental, and academic laboratories in the United States and worldwide, has been under revision in FY 1983 to 1) eliminate outmoded or unused methods; 2) combine similar methods for the same analyte; 3) include additional data; 4) add sections on applicability, evaluation of method, and quality control; 5) create revised multi-analyte methods for analytes that use the same sampling and analytical procedures; 6) provide a concise method format; and 7) introduce a numbered index system and a cross-reference to earlier editions.

Laboratory Quality Assurance

Proficiency testing is essential in assuring the quality of health evaluations, setting standards, determining compliance, and evaluating controls. In FY 1983, the Proficiency Analytical Testing (PAT) program grew from 384 to 416 participating laboratories--due largely to increased activity in evaluating and removing asbestos from public buildings. More complex organic mixtures were incorporated into the program, and the PAT dust-generation system was modified.

Because of the large variations in results that different laboratories show when analyzing for respirable silica, the Institute asked the National Bureau of Standards (NBS) to develop a Standard Reference Material for respirable silica calibration. It will be commercially available from NBS in 1984.

3. Control

Control of occupational safety and health problems is another key to the Institute's prevention program. Control measures fall under the broad categories of engineering controls, personal protective devices, and altered work practices, and include environmental and medical monitoring to detect failures in control systems. Through engineering, ergonomics, and industrial hygiene and safety, the Institute's investigators recommend systems to control occupational hazards.

a. Engineering

Engineering Control Data Base

Considerable information has been developed on engineering controls in various industries. Unfortunately, much of this information is not publicly available or is poorly organized and difficult to locate. The Institute is now cataloging existing NIOSH control-technology work, by industrial operation or process, and is summarizing this information for each process into a single reference. Coordination with other government agencies, Federal and State, will create a pool of control-technology information for a comprehensive data base that can be made available to design engineers and to the occupational health community.

Control Technology Assessment for Formaldehyde Manufacturing

In-depth surveys showed that plants that produce formaldehyde are generally within the current OSHA standard: an 8-hour TWA of 3 ppm. A report details the controls used by these plants to reduce exposures to formaldehyde during quality-control sampling, tank-car loading, and various maintenance operations.

Semiconductor Manufacturing

In 1977, approximately 114,000 persons were employed in manufacturing semiconductors, and the industry has grown considerably in recent years. These workers are potentially exposed to such toxic substances as arsine, phosphine, silane, boron trifluoride, carbon tetrafluoride, phosphorus oxychloride, and hydrofluoric acid as well as radio-frequency (RF) radiation and X-radiation. Walk-through surveys were conducted at 21 plants to locate effective control technology, and in-depth surveys were conducted at four plants to gather detailed information about these controls. The surveys identified a previously unrecognized exposure to arsenic during the offgassing of silicon wafers that have been implanted with arsenic in production. This can now be controlled as a result of the findings and recommendations of this research.

Manufacture of Oral Contraceptives

Oral contraceptives are manufactured in batch pharmaceutical processes that require frequent operator/equipment interaction. The potential for occupational exposure to dusts containing the potent active ingredients is considerable. As a result of in-depth sampling surveys conducted at two

plants and information on control practices obtained from other companies, a preferred control strategy was proposed that combines maximum containment, careful isolation of the hazardous operations, well-designed local ventilation, and the use of supplied-air suits as an additional safeguard.

Styrene Vapors in Fiber Reinforced Plastic

Exposure to styrene, a major component in the fiberglass, reinforced plastic (FRP) industry, can cause dermatologic problems and neurotoxic illness. It is estimated that 6,800 workers are exposed in the boatbuilding industry and up to 25,000 in the entire FRP industry. Control information, gathered during plant surveys, included altered work practices, local exhaust, and push-pull ventilation to protect workers exposed during the spray-on and roll-out of ~~these polyester/styrene resins.~~

Industrial Use of Adhesives

Although adhesive bonding has many advantages over other joining methods, some adhesives involve agents that are potentially harmful to workers. The control of formaldehyde emissions was tested during hot-press veneering. Formaldehyde has been implicated as the cause of dermatologic problems and nasal cancer. Application of design and work-practice features developed in this study will appreciably reduce occupational exposures to formaldehyde vapor.

Petroleum-Refining Operations

Although most petroleum-refining processes operate under pressure or vacuum in closed processing systems, some employee exposures may occur during process leaks, equipment failures, sample collection and analysis, product loading, waste treatment, and equipment maintenance. Such exposures were examined and measured in FY 1983. The engineering controls and changes in work practices recommended as a result of this study are useful not only in petroleum refineries, but are readily adaptable to chemical processing and other industries where potential exposure to toxic materials exists.

Fermentation Processes

Fermentation is currently used to manufacture a variety of products, including antibiotics, organic acids, enzymes, ethanol, and vitamins. In 1977, 29 U.S. companies (excluding alcoholic-beverage producers) used fermentation processes. This is expected to increase as new strains of organisms are developed with recombinant DNA technology; the number of workers involved may increase to over 200,000 in the next 20 years. The present study, which focused on the enzyme-production industry, conducted seven walk-through surveys to locate firms with good controls. Following in-depth surveys, information on these controls will be disseminated to the entire industry.

Disposal of Hazardous Wastes

Hazardous wastes, characterized by widely variable composition and form, require relatively labor-intensive operations for disposal, and thus possibilities exist for occupational exposure. A report was prepared describing the engineering and work-practice controls used by three large, technically advanced companies that have on-site incinerators. Many of the concepts, practices, and design features are transferable to other facilities. Research is continuing on possible risks to workers at hazardous waste clean-up sites and on developing industrial hygiene tools to identify these risks. NIOSH put together a multi-discipline task force to evaluate occupational safety and health problems in the hazardous waste program. More than 32 employee visits were made this year to identify and assess risks to

workers at uncontrolled hazardous waste sites; detailed industrial hygiene sampling was done at two sites. Six research studies were begun on personal protective equipment and the evaluation of industrial hygiene instrumentation for hazardous wastes. The Institute also reviewed EPA's safety plans for such hazardous waste sites and has made recommendations for improvement.

Heat Sealers

A guide was completed that describes engineering technology for controlling electromagnetic radiation produced by heat sealers. The guide presents details on guarding, shielding, and grounding heat sealers to reduce emissions of electromagnetic radiation.

Control of Workplace Emissions

Several studies demonstrated effective methods for reducing exposure to toxic fumes.

Wood-dust emissions from belt sanders (thought to be responsible for several illnesses, including nasal cancer) can be significantly reduced by proper design and the use of slot exhaust hoods and air jets that strip dust adhering to the belt.

Ten control techniques to reduce exposure to lead fumes in secondary smelting operations were examined, and the effectiveness of nine of these was demonstrated in a scrap reprocessing plant.

Metal fumes from welding and foundry operations can be reduced by local exhaust ventilation placed close to the point of process emission. Even more efficient is push-pull ventilation, which uses air-push jets in conjunction with exhaust ventilation. This latter technique may also lower heating/cooling costs by reducing the amount of air that must be exhausted.

Control Monitoring of Workplace Emissions

The effectiveness of emission controls must be constantly monitored to detect any control failures. Two such monitoring systems were tested this year. Light-scattering sensors were examined using three different instrument models in a coal-dust chamber, and the usefulness of tracer-gas techniques was demonstrated for measuring the efficiency of exhaust hoods.

b. Personal Protective Devices

Certification of Respirators

The Institute is responsible for testing and certifying, monitoring, and documenting data on respirators that are used to protect against toxic and irritating materials in the work atmosphere. This includes air-purifying respirators (e.g., dust, fume, and mist respirators, chemical-cartridge respirators, and gas masks) as well as atmosphere-supplied respirators (e.g., self-contained breathing apparatus). Respirators submitted by manufacturers are evaluated in the laboratory, and quality-control documentation for each device is reviewed. Approvals, extensions, or denials of certification were issued for 297 respirators in FY 1983; 80 percent of all approvals and major modification applications were completely evaluated within three months of receipt. A NIOSH Certified Equipment List is updated annually to provide current information on approved respirators. The Institute also purchases sample, off-the-shelf respirators for testing and evaluation. It investigates

reported problems with certified respirators, evaluates the problems, and, if necessary, issues warnings, notices, stop-sale requests, or recall requests to users. In FY 1983, 36 such problems were investigated, and seven warnings were issued.

Research on Respirator Use, Performance, and Testing

In addition to certifying respirators, the Institute conducts research on respirator use and the improvement of respiratory protective equipment.

To determine conditions under which respirators may be used safely, normal workers and workers with obstructive and restrictive lung disease were tested wearing protective masks during exercise. The results indicated that most workers, even with moderate lung disease, can safely wear most respirators to protect themselves from occupational hazards.

The protocol was written and is now undergoing review for a study on the fit of respirator facepieces. These data will help determine whether a relationship exists between quantitative fit factors and workplace protection factors. They will also be used in conjunction with other research to establish relationships between laboratory performance tests and field performance of respirators.

Laboratory studies are being conducted to validate the Institute's test methods for evaluating respirators. These studies include research on the adequacy of the present organic-vapor cartridge and canister tests and the effects of respirator filter resistance and efficiency on protection factors.

Chemical Protective Clothing

The Institute provides evaluation data and selection information on chemical protective clothing that is used to reduce or eliminate skin exposure to substances that contribute to dermatitis, heavy-metal poisoning, occupational cancer, or neurotoxic illness. A self-examination questionnaire was prepared to characterize industrial needs, and test methods are being developed and modified to measure penetration and/or permeation.

Compendium on Hearing Protectors

The 1975 compendium on commercial hearing protectors was updated. It contains information on the sound-attenuation properties of most commercially available personal hearing protectors and will be distributed in 1984.

4. Dissemination

Research results are of limited value unless they are actually applied to the protection of workers. Dissemination is designed to inform the public of identified problems and their solutions, recommend standards, and share information with other groups involved in improving workplace conditions. By transferring information to both public and private organizations, the prevention of identified problems can be promoted on a much broader front than would be possible through Institute action alone. Technology transfer is accomplished through producing and presenting education and manpower training programs; preparing criteria and standards; publishing booklets, manuals, and articles in the scientific literature; developing and maintaining data bases; participating in scientific meetings and conferences; funding research; and cooperating with other organizations that have mutual interests.

a. Documents and Standards

Documents

Criteria Documents, Current Intelligence Bulletins (CIB) (to quickly disseminate new information on recently recognized hazards), Technical Guidelines Documents, and other NIOSH policy documents provide information on the extent of occupational hazards, the human health effects, animal toxicology, and workplace exposures; they also recommend actions to help eliminate or reduce the hazards. These documents are sent to the Department of Labor to aid in setting standards and are made available to the occupational safety and health community. In FY 1983, recommendations were completed on styrene; industrial excavation and trenching; drilling of oil and gas wells; the unexpected and uncontrolled release of hazardous energy during maintenance and servicing tasks (lockout/tag-out); and prevention of fires, explosions, dust inhalation, and general safety hazards in grain elevators and feed mills. CIB's were prepared on vibration syndrome and glycol ethers. A recommended standard for exposure to radio-frequency/microwave radiation, in preparation for four years, was completed.

Response to OSHA and MSHA

The Institute not only makes recommendations through the formal transmission of criteria documents but prepares comments for OSHA and MSHA on proposed workplace standards. In FY 1983, Institute personnel participated in public hearings and/or prepared comments on the following subjects: asbestos; confined spaces; cotton dust; ethylene oxide; ethylene dibromide; field sanitation; methods of compliance; underground construction; revision of the MSHA underground-coal-mine, air contaminant standard; and revision of the MSHA metal/nonmetal, air-quality standards.

b. Training

NIOSH conducts technical training courses for various Federal, State, and local government agencies and for occupational safety and health practitioners in industry, management, and labor unions. Orientation courses are held for new NIOSH personnel and continuing education courses help existing staff members to maintain competence and further career development.

Examples of the courses presented in FY 1983 include customized training courses presented to the U.S. Coast Guard, the MSHA Training Academy, and the International Operations of the IBM Corporation in Paris, France; a beginning course for State health agency personnel presented in six states and an advanced course in industrial hygiene given in one of these; training programs presented to the American Federation of Government Employees, (AFL/CIO), the International Molders and Allied Workers Union, the Joint Labor/Management Health and Safety Committee of the Oil, Chemical, and Atomic Workers International Union; occupational safety and health training programs presented to vocational education teachers and supervisors in several areas and vocational train-the-trainer workshops that reached participants from 17 states. An estimated 13,700 occupational safety and health practitioners participated in continuing education programs conducted or supported by NIOSH. The approval system for training courses on Pulmonary Function Testing was maintained as required under the OSHA Cotton Dust Standard. In FY 1983, 10 new courses were approved, and 32 ongoing courses were reapproved.

c. Curriculum Development

Through assimilation and correlation of information produced in the Institute's research and standards-development programs, the curriculum development activity custom designs programs to meet the needs of various disciplines at varying levels of complexity.

Some examples of the curriculum development activities for FY 1983 include the following: An instructor's manual and student text were completed for State sanitarians and other State health department personnel. Materials were produced on preventing the harmful effects of RF radiation, hazardous vibration, and heat stress. Instructional materials were developed on hazards associated with entry into confined spaces. The training resource manual, "Safety and Health in Confined Workspaces," was reviewed by more than 20 representatives from major labor unions and industrial firms in the construction industry. A manual was prepared on engineering control of hazards in the dry cleaning industry. The training course, "Health Issues of VDT Use," was pilot tested with supervisors of VDT operations. Videotape programs were produced on completed research and on selected seminars that were presented by NIOSH research staff. Work was begun on the design of a training program on the Top Ten for State and local health agency personnel, and videotapes were completed on three of the Top Ten: musculoskeletal disorders, noise-induced hearing loss, and psychologic disorders. An assessment of curriculum needs was conducted for an advanced course for occupational health nurses. Revision work on the NIOSH training syllabus was continued. A slide/tape package, based on a module for a simulated company ("ELCAB"), was developed for safety training. The initial draft of a resource training guide is now undergoing review for managers of respiratory-protection programs and for the operation, care, and maintenance of self-contained breathing apparatus. Work was begun to design a track in occupational safety and health for incorporation into the existing Applied Epidemiology Course of the Center for Professional Development and Training, CDC. The possibility of initiating occupational health training for general medical practitioners was explored and will be started in 1984. An instructional package was developed for training X-ray B-readers. Various training materials were distributed through the NIOSH Clearinghouse, NTIS, the National Audiovisual Center, and other mechanisms.

Hazardous Waste Training and Dissemination Program

As a part of the Superfund Interagency Agreement with EPA, NIOSH is preparing curriculum materials necessary for training individuals who work at hazardous waste dump sites. Industrial hygiene and safety principles will be incorporated into a training package to prepare personnel for potential exposure to hazardous wastes, incorporating new information now being developed by safety research on personal protective equipment (including respirators and protective clothing). The program will deal with exposure problems in the clean-up of hazardous waste sites, in operational hazardous waste treatment and disposal sites, and during emergency response to spills of hazardous materials on- and off-site; it will be field tested to assure that it meets the needs of the personnel for whom it was designed. Part I will be a train-the-trainer program for management and health professionals; part II will be used by management to train their workers. In FY 1983, course outlines were developed, reviewed, and revised for the emergency spills course, for the uncontrolled waste site courses, and for the train-the-trainer

course. The Institute is developing a Hazardous Waste Occupational Safety and Health Comprehensive Guidance Manual; a second draft has now been submitted for review to a working group consisting of the U.S. Coast Guard, OSHA, and EPA. The development of a Hazardous Waste Occupational Safety and Health Textbook for graduate industrial hygienists is about 50 percent complete.

In addition, the Institute provided information on hazardous wastes through conferences and publications to disseminate field study results and research findings. A hazardous waste exhibit was presented at a workers conference, and Institute members participated in 14 technical conferences and workshops on hazardous wastes. A reference file of occupational safety and health information related to hazardous waste was increased by 200 to more than 2,300 entries; this will be included in NIOSHTIC, the Institute's computerized data base for the retrieval of occupational safety and health information. NIOSH distributed the Hazardous Waste Worker Bulletin and copies of other literature on the subject in response to numerous inquiries throughout the year.

Developing and Evaluating an Occupational Safety Training Program
An occupational safety training program for industrial lift-truck operators was developed and evaluated using a behavior (work) sampling method. Observations indicated that 1) the training was effective and endured beyond the performance-feedback stage; 2) continued practice, peer modeling, and management support tend to prolong endurance of the safe behaviors; and 3) a behavior-sampling procedure is effective in developing and evaluating an occupational safety-training program. Course materials include a manual and slide/tape modules.

d. Educational Resources

The Occupational Safety and Health Act calls for an adequate supply of resources, i.e., qualified personnel and educational programs to carry out the purposes of the Act. The Institute assesses these resource requirements, evaluates current programs, and identifies trends and gaps between manpower needs and supply/demand to better use its funding and expertise for education and training in academic and non-Federal sectors. In FY 1983, the Institute continued the training grants and grants to the 15 Educational Resource Centers (ERC). In the 1982-1983 school year, 738 full-time students were enrolled in ERC's and 177 students were in other training-grant programs for the preparation of occupational safety and health professionals. In addition, 612 students took professional preparation on a part-time basis. Another 1,644 students from other disciplines took one or more of the occupational safety and health courses offered by the ERC's as electives. The Institute held the First International Symposium on Occupational Health Nursing Practice, Research, and Education and produced a videotape of the major themes for dissemination.

Efforts are continuing to influence occupational safety and health through the educational systems for specific professions, particularly in schools of engineering and business. Contacts were made with engineering schools and professional engineering societies, and studies were initiated with faculties of engineering schools to develop occupational safety and health materials for use in upper-level, undergraduate engineering courses. A Control Technology Engineering Education Steering Committee was established to provide consultation for these activities. A train-the-trainer workshop was conducted for faculties of various schools of business administration.

Occupational safety and health instructional material was incorporated into the curriculum of two engineering colleges and one business administration school. Curriculum materials are under development at two other engineering schools.

e. Information Services

Information Systems

The Document Information Directory System (DIDS), which tracks all NIOSH final reports, was expanded to include NIOSH testimony before Congress, OSHA, and MSHA. The NIOSH Publications Catalog was revised with a changed format to reflect user needs. In FY 1983, 18,000 new documents were added to the NIOSHTIC data base, and provisions were made to have NIOSHTIC available internationally on-line through DIALOG, Lockheed Information System's information retrieval system. Under mandate of the OSHAct of 1970, NIOSH annually publishes the Registry of Toxic Effects of Chemical Substances (RTECS), which lists the known toxic and biologic effects of toxic chemical substances; quarterly updates are available on microfiche. During FY 1983, RTECS was increased by 6,000 new substances and now contains more than 64,000 unique compounds; over 175,000 synonyms are included in the file. The current-awareness portion of the file was expanded to help in setting priorities by using the primary data lines for skin and eye irritation, in vitro and in vivo mutation, reproductive effects, tumorigenic agents, and acute toxicity.

Technical Information Services

Literature searches were performed for NIOSH research staff, the general public, and the scientific community. The Institute developed information profiles for specific chemicals and processes and identified the user population and heavy users of its services. Information requests were filled for numerous NIOSH Health Hazard Evaluation Reports, contract reports, numbered publications, and industry-wide studies. The library provided reference services, acquisitions of requested publications, interlibrary loans, and translations; the updated translation index now contains citations to more than 7,000 translations. NIOSH presented exhibits at nine scientific and technical conferences and began development of an exhibit on hazardous wastes for use in the Institute's Superfund activities.

Health Risk Appraisal

In cooperation with the Center for Health Promotion and Education, CDC, and Health and Welfare, Canada, the Institute helped to plan two conferences involving health risk appraisal (HRA) in FY 1983. Plenary sessions on "Health Promotion at the Worksite," and "The NIOSH Health Promotion Implementation Plan" were held; session proceedings will be available for dissemination.

In FY 1983, NIOSH awarded grants to two schools of public health to develop variations of HRA for use at worksites. These will result in production of 1) a modified HRA with occupational risk factors, for use with blue collar workers, 2) a model curriculum for graduate students in public health, using HRA as a framework to teach the interactive nature of risks, and 3) industry-specific models for foundry workers and for agriculture workers exposed to pesticides and herbicides.

f. Publications

NIOSH personnel are widely published in scientific journals and other periodicals of occupational interest. Research results are given careful scientific peer review before being accepted for publication in these journals. These articles are an effective means of disseminating the Institute's research findings and recommendations to persons interested and involved in occupational safety and health. The publications that appeared in FY 1983 as a result of NIOSH activities are listed below.

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