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ANNUAL REPORT ON

OCCUPATIONAL SAFETY AND HEALTH

UNDER PUBLIC LAW 91-596

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
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CONTENTS

EXECUTIVE SUMMARY

The reporting period January 1 through September 30, 1976, is being used for this report as a one-time transition period because of the change in Federal fiscal years. During this period, the National Institute for Occupational Safety and Health (NIOSH) expanded its efforts in the areas of recommending standards and investigating occupational cancer. The Institute also began initiatives concerning women at work and the issuance of Current Intelligence Bulletins to inform the public, as well as the occupational health community, of newly discovered health hazards affecting workers.

RECOMMENDING STANDARDS

In developing standards, NIOSH is considering previously unused data banks and information developed by other governmental agencies, trade associations, and labor unions. This permits the identification of occupational safety and health hazards sufficiently early to allow for gathering information so that the criteria documents will reflect an evaluation of all pertinent data.

NIOSH plans to produce approximately 24 criteria documents a year. For the 1976 reporting period, 22 documents were completed and 3 documents revised for transmittal to the Department of Labor. Existing recommended standards will be considered for update every 2 years. Currently, 13 recommended standards are being updated. For the joint NIOSH/Occupational Safety and Health Administration (OSHA) Standards Completion Program (SCP), NIOSH, during 1976, completed its technical input for the project by compiling 94 Draft SCP Technical Standards and transmitting them to the Department of Labor.

Revised coal mine standards include a new standard maximum exposure to asbestos issued March 10, 1976. This provides for coal mines the same standard for asbestos as the one covering other workplaces. Recommended revised standards for airborne contaminants, noise exposures, and sanitation have also been developed. Statistical analyses of data derived from a 4 1/2-year inhalation study of monkeys exposed to bituminous coal dust have been completed. These analyses are being evaluated as a basis for improved standards for the protection of coal miners.

OCCUPATIONAL CANCER

In 1976, the NIOSH toxicology research program placed major emphasis upon high-production industrial chemicals whose carcinogenic, mutagenic, and teratogenic potentials were unknown.

A major program designed to study the hazard of coal tar in producing bronchogenic carcinoma and other cancers was completed. An 18-month inhalation study describing the carcinogenic effects of coal tar aerosols on laboratory animals was also completed.

A contract was awarded to review the world literature published during 1971-1975 related to the carcinogenic properties of ionizing and nonionizing radiation. A state-of-the-art report will be prepared to summarize the pertinent literature identifying specific gaps in the present knowledge of radiation carcinogenesis. Also, it will state recommendations for future research.

NIOSH had co-sponsored the New York Academy of Sciences' 1975 Conference on Occupational Carcinogenesis. The papers presented were published in 1976 and constitute a major contribution in occupational carcinogenesis.

Experimental animal research was continued on:

(1) the pathologic effects of abrasive blasting materials,
(2) factors influencing the carcinogenicity of smelter dusts (including sulfur dioxide),
(3) tumor induction by arsenic in rats on nutritionally deficient diets,
(4) molecular mechanisms in occupational carcinogenesis, and
(5) the co-carcinogenic effects of asbestos and benzo-(a)-pyrene.

The 1976 edition of The Registry of Toxic Effects of Chemical Substances, an annual NIOSH publication, lists 21,729 different chemicals, including over 5,000 new chemicals. It provides specific toxicological data on each. The new listings include 1,913 carcinogens, 34 mutagens, and 295 teratogens.

Examples, not necessarily all inclusive, of additional efforts to increase the data base on which action could be taken to protect workers from exposure to carcinogens include:

(1) A study of cancer in relation to occupation, completed in September 1976, to identify several strong correlations between occupation and cancer. Specific occupation/cancer relations were leather workers/bladder cancer, dairy farmers/bladder cancer, and hairdressers and cosmetologists/genital cancer.
(2) Completion of a computer file to include data from the National Cancer Institute publication, "U.S. Cancer Mortality by County: 1950-1969." The file includes observed numbers of deaths and age-adjusted death rates for each race and sex group, by cancer site, for the total U.S. population and for every U.S. county and state.
(3) Holding a symposium on April 30, 1976, on the possible association of leukemia with the manufacture of styrene-butadiene rubber. This symposium allowed industry and labor, as well as research scientists, to discuss mutual problems and to exchange data toward taking necessary action.

(4) Preparation of detailed analyses of cancer mortality patterns within coke plants. The data were the most current presented at the OSHA coke oven hearings on cancer risks associated with employment in specific work stations around coke ovens.
(5) Investigations into the possibility that the reaction of formaldehyde and ionic chloride compounds in selected work environments produces bis-chloromethyl ether (BCME), a potent lung carcinogen. While

numerous studies are available to document this effect, data describing its formation or extent of occurrence in the occupational setting are minimal. The kinetics of the suspected reaction have been developed, walk-through and detailed industrial hygiene surveys completed, and a final report is in preparation.

(6) Study of coal gasification processes involving many of the polycyclic hydrocarbons that are closely related to coke oven emissions, which have been associated with excess risk of lung cancer. The purpose of this industrywide study is to characterize these worker exposures and to define appropriate industrial hygiene and control technology practices that will be of use in reducing exposure levels.

(7) A retrospective cohort analysis and industrial hygiene study of a cohort of U.S. workers having sufficient latency to demonstrate any chronic effects from benzene exposure. This study was initiated because previous studies have shown the association between benzene exposures and damage to the hematopoietic system and development of leukemia.

(8) A retrospective mortality study to evaluate the potential for excess occupational disease among pesticide formulators. Published studies on pesticide formulators have shown the need to evaluate the risk to them of chronic or long-latency diseases, such as cancer, kidney and liver diseases, hypertension-related diseases, and abnormalities of offspring. Existing studies are far from conclusive and, because of the nature of the industry (i.e., potential high exposures among a large but diffuse population), a retrospective mortality study was needed.

WOMEN IN THE WORK FORCE

Closely related to the NIOSH Occupational Cancer initiative is the NIOSH initiative "Women in the Work Force." Several projects are under way to develop data that are not now available on the effects of occupational exposure on women and the fetus. These include projects with particular focus on women, as follows:

(1) mutagenic and teratogenic effects of substances on the male and female reproductive functions,
(2) workers' compensation implications of exposure to mutagens and teratogens, and
(3) a cross-sectional reproductive study of pharmaceutical workers directed at detecting the extent of risk of miscarriages and birth defects in the offspring of exposed workers.

Similar studies are also being initiated on workers exposed to dimethyl formamide, carbon disulfide, lead, and chloroprene. The results from these projects, with an evaluation of how women are affected, will be published as they become available.

In addition, under an interagency agreement with the U.S. Air Force School of Aerospace Medicine, research has been done to determine the effects of radio frequency (RF) radiation on lymphocyte division response in animals and cell cultures and on ribonucleic acid (RNA) and deoxyribonucleic acid (DNA) structure.

A publication is being prepared describing the results of this study. Future RF research will concentrate on the potential teratogenic effects, since most industrial RF sources are operated by women.

NIOSH cosponsored, with the Society for Occupational and Environmental Health and the National Foundation--March of Dimes, the "Conference on Women and the Workplace," held in Washington, D.C. , June 17-19, 1976. The conference was a state-of-the-art presentation of the scientific, social, and political implications of women at work. A publication of the proceedings is available from the Society for Occupational and Environmental Health.

CURRENT INTELLIGENCE BULLETINS

NIOSH evaluates new information for the purpose of identifying occupational safety and health hazards which are either generally unrecognized or more severe than generally recognized. When a Current Intelligence Bulletin is warranted by this evaluation, NIOSH quickly alerts the occupational health community to the unrecognized risks.

During this reporting period, NIOSH alerted the occupational health community to the potential carcinogenic hazards of:

(1) Ethylene dibromide (in anti-knock additives for gasoline and in fumigants for grains and produce),
(2) chromate pigments (in paints, printing inks, and floor coverings),
(3) asbestos (in the servicing of brake and clutch assemblies),
(4) hexamethyl-phosphoric triamide (a widely used laboratory solvent),
(5) polychlorinated biphenyls (dielectrics used in most electrical capacitors and some transformers),
(6) chloroform (used to prepare fluorocarbons, as a multi-use solvent, and in numerous pharmaceuticals), and
(7) dimethylcarbamoyl chloride (used to produce certain pharmaceuticals).

In addition, Current Intelligence Bulletins were issued in 1976 for diaminodiphenylmethane and sodium azide. (Diaminodiphenylmethane is used in the preparation of polyurethane foam as an epoxy hardening agent. Sodium azide is a clinical laboratory reagent which may create an explosive hazard in plumbing systems.)

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) was established in the Department of Health, Education, and Welfare by Public Law 91-596, the Occupational Safety and Health Act of 1970 to:

(1) Develop and establish recommended occupational safety and health standards, and
(2) perform all functions of the Secretary of Health, Education, and Welfare under Sections 20 and 21 of the Act.

The implementation of the stated national intent, as expressed in that Act, has been going on since 1971. It has not been as an initial impetus, but as a recharged effort now based on statutory recognition of a decades-long concern in the United States with worker health. The concern for worker health depends to a large extent on the effectiveness of NIOSH in the implementation of its statutory mandate.

What is the statutory mandate given to NIOSH? Implicit in NIOSH's own title and in the stated purpose of the Act (Section 2) "to assure so far as possible every working man and woman in the Nation safe and healthful working condition," is the national-level scope of the functions of the Institute.

The establishment of NIOSH within the Department of Health, Education, and Welfare (HEW) was the culmination of the organizational process in the Federal-level study of the health problems of workers in the Nation's expanding industrial economy. This process had its initial, formal organizational expression in 1914 with the establishment of the Office of Industrial Hygiene and Sanitation in the U.S. Public Health Service. It continued with various changes in title, including that of the predecessor of NIOSH, the Bureau of Occupational Safety and Health.

All of these previous organizations were administratively determined and then organizationally satellited within various parent organizations. In 1970, the Act statutorily defined NIOSH and set it in an executive department, HEW, as a functioning administrative entity to provide the services necessary "to carry out the policy set forth in section 2 of (the) Act."

HOW DOES NIOSH CARRY OUT ITS STATUTORY MANDATE?

NIOSH is the principal Federal unit engaged in research, education, and training in a national effort to eliminate on-the-job hazards to the health and safety of America's working men and women.

Under the Occupational Safety and Health Act, NIOSH has the responsibility for conducting research designed to produce recommendations for new or improved

occupational safety and health standards. These recommendations are transmitted to the Department of Labor (DOL), which has the responsibility for the final setting, promulgation, and enforcement of the standards.

Functionally, NIOSH also operates under, and in accordance with, other legislation, particularly the Federal Coal Mine Health and Safety Act of 1969 and various titles of the Public Health Service Act, as amended (42 U.S.C. 201 et seq). It is the Occupational Safety and Health Act, however, that gives NIOSH a listing of priorities, and a source of operational and policy guidelines.

Taken broadly, Section 20 of the Act directs HEW to undertake research relating to occupational safety and health, including studies of psychological factors, innovative methods, techniques and approaches, and motivational and behavioral factors. Section 21 of the Act directs HEW to conduct education programs to provide an adequate supply of qualified personnel to carry out the purposes of the Act, as well as informational programs on the importance of and proper use of adequate safety and health equipment.

There are other sections of the Act that delineate or determine how NIOSH functions:

Section 20(b), regarding inspections for Section 20 functions, makes Section 8 (on inspections, investigations, and recordkeeping) available to NIOSH, providing the statutory base for right-of-entry. The right of NIOSH to inspect a private place of employment was affirmed in a consent decree on September 19, 1973. A new Part 85a, of 42 CFR, establishing regulations governing the inspection of workplaces by NIOSH, was issued on October 14, 1976. This regulation was in accordance with Section 8 (g)(2), which provides that "...the Secretary of Labor and Secretary of Health, Education, and Welfare shall each prescribe such rules and regulations...necessary to carry out their responsibilities under (the) Act, including rules and regulations dealing with the inspection of an employer's establishment."

Although promulgation of standards is the responsibility of the Department of Labor under Section 6, NIOSH has particular interest in two portions of that section.

First, Section 6(b)(7) provides that "where appropriate, any such standard shall prescribe the type and frequency of medical examinations...In the event such medical examinations are in the nature of research, as determined by the Secretary of Health, Education, and Welfare, such examinations may be furnished at the expense of the Secretary of Health, Education, and Welfare." To date, no promulgated standard has prescribed medical examinations for research purposes, and those prescribed for regulatory purposes are at the expense of the employer.

Second, Section 6(g) makes clear the Congressional intent that NIOSH have a role in setting priorities for development and promulgation of standards. This section provides that "In determining the priority for establishing standards under this section, the Secretary of Labor shall...give due regard to the recommendations of the Secretary of Health, Education, and Welfare regarding the need for mandatory standards in determining the priority for establishing such standards."

Section 8 (g) provides for the prescribing of rules and regulations. It also covers authority to compile, analyze, and publish, either in summary or detailed form, all reports or information obtained under the section. This information is available to the public from NIOSH or the National Technical Information Service (NTIS).

To aid in the area of informational programs, NIOSH has instituted an automated storage and retrieval information system which is available to NIOSH personnel. It assists them in the timely reply to requests for information about occupational safety and health.

In addition, in the area of information coordination, NIOSH acts as the national center in the United States for the International Occupational Safety and Health Information Center (CIS). NIOSH receives all CIS material in microfiche. It uses the material to contribute to the automated storage and retrieval system data base and for timely support to criteria document development.

Under the provisions of Sections 20 and 21, NIOSH carries out a broad program in research, training, and technical assistance upon request and upon its own initiative. These activities are carried out through organizational programs that have been established on the basis of functional responsibilities. Divisions and offices in NIOSH are shown in the chart with branches and sections. Details of NIOSH activities as carried out by these units during this reporting period are given in the following pages.

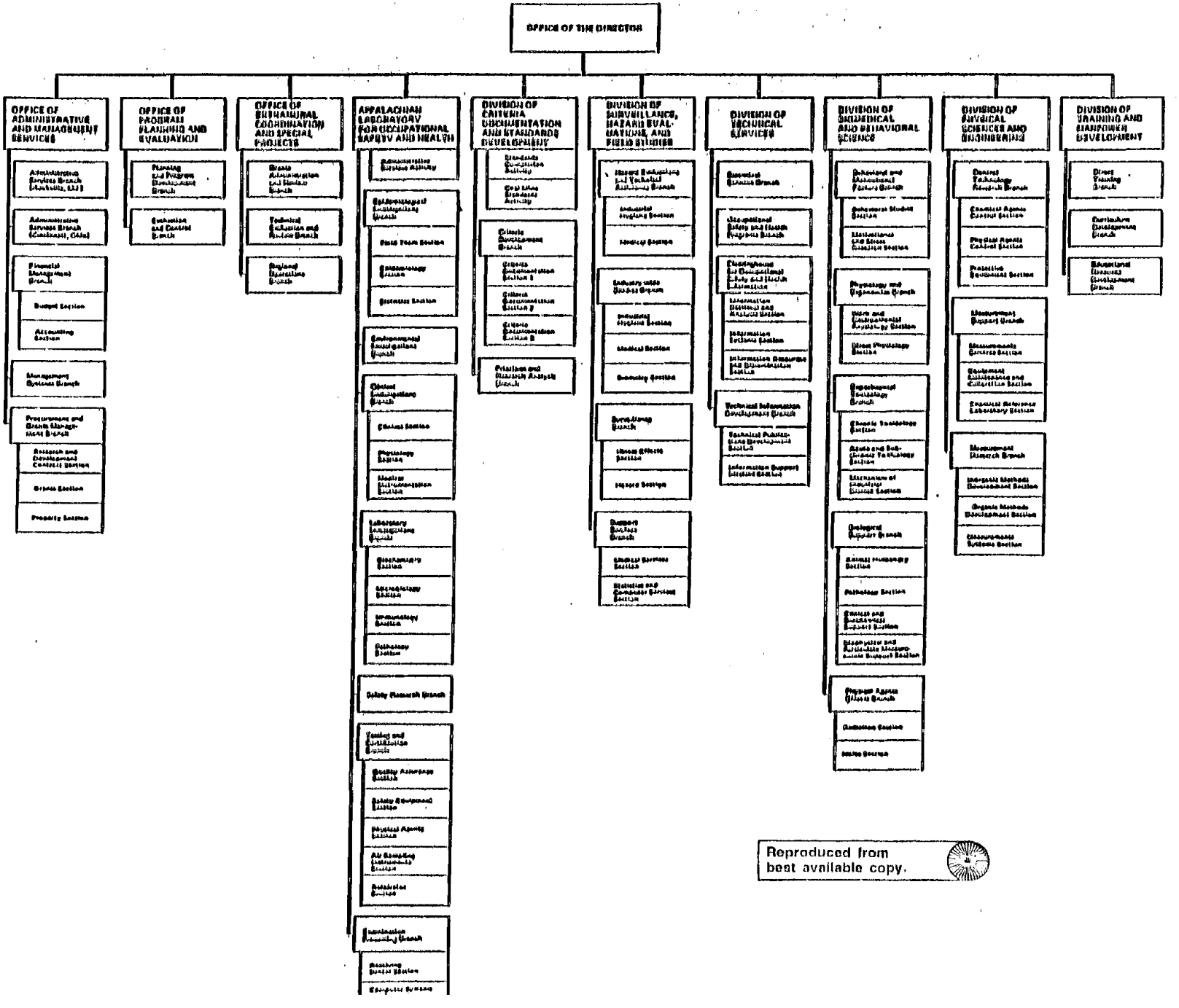
DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

JUNE 1978

PUBLIC HEALTH SERVICE

CENTER FOR DISEASE CONTROL

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH



PROGRAM ACTIVITIES

DIVISION OF TECHNICAL SERVICES

The Division of Technical Services, through its four branches,

(1) develops guidelines for occupational safety and health programs,
(2) supplies technical information from a computerized data base to the research divisions of the Institute and the public,
(3) disseminates, as published, the Institute's recommendations and findings, and
(4) provides editorial and statistical services for Institute activities.

The Division's professional staff includes industrial hygienists, technical information specialists, statisticians, safety specialists, graphic artists and illustrators, editors and writers, nurses, physicians, public health advisors, chemists, and toxicologists.

CLEARINGHOUSE FOR OCCUPATIONAL SAFETY AND HEALTH INFORMATION

The Clearinghouse for Occupational Safety and Health Information Branch is a resource facility. It provides technical information, from a computerized information storage center, to the research staff of the Institute and to the public. The Clearinghouse, in 1976, processed over 7,000 entries from the current literature into the data base.

The NIOSH library subscribes to 275 journals and periodicals in fields related to health and safety and maintains approximately 7,000 volumes as reference sources. The Clearinghouse disseminated 750,000 NIOSH publications through mailings and at meetings of health and safety professional societies. This direct distribution is supplemented by distributions by the Government Printing Office (GPO) and the National Technical Information Service (NTIS).

OCCUPATIONAL SAFETY AND HEALTH PROGRAMS

The Occupational Safety and Health Programs Branch was established in 1976 to develop guidelines for model health and safety programs. These guidelines are intended to define, for the Nation's employers, what comprises a good, workable health and safety program. One program under development will provide self-evaluation techniques which any industry can use as a guide in defining criteria to use in assessing the effectiveness of its safety and health programs.

The Occupational Safety and Health Programs Branch also reviews, for the Department of Health, Education, and Welfare, those programs established by Federal agencies under Executive Order 11807 (Occupational Safety and Health Programs for Federal Employees).

In the general field of public health, the Occupational Safety and Health Programs Branch is studying the implications of health planning and health maintenance organizations as sources for occupational health services. Congressional national health insurance proposals were reviewed and comments and recommendations made to the appropriate agencies.

The Branch is developing a set of recommended health and safety procedures to be used in laboratories in the Nation's schools and colleges. A program for vocational schools, for example, focuses on protecting the students from safety hazards. It also focuses on making the students, the Nation's future workforce, aware of potential health and safety hazards and how to correct or eliminate these hazards when they do enter the workplace.

Branch efforts related to the NIOSH emphasis on "Women in the Work Force" deal with the mutagenic and teratogenic effects of substances on the male and female reproductive functions. The model program details guidelines for the prevention of worker exposure, taking into account information developed in other NIOSH research projects. A study of workers' compensation implications of exposure to mutagens and teratogens is under way.

TECHNICAL INFORMATION DEVELOPMENT

The Technical Information Development Branch researches occupational health and safety problems through surveys of plants and discussions with management and labor. The developed occupational health and safety information is written and disseminated to the employer, the employee, the health and safety professional, and the general public. The Branch also provides writing expertise, editorial review, and graphic arts and illustration service for all NIOSH publications and is responsible for the preparation of mandated reports.

In the 1976 reporting period, eight Health and Safety Guides were published on the following subjects:

Auto and Home Supply Stores
Eating and Drinking Places
Farm and Garden Equipment Manufacturers
Ferrous and Nonferrous Foundries
Millwork Shops
Plumbing, Heating, and Air Conditioning Contractors
Scrap Processors
Signs and Advertising Displays

The Guides provide management-oriented digests of OSHA standards, explanations of health and safety hazards common to a specific industry, and inspection checklists tailored for the industry. The Guides incorporate requirements, explain hazard recognition-evaluation-control, and contain recommended good practices. They are of particular value to the small businessman who cannot afford the services of a safety and health consultant, or who has no health and safety staff.

During this reporting period, nearly 400,000 Guides were mailed directly to employers with approximately 3,780,000 employees. To date, over a million copies of the Health and Safety Guides have been distributed to employers with an estimated total of over 10 million employees.

The selection of industries for coverage in a Guide is based on a variety of criteria. These include the number of employees who work in the industry, the accident/illness incidence rate for the industry, and the interest which the industry and its trade associations express in development of a Guide. Trade associations, insurance companies, professional organizations, and Federal and State organizations are contacted to assist in securing data and to do technical review.

Future subject industries for development of Health and Safety Guides include:

Automotive Parts Recyclers
Construction Machinery Manufacturers
Hospitals
Lighting Fixtures and Wiring Services
Manufacturers and Users of Carcinogens
Meat Packing
Metal Coating and Allied Services
Metal Furniture and Mattress Manufacturers
Miscellaneous Chemical Products
Pesticide Formulators
Pre-fabricated Wooden Buildings
Public Warehousing
Sawmills
Screw Machine Products
Steel Fabricators
Storage Battery Manufacturers
Tanning
Textile and Woodworking Machinery Manufacturers
Tool and Die Shops
Toys and Games Manufacturers
Veneer, Plywood Mills

In 1976, a series of Employee Good Practices Manuals was initiated. These Manuals are directed to employees who work in a specific industry or with a particular hazardous substance or specific equipment. The Manuals contain listings of health and safety hazards and suggestions for control measures that the employee can adopt through the use of personal protective equipment or good work practices. The Manuals also have lists of the controls that management must adopt to limit employee exposure to the hazards.

The following Good Practices Manuals were published during the first 9 months of 1976:

Abrasive Metal Finishing
Epoxy Wise is Health Wise (epoxy resin workers)
Fiberglass Layup and Sprayup
Prescription for Battery Workers (lead-acid storage battery)
Rendering Plants
Spray Painting
Tannery Workers
Urethane Foams
Working Safely with Pesticides (formulating)

Subject areas planned for publications or which are presently under development include:

Auto Body Shop Workers
Electroplaters
Foundry Workers--Melting and Pouring
Foundry Workers--Molding and Coremaking
Foundry Workers--Shakeout, Grinding, and Finishing
Insulation Installers
Printing Industry
Textile Dyers and Finishers

These subject areas were chosen because of the specific mention in the OSHA standards of training requirements for these operations. The publications will assist the small businessman in establishing the training programs required under the Act at minimum expense, effort, and burden. They will also ensure that the training received by employees meets a certain minimum level.

Publication proposals that have been well received by trade associations, private companies, and labor organizations include:

Crane Operators
Flammable and Combustible Liquids
Laundry Machinery Operations
Mechanical Power Press Operations
Power-actuated Fastening Tools
Powered Industrial Trucks
Pulpwood Logging
Storage and Handling of Anhydrous Ammonia
Use of Respirators

Many of the Health and Safety Guides have been reprinted for distribution throughout an industry or a company's plant locations. Several of the Employee Good Practices Manuals also have been reprinted by private-sector employers for distribution to the employees.

Both the Guides and the Manuals have been used as aids in maintaining ongoing, effective safety programs and in implementing employee health and safety training. Many small businesses have ordered multiple copies of the books and have distributed them to all of their employees. This establishes a uniform safety and health policy and makes both management and the worker aware of hazards and ways to eliminate or control them.

The 1976 edition of The Registry of Toxic Effects of Chemical Substances includes 5,228 new listings. It lists 21,729 substances and provides specific toxicological data on each listing. Of special importance is the listing of 1,913 carcinogens, 34 mutagens, and 295 teratogens. Significant additions to the references cited in the Registry include 218 citations to NIOSH Criteria Documents and 1,529 to OSHA and Department of Transportation (DOT) standards.

Future publication of the Registry includes its regular production in microfiche format. New data entries will be added for in vitro mutagenesis test data.

To facilitate the utilization of the Registry in specific occupational health problems, data on eye and skin irritation effects will also be incorporated. An Editorial Review Board for the Registry will be established to resolve problems arising out of interpretations of toxicological information and to review inclusion criteria for the chemicals listed.

The Information Support Services Section provided editorial review and graphics design for over 100 NIOSH publications.

The Information Support Services Section has developed a set of detailed guidelines outlining manuscript preparation requirements. The adoption of these guidelines as a part of the NIOSH clearance procedure will ensure a uniformity of style, presentation, and appearance for all publications.

STATISTICAL SERVICES

The Statistical Services Branch provides statistical, mathematical, and related data processing services to the research efforts of NIOSH. The application of mathematical statistics provides for objectivity, lack of bias, and efficiency in the conduct of research investigations. It also permits determination of the limits of error in the numerical results derived in studies in certain areas. These include the experimental evaluation of the effects of occupational hazards, the development of methods of measurement, and the development of hazard controls.

One of the major achievements of the Statistical Services Branch was the writing of the Occupational Exposures Sampling Strategy Manual. It outlines a decision logic to follow for determining employee exposure to toxic substances, the need for further sampling at certain levels of exposure, and the establishment of a schedule for follow-up sampling. Four hundred copies were distributed for technical review, the draft was revised and edited, and the completed publication will soon be available. This manual will serve as a guide to employers. It will be of particular advantage to the small businessman who may not have a full health surveillance and industrial hygiene staff. Also, it will be helpful to the employer who may not be completely familiar with methods for establishing sampling strategy.

Since most employee exposures are to mixtures of toxic chemical substances, rather than to isolated agents, future emphasis in the Branch's projects will be on the mixtures. Emphasis will be on developing a decision logic, procedures, and recommendations for determining the analytical accuracy of sampling the mixtures. Another field of endeavor will be developing methods for statistical analysis to determine the biological effects of mixtures of toxic substances.

DIVISION OF PHYSICAL SCIENCES AND ENGINEERING

The Division of Physical Sciences and Engineering (DPSE)

(1) develops engineering control systems (e.g., ventilation systems to remove toxic fumes),
(2) establishes methods for the collection and testing of samples taken at the workplace,
(3) provides laboratory analysis of these samples for the other research divisions of NIOSH,
(4) maintains and calibrates the instruments and equipment used by NIOSH and OSHA, and
(5) establishes quality assurance programs for industrial hygiene laboratories.

ENGINEERING CONTROL SYSTEMS

In 1976, NIOSH began to assess and evaluate the current technology available for, and used in, the control of chemical and physical hazards. Much of the work dealt with ventilation and air recirculating systems.

Programs completed were ones that (1) evaluated recirculating exhaust air from industrial processes, (2) established a work practices program for abrasive blasting, and (3) set guidelines for industrial ventilation.

New projects in this area are assessing the control systems used in the plastics and resins industries and in industries using cutting fluids. Another project is a follow-up study to the exhaust air program. It will develop guidelines and criteria for the design, operation, and maintenance of safe and effective recirculation systems.

Problems encountered in these projects were industries' lack of awareness of the control systems available to them and lack of standardization for the parameters necessary in the proper design of ventilation systems. Another problem was the failure of many industries to use the recommended controls for meeting the minimum standards for some processes and substances.

Plans for the future include the assessment of the drycleaning, textile finishing, nonferrous metal smelter, and foundries industries. Engineering control systems will also be developed for the use of diesel-powered equipment in coal mines and for the control of worker exposure to carcinogens. Additional research is planned in engineering controls for pneumatic tool noise, heat shield emissions, ultraviolet reflectance, and physical agents associated with welding and brazing operations. There are also plans to update the NIOSH Compendium of Materials for Noise Control.

Protective Equipment Research

New performance criteria have been developed for the particulate filters in respirators and also to improve the fit of dust, fume, and mist respirators themselves. Proposed changes in the regulations for respirator approval are being considered. Recommendations for improved test methods for organic vapor respirators were received.

A test system was constructed to evaluate commercially available pesticide cartridges against selected pesticides. The purpose of this research project is to assess the adequacy of the current pesticide cartridge approval procedure which requires the use of only a single test agent (carbon tetrachloride). Cartridge service-life against two pesticides has been determined and results indicate service-lives much lower than for the approval test agent, carbon tetrachloride.

There is satisfactory progress in the evaluation of the present paint spray respirator cartridge approval test procedure used at the NIOSH Testing and Certification Branch. The evaluation of activated charcoal is continuing with the investigation of the effects of moisture and competing vapors on this important sorbent material.

The respirator provisions of approximately 225 Draft Technical Standards from the Standards Completion Program (SCP) were reviewed. Other SCP work approved for publication includes a respirator protection factor document and a contract report entitled "Recommended Industrial Ventilation Guidelines." NIOSH also published a manual entitled "A Guide to Industrial Respiratory Protection" (HEW Publication No. (NIOSH) 76-189).

Future research will include the development and evaluation of a prototype end-of-service-life indicator for gas and vapor respirators and the development of performance requirements for protective clothing to be worn by workers exposed to carcinogens.

Safety Research

Safety research is directed toward the elimination of industrial accidents. To eliminate slips and falls in the workplace, a universal friction testing device was developed. Also, criteria for industrial floors and work surfaces were published in "Standardization of Friction Testing of Industrial Working Surfaces" (HEW Publication No. (NIOSH) 76-123).

The feasibility of improved head protection and the need for an improved occupational head protection standard were demonstrated. Research in 1976 also revealed the need for standards for fire-fighters' gloves and provided criteria for the safeguarding of mechanical power presses. In addition, research into the factors of impact resistance and thickness of safety glass lenses has resulted in suggestions for improvement in the standards for absorptive lenses; methods for ballistic tests, and the necessity for research into the characteristics of optical protection.

ANALYTICAL METHODS DEVELOPMENT

Analytical methods development involves the collection and testing of air samples taken at the workplace. Current regulations require measurement of increasingly smaller quantities of highly toxic substances. To comply with regulations and to assure the accuracy of testing, new quantitative air sampling and analytical methods were developed for 4,4'-methylene-bis (2-chloraniline), benzidine, 3,3'-dichlorobenzidine, and cyclohexylamine. Completion of methods development for eight OSHA regulated carcinogens and five polyfunctional aliphatic amines, such as ethylenediamine and ethanolamine, is scheduled.

Methods for quantitative analysis of polychlorinated biphenyls (PCB's) and kepone were developed along with a new, rapid, analytical procedure for determination of benzo(a)pyrene in coke oven emissions.

Sampling and analytical sections of the following NIOSH Criteria Documents were critically reviewed for:

(1) acrylamide
(2) allyl chloride
(3) boron trifluoride
(4) cadmium
(5) carbaryl
(6) carbon monoxide
(7) chlorine
(8) ethyl parathion
(9) fluorine
(10) inorganic cyanides
(11) malathion
(12) methyl parathion
(13) organotin compounds
(14) phosphine
(15) tetrachloroethylene
(16) zinc chloride

The monitoring portion of the Standards Completion Program (SCP) was completed in 1976. Fifty-eight environmental monitoring methods for toxic substances were validated for precision and accuracy by NIOSH in 1976 and transmitted to the Department of Labor for use in the OSHA Compliance Program. Of those substances in Tables Z-1, -2, -3, of the OSHA Health Standards (1910.1000), there were approximately 170 compounds which did not meet the validation criteria of the sampling and analytical phase of the SCP. A follow-up project, begun in 1976 and to run for 3 years, will spend approximately 50 man-days of effort on each of 130 of these compounds in order to develop analytical methods which meet the SCP validation criteria. Over 150 sampling procedures used to evaluate worker exposure, which were the result of SCP, have been made part of the NIOSH Sampling Data Sheet Manual.

Validation of an analytical method to determine sodium hydroxide mists as measured by total alkalinity has been completed. A sampling method was developed for nitric acid. An electrostatic precipitator was evaluated for the collection

of large amounts of aerosols from abrasive blasting operations for use in toxicological studies. A study was performed to evaluate battery life in personal sampling pumps and a report is planned for publication.

Evaluation of the atomic absorption spectroscopy method for beryllium has shown that there is a positive bias in the application of the method to industrial hygiene samples. Alternate procedures are being evaluated. A proposed method for mercury analysis, which collects and quantifies (as discrete species) the metallic mercury and organomercury components of contaminated air, has also been evaluated and improved. A new sampling procedure was written for elemental mercury. A careful assessment of the precision and the detection limits to be expected for arsenic has been completed; additional work is planned to lower the detection limit for precise determination of arsenic. Other efforts have included evaluation of analytical methods for lead, fluorides, and phosphorus vapors.

A feasibility study is in progress to miniaturize a gas chromatograph to the size of a pocket calculator. It would become a "personal monitor" for up to 10 different contaminants. It will continuously determine exposure to each of the substances and provide an alarm if the workers are exposed to a ceiling-high concentration of any contaminant. If the results of this study are encouraging, a contract is planned to be let to build a prototype monitoring instrument.

Development of an instrument was initiated for the simultaneous, multi-element analyses of samples typical of those found in industrial environments. The instrument would use the inductively coupled plasma optical emission spectroscopy technique. With the development of this system, it will be possible for any combination of up to 20 elements to be analyzed per sample.

Portable, battery-powered personal sampling pumps are being evaluated under very cold conditions. This research is needed to determine if currently existing personal monitoring equipment can function properly at temperatures down to -50°C. Operating problems with these pumps under the test conditions are to be identified and recommendations for their solutions provided.

Research into fibrous aerosol sampling methods and devices has progressed with the determination of the respirable fraction of various fibrous glass aerosols. Research will continue to compare the horizontal elutriator, 10-millimeter nylon cyclone, spiral centrifuge, and Anderson impactor samplers for fibrous aerosols. With funds provided by the Environmental Protection Agency (EPA), the Bureau of Mines, and NIOSH, a portable, direct-reading fibrous aerosol monitor is being developed and two prototypes fabricated.

Evaluations of portable, direct-reading instruments for hydrogen sulfide have been completed. A number of deaths have occurred due to exposures to high concentrations of this substance. Portable instruments are needed to be able to measure concentrations of H_2S on a continuous basis. Performance and testing specifications were developed to be used by the Testing and Certification Branch for certification programs for portable air monitors.

Developed in 1976 are a portable, direct-reading phosphorus instrument for the monitoring of organophosphorus pesticides and a prototype whole-air sampler to collect personal air samples from workers over an 8-hour period.

New personal sampling methods were developed or evaluated for:

(1) arsine,
(2) mercury,
(3) ozone,
(4) carbon disulfide,
(5) epichlorohydrin, and
(6) polychlorinated biphenyls.

Most of these methods (tested for gases and vapors in air) utilize the collection of the contaminant on a solid sorbent.

Continuing research in asbestos analytical methods has resulted in new methods to measure asbestos mass, based on X-ray diffraction and differential thermal analysis techniques. This is significant in view of recent research indicating that the total mass of inhaled asbestos may be more pertinent to adverse health effects than the number of fibers. Differential thermal analysis has been used to determine the percent of chrysotile asbestos in bulk samples. An X-ray diffraction method has been developed, using personal sampling techniques, for the determination of chrysotile asbestos collected on filters. This work will be extended to the analysis of tremolite asbestos and the determination of matrix effects and interferences in these methods.

Routine analytical chemistry support was provided during 1976 by both the NIOSH Cincinnati laboratory and by a NIOSH contractor. Because of an increased volume of analyses imposed upon the Services Section, the overall capability has become more efficient by separating the special measurement activity from the routine activity. The in-house program devoted significantly more of its time and efforts to quick response method development and expansion of its capabilities in special measurement activities. Practically all routine samples were sent to the contractor for analyses.

During 1976 (January through September), 27,629 analyses were performed on 15,043 samples. The contractor was responsible for 22,280 analyses on 12,466 samples. The NIOSH Cincinnati laboratory was responsible for the special handling of the remaining 2,577 samples, incorporating some 5,349 analyses.

Examples of substances for which routine methods of analyses are not well established, and, hence, which are more difficult to measure, are:

(1) vinyl cyclohexane dioxide,
(2) polynuclear aromatics,
(3) volatile trace metals,
(4) nitrogen trichloride,
(5) benzopyrenes,
(6) phosphene,
(7) phthalates,
(8) epichlorohydrin,
(9) N,N-dimethyl-p-toluidine,
(10) hydroquinone, and
(11) hexamethylene diisocyanate.

More easily determinable substances analyzed in support of NIOSH research activities were benzene, toluene, Stoddard solvent, chloroform, nonvolatile trace metals, acid mists, and metal fumes. Although analytical methods for these compounds are reasonably well established, in some cases the nature of the sample matrix, possible interferences, sample instability, and concentration levels necessitated a nonroutine measurement approach.

The short-term method development effort was continued during 1976. This effort is designed to fill immediate needs for quick solutions to measurement problems emerging as a result of the NIOSH Health Hazard Evaluation Program and field studies. Much of the support provided to field studies involves situations in which exposure to unknown substances occurs. This requires an extensive effort to identify the toxic component(s) before the levels can be measured. The support provided, therefore, requires a diversity of analytical expertise and a great amount of flexibility in the face of changing priorities. The analytical methods provided by the short-term methods effort are not validated or field tested procedures, but, rather, satisfy precision, accuracy, and specificity criteria for each problem.

Short-term, quick-response methods were developed during 1976 for assessment of exposure to:

(1) polycyclic aromatic hydrocarbons in a roofing and asphalt industry study,
(2) perchloromethyl mercaptan intermediate in the manufacturing of fungicides,
(3) azelaic acid in production and bagging operations,
(4) zirconium oxide and zirconium oxychloride in a chemical manufacturing plant,
(5) methylethylketone peroxide used as an initiator in a polyester resin manufacturing process, and
(6) hexamethylene diisocyanate in a commercial cleaning operation.

MAINTENANCE AND CALIBRATION

The Maintenance and Calibration Laboratory jointly supports OSHA compliance activities, through an interagency agreement, and NIOSH field studies by providing maintenance and calibration of air sampling and direct measuring instruments. The maintenance and calibration activities consist of three major functions:

(1) maintaining and calibrating sampling equipment used by NIOSH and OSHA,
(2) improving and developing calibration systems, and
(3) acceptance testing of equipment.

The NIOSH calibration systems in operation during 1976 were those for:

(1) light,
(2) noise (steady, impact, and also reverberant room),
(3) low and high volume air flow rates,
(4) low and high air velocities,
(5) mercury vapor,
(6) carbon monoxide,
(7) hydrogen sulfide,
(8) ozone,
(9) halogenated hydrocarbons,
(10) high energy ionizing radiation,
(11) low energy X-ray radiation, and
(12) microwave radiation.

Approximately 20,000 instruments were calibrated during 1976, including significant numbers of the following: personal sampling pumps, anemometers, noise dosimeters, sound meters, sound calibrators, ionizing radiation equipment, microwave meters, and light meters. NIOSH calibrated equipment is used throughout the country to support OSHA compliance inspections and NIOSH field studies.

Acceptance tests were performed for about 40 OSHA equipment purchase contracts to make certain that the equipment met specifications. These tests provide the basis for withholding payment for equipment which does not meet specifications. The maintenance and calibration services provided to OSHA comprise about 80% of the total calibration effort of DPSE.

CHEMICAL REFERENCE LABORATORY

The NIOSH Chemical Reference Laboratory (CRL) operates the Proficiency Analytical Testing (PAT) program to meet the need for reducing the wide variation of results between different industrial hygiene laboratories.

From January through September 1976, the CRL prepared and submitted over 11,000 proficiency test samples to the 146 participating laboratories. This was an increase of 12% in the number of participating laboratories from last year.

Of these 146 laboratories in the PAT program, 13 are Federal, 38 are State and local governmental, 86 are commercial or industrial, 7 are universities, and 2 are Canadian.

Proficiency test samples analyzed by each laboratory under the PAT program included inorganic lead, zinc, and cadmium; free silica; asbestos; and eight organic solvents (benzene, carbon tetrachloride, chloroform, ethylene dichloride, p-dioxane, toluene, trichloroethylene, and xylene). The accuracy of the determinations submitted by the participating laboratories has shown a continuing improvement.

A further increase in the number of laboratories participating in the PAT program is expected, particularly by laboratories in the private sector. In addition, the variety of reference samples will be expanded to include a mixture of solvents as a single sample. The feasibility of expanding the number of contaminants used as reference standards will also be studied.

Discussions were held with CDC and congressional aides in an attempt to include the NIOSH laboratory Proficiency Analytical Testing (PAT) program in the amendments to the Clinical Laboratories Improvement Act of 1967. This would give HEW mandated authority to license all laboratories which perform health-related testing.

DIVISION OF CRITERIA DOCUMENTATION AND STANDARDS DEVELOPMENT

The Division of Criteria Documentation and Standards Development (DCDSD)

(1) evaluates various chemical and physical agents and work processes that may pose an occupational health risk;
(2) identifies, in a priority system, high-risk hazards and schedules the development of recommended standards and criteria; and
(3) prepares standards and criteria and transmits them to the Department of Labor or the Department of the Interior, as appropriate, for promulgation in regulations.

EVALUATION AND PRIORITIZATION OF HAZARDS

In 1976, priorities for the development of recommended standards (criteria documents) were identified through FY 1978. In addition, a tentative listing through FY 1979 was completed. The following five parameters were used in setting the priorities:

(1) number of workers exposed,
(2) severity of the toxic response,
(3) potential carcinogenicity,
(4) existence of an OSHA standard, and
(5) new information regarding occupational health hazards (including the recommendations of professional societies and private standards organizations).

Among the facts that must be considered in the establishment of priorities in the future are:

(1) Industry is using many chemicals which have not been evaluated as to their toxic potential.
(2) Criteria documents have already been prepared by NIOSH on exposure to single compounds which place large populations at risk.
(3) Severity ratings for toxicity of chemical compounds and extent of job exposures in past priority lists have not placed enough emphasis on chronic aspects of hazardous agents, including carcinogenicity, mutagenicity, and teratogenicity.
(4) Previous priority lists have not been routinely kept up to date for purposes of monitoring those hazards which may present an immediate problem or emergency situation.

To address the above concerns, a new, more comprehensive priorities system was developed in 1976 for implementation in 1977. The new system makes use of previously unused data banks and information developed by other government agencies, trade associations, and labor unions. Hazards will be identified 3 years prior to the development of criteria documentation so that research divisions will have time to develop data essential to the preparation of standards.

EVALUATION OF SPECIAL HAZARDS

Evaluation of special hazards was begun late in calendar 1975 under the title "Recommended Standards for Carcinogens." This project reflects NIOSH's recognition of the need for alternative forms of health hazard evaluation. These were to provide a more immediate response and more definitive control recommendations than those presented in the more time-consuming criteria documents.

A working priority list of 58 chemical substances with reported carcinogenic effects was established. Bibliographies of pertinent literature were developed. Evaluation procedures and a document format for hazards were then prepared. Information was collected for the 58 subjects, and several were selected as possible candidates for prototype document development.

Organometallics in the Workplace

Chemicals in the organometallics class require singular attention because they did not attain prominence in the industrial world until the 1950's. It was then that they were found to be excellent catalysts in the preparation of high polymers used in the manufacture of plastic construction material, synthetic rubber, and coatings. Because of the rapid expansion of this area, nomenclature is in a state of chaos and ambiguity.

It is essential to first identify organometallics in the workplace before the hazard can be assessed. Identification is being accomplished by contract to provide NIOSH with a three-part list of organometallics:

Part I - Organometallics produced for, and used in, industry and commerce on a large scale.
Part II - Organometallics produced for, and used in, medical and research laboratories, primarily as reagents.
Part III - Organometallics used in research phases of developmental processes, either in industry or academic laboratories.

RECOMMENDED CRITERIA AND STANDARDS

Preparation of Criteria Documents

In the 1976 reporting period, 22 criteria documents were completed and 3 documents revised for transmittal to the Department of Labor (Table 1).

While every attempt is being made to complete criteria documents on schedule, there are potential problems. Most of the earlier documents were on single chemicals, such as carbon monoxide, beryllium, toluene, and benzene. In an attempt to broaden the coverage of criteria documents, a number of groups of compounds were selected, such as alkanes, solvents (refined petroleum), and fluorocarbon polymer decomposition products.

This greatly increases the complexity of preparing criteria documents for the following reasons:

(1) the need to greatly expand the literature search, thereby increasing the likelihood of a delay in identifying and securing copies of the essential literature,
(2) the difficulty in scientifically evaluating and correlating biological data on a group of compounds that, although similar in chemical structure or composition, may be dissimilar in other important respects, and
(3) the difficulty in developing a recommended health standard applicable to the entire group, when the critical biological data may be available for only a small component of the group.

Criteria Document Update and Revision

It is apparent that recommended standards may need periodic revision and that new research information should be added to the older recommended standards in the form of an update addendum.

Since 1972, over 50 criteria documents with recommended standards have been prepared by NIOSH. Of these, several of the standards have been revised, including benzene, carbon tetrachloride, chloroform, and inorganic arsenic, which were revised on the basis of new evidence for carcinogenicity.

It is currently planned to consider a recommended standard for update every 2 years. If there is sufficient new information, or if some outstanding new information has been published (such as carcinogenicity data), a determination is made regarding the need for a complete revision of the NIOSH recommendations. A revision is made only if new information warrants a significant change in the present recommendation. If no revision is warranted, then the update data is published as an addendum to the recommended standard.

Currently, 13 recommended standards are being updated by contract agreement. They are hot environments, carbon monoxide, noise, ultraviolet radiation, inorganic lead, coke oven emissions, toluene, inorganic mercury, vinyl chloride, sulfuric acid, ammonia, cotton dust, and silica. It is anticipated that this activity will be a continuing, long-term program.

Process Standards - Energy

Alternative energy sources are being pursued by the Energy and Research Development Administration (ERDA) to meet the Nation's current and future energy needs.

It is known that certain chemicals and processes related to these developing technologies pose potential safety and health hazards for workers. As an alternative to recommending standards for groups of chemicals per se, NIOSH is attempting to develop standards for processes which involve the potentially toxic chemicals.

During the 1976 reporting period, a contract was awarded for development of two documents: the first, to propose criteria for good work practices in coal gasification pilot plants; the second, to predict and propose control strategies for hazardous exposures in coal gasification demonstration and commercial scale plants. It is anticipated that activities related to research interests in the Environmental Protection Agency (EPA) and the Energy and Research Development Administration will continue through FY 78. These will center around development of guidelines and recommendations for coal liquefaction and oil shale production facilities.

Process Standards - Pesticides

The 1976 edition of the Registry of Toxic Effects of Chemical Substances lists over 1,800 entries which are classified as pesticides. By definition, pesticides are toxic chemicals. They are produced for the purpose of destroying, repelling, preventing, or mitigating any unwanted pest (insect, rodent, nematode, fungus, weed, plant, virus, or bacteria). The preparation of individual standards for each of these pesticides was recognized as a formidable task.

As an initial step to a NIOSH Recommended Standard for Occupational Exposures in the Manufacture and Formulation of Pesticides, NIOSH called a meeting of concerned groups in August 1976 to discuss the tentative NIOSH plans. In attendance were various members of NIOSH and other government agencies. The Oil, Chemical, and Atomic Workers; National Agricultural Chemical Association; and Chemical Specialties Manufacturing Association were also represented. The consensus gained from the participants was that the plan for a single, broad, work practices recommended standard that would protect the employee from the toxic effects of any pesticide is a logical first approach to address an urgent problem.

DCDSD plans to develop a standard that will recommend various work practices, including use of respirators and protective clothing. The main thrust will be to recommend various improvements in engineering and control of hazardous emissions which would affect employee health. The recommended standard will also characterize the industry and describe toxic effects of pesticides.

Standards Completion Program

The standards are developed under this program by joint NIOSH/OSHA working groups, each of which is responsible for a specific function in the technical standards development process. Each completed standard will include procedures for:

(1) informing the employee of potential hazards,
(2) monitoring, engineering, and hazard control mechanisms,
(3) establishing effective monitoring techniques and intervals,
(4) establishing medical surveillance and testing programs, and
(5) evaluating fire and other injury hazards.

During 1976, NIOSH completed its technical input for this project by compiling 94 Draft Technical Standards and transmitting them to the Department of Labor. Notices of availability (for public inspection) for 16 of these were published in the Federal Register by the DOL. Following is a list of those substances for which Notices of Availability have appeared:

(1) acetic anhydride
(2) acetonitrile (methyl cyanide)
(3) acrylonitrile
(4) aniline
(5) cresol, all isomers
(6) dimethylaniline
(7) ethylamine
(8) hydrogen bromide
(9) hydrogen fluoride
(10) morpholine
(11) phenol
(12) phenylhydrazine
(13) pyridine
(14) sulfuric acid
(15) toluidine
(16) xylidine (dimethylaminobenzene)

NIOSH is making an effort to make the vast amount of technical information assembled under the NIOSH/OSHA Standards Completion Program more readily available to employers, employees, occupational health professionals, and others who may be interested. NIOSH, by contract, will edit and condense the collected information and data into nonregulatory language and more easily understood guides for publication. Three technical information documents will result:

(1) An industrial hygiene handbook consisting of a pocketsize volume to include, in tabular form, information on physical and chemical data, personal protection, sanitation, respiratory protection, health hazard data, and medical surveillance on each of approximately 400 toxic substances.
(2) Guidelines to employers for determining, and to employees for learning, appropriate respiratory protection, personal protection, environmental monitoring, first-aid procedures, medical surveillance, and other information for each of approximately 400 toxic substances.
(3) Technical reference documents pertaining to the areas of concern mentioned in (1) and (2) above.

Coal Mine Standards

During 1976, the major involvement of DCDSD in the coal mining standards activity was in the preparation of revised standards for airborne contaminants, noise measurement, and improved sanitation. In March 1976, revised regulations (30 CFR 71.202) were published in the Federal Register. The regulations reduced the standard for maximum exposure to asbestos at surface coal mines and surface worksites of underground coal mines. The standards were reduced to

2 fibers per cubic centimeter of air for a time-weighted 8-hour daily exposure and 10 fibers per cubic centimeter of air for any 1-hour exposure per 8-hour day. These standards provide for increased protection against asbestos, mainly to construction workers and welders.

The new contaminant standards will require a revised schedule for sampling respirable coal mine dust in high-risk occupations. The new standards will also call for the substitution of area sampling for personal sampling of non-high-risk occupations, better "quality control" for dust samples, and a reduction of the silica standard to 50 micrograms per cubic meter of air. The standards will incorporate NIOSH recommended standards for airborne contaminants in the place of the American Conference of Governmental Industrial Hygenists (ACGIH) threshold limit values. The revised regulation on noise measurement will allow the use of integrating sound level meters (noise dosimeters) to determine noise exposure levels. This revision is necessary because noise dosimeters were not generally available when the original regulations were promulgated. The sanitary standards will specify the drinking water criteria developed by the Environmental Protection Agency, and provide for better sanitation in bath houses and change rooms.

In June 1976, a contract was awarded to investigate the types of emergency medical situations which occur in coal mining. The results of this contract will aid in drafting revised regulations concerned with first-aid supplies, training, and emergency medical care and vehicles.

TABLE 1. SUMMARY OF NIOSH RECOMMENDATIONS FOR OCCUPATIONAL HEALTH STANDARDS (Including Revisions) Transmitted to the Department of Labor Jan. 1, 1976 - Sept. 30, 1976.

Substance	Transmitted to OSHA	Current OSHA Environmental Standard	NIOSH Recommendation for Environmental Exposure Limit	Health Effect Considered	Comments
Acetylene	July 1, 1976	2,500-ppm (10% of lower explosive limit)	No exposure in excess of 2,500-ppm	Indirect asphyxia	Employers to check for, and inform employees of, contaminants such as arsine and phosphine
Allyl chloride	September 21, 1976	1-ppm, 8-hr TWA	1-ppm TWA; 3-ppm ceiling (15-minute)	Liver, kidney, lung effects	Urine, blood, and pulmonary function testing required
Benzene	July 24, 1974 Revised August 20, 1976	10-ppm, 8-hr TWA; 25-ppm acceptable ceiling; 50-ppm maximum ceiling (10-minute)	1-ppm ceiling (120-minute)	Blood changes including leukemia	Urine monitoring required
Cadmium	August 23, 1976	0.1 mg/cu m, 8-hr TWA; 0.3 mg/cu m ceiling (fume; erroneously published as 3 mg/cu m) 0.2 mg/cu m, 8-hr TWA; 0.6 mg/cu m ceiling (dust)	40 ug Cd/cu m TWA; 200 ug Cd/cu m ceiling (15-minute)	Lung and kidney effects	Urine and pulmonary function testing required
Carbaryl	September 30, 1976	5 mg/cu m, 8-hr TWA	5 mg/cu m TWA	Nervous system effects	Medical warnings of possible effects on reproductive system and minimum exposure during pregnancy required; skin and eye contact to be prevented

Note - NIOSH Time-weighted average (TWA) recommendations based on up to a 10 hr. exposure unless otherwise noted.

TABLE 1. SUMMARY OF NIOSH RECOMMENDATIONS FOR OCCUPATIONAL HEALTH STANDARDS (Including Revisions) Transmitted to the Department of Labor Jan. 1, 1976 - Sept. 30, 1976. (Continued)

Substance	Transmitted to OSHA	Current OSHA Environmental Standard	NIOSH Recommendation for Environmental Exposure Limit	Health Effect Considered	Comments
Carbon dioxide	August 11, 1976	5,000-ppm, 8-hr TWA	10,000-ppm TWA; 30,000-ppm ceiling (10-minute)	Respiratory effects	
Carbon tetrachloride	December 22, 1975 Revised June 9, 1976	10-ppm, 8-hr TWA 25-ppm acceptable ceiling; 200-ppm maximum ceiling (5 minutes in 4 hours)	2-ppm ceiling (60-minute)	Liver cancer	
Chlorine	May 25, 1976	1-ppm, 8-hr TWA	0.5-ppm ceiling (15-minute)	Eye/airway irritation	Chest X-rays required
Chloroform	September 11, 1974, Revised June 9, 1976	50-ppm ceiling	2-ppm ceiling (60-minute)	Liver or kidney tumors and central nervous system effects	Current Federal standard should be TWA: published as "C" in error
Epichlorohydrin	September 17, 1976	5-ppm, 8-hr TWA (20 mg/cu m)	2 mg/cu m TWA; 19 mg/cu m ceiling (15-minute)	Skin, kidney, liver, and respiratory system effects	Medical warning of possible infertility effects required; hazardous liquid, skin
Ethylene dichloride	March 9, 1976	50-ppm, 8-hr TWA 100-ppm acceptable ceiling; 200-ppm maximum ceiling (5-minutes in 3 hours)	5-ppm TWA 15-ppm ceiling (15-minute)	Nervous system, respiratory, heart, liver effects	Nursing infants at risk

TABLE 1. SUMMARY OF NIOSH RECOMMENDATIONS FOR OCCUPATIONAL HEALTH STANDARDS (Including Revisions) Transmitted to the Department of Labor Jan. 1, 1976 - Sept. 30, 1976. (Continued)

Substance	Transmitted to OSHA	Current OSHA Environmental Standard	NIOSH Recommendation for Environmental Exposure Limit	Health Effect Considered	Comments
Hydrogen fluoride	March 9, 1976	3-ppm, 8-hr TWA	2.5 mg F/cu m TWA; 5.0 mg/cu m ceiling (15-minute, fluoride ion)	Skin/eye/airway irritation; bone effects	Pelvic X-ray (male) and urine testing required
Isopropyl alcohol	March 9, 1976	400-ppm, 8-hr TWA	400-ppm TWA, 800-ppm ceiling (15-minute)	Mucous membrane irritation; possible cancer threat in manufacturing process	More stringent work practices and medical surveillance for manufacturing workers
Kepone	January 27, 1976	None	1 ug/cu m ceiling (15-minute)	Nervous system effects; liver cancer	Liver function testing required
Malathion	July 1, 1976	15 mg/cu m, 8-hr TWA	15 mg/cu m TWA	Nervous system effects	Skin contact to be prevented; blood chemistry monitoring required
Methyl alcohol	March 22, 1976	200-ppm TWA 500-ppm ceiling	200-ppm TWA; 500-ppm ceiling (15-minute)	Blindness; metabolic acidosis	
Methyl parathion	September 30, 1976	None	0.2 mg/cu m TWA	Nervous system effects	Skin contact to be prevented; blood chemistry monitoring required

TABLE 1. SUMMARY OF NIOSH RECOMMENDATIONS FOR OCCUPATIONAL HEALTH STANDARDS (Including Revisions) Transmitted to the Department of Labor Jan. 1, 1976 - Sept. 30, 1976. (Continued)

Substance	Transmitted to OSHA	Current OSHA Environmental Standard	NIOSH Recommendation for Environmental Exposure Limit	Health Effect Considered	Comments
Methylene chloride	March 9, 1976	500-ppm, 8-hr TWA; 1000-ppm acceptable ceiling; 2000-ppm maximum (5-minutes in 2 hours)	75-ppm TWA; 500-ppm ceiling, (15-minute). TWA to be lowered in presence of carbon monoxide	Central nervous system effects; carbon monoxide toxicity	Blood testing required
Nitric acid	March 9, 1976	2-ppm, 8-hr TWA	2-ppm TWA	Dental erosion, nasal/lung irritation	Hazardous liquid, eyes and skin. Chest X-ray required
Nitrogen oxides	March 22, 1976	NO_2: 5-ppm, 8-hr TWA	NO_2: 1-ppm ceiling	Airway effects	Pulmonary function testing required
		NO: 25-ppm, 8-hr TWA	NO: 25-ppm TWA	Blood effects	
Parathion	June 30, 1976	0.1 mg/cu m TWA	0.05 mg/cu m TWA	Nervous system effects	Skin contact to be prevented; blood chemistry monitoring required
Phenol	June 30, 1976	5-ppm, 8-hr TWA	20 mg/cu m TWA; 60 mg/cu m ceiling (15-minute)	Skin, eye, CNS, liver, and kidney effects	Hazardous substance, skin and eyes
Phosgene	February 23, 1976	0.1-ppm, 8-hr TWA	0.1-ppm TWA; 0.2-ppm ceiling (15-minute)	Airway effects	Pulmonary function testing and X-ray required

TABLE 1. SUMMARY OF NIOSH RECOMMENDATIONS FOR OCCUPATIONAL HEALTH STANDARDS (Including Revisions) Transmitted to the Department of Labor Jan. 1, 1976 - Sept. 30, 1976. (Continued)

Substance	Transmitted to OSHA	Current OSHA Environmental Standard	NIOSH Recommendation for Environmental Exposure Limit	Health Effect Considered	Comments
Tetrachloroethylene	July 2, 1976	100-ppm, 8-hr TWA; 200-ppm acceptable maximum ceiling; 300-ppm maximum ceiling (5-minutes in 3 hours)	50-ppm TWA; 100-ppm ceiling (15-minute)	Nervous system, heart, respiratory, liver effects	Medical warning of possible congenital abnormalities required
1,1,1-Trichloroethane	July 2, 1976	350-ppm, 8-hr TWA	350 ppm ceiling (15-minute)	Nervous system, liver, and heart effects	Action level set at 200-ppm TWA; medical warning of possible congenital abnormalities required

DIVISION OF SURVEILLANCE, HAZARD EVALUATIONS, AND FIELD STUDIES

The Division of Surveillance, Hazard Evaluations, and Field Studies (DSHEFS)

(1) develops and maintains a surveillance system of the Nation's workers and their workplaces to make an early detection and continuous assessment of the magnitude and extent of job-related illnesses, exposures, and hazardous agents;
(2) conducts the legislatively mandated health hazard evaluation and industrywide epidemiological research programs through longitudinal record studies and clinical/environmental field studies and surveys to identify the occupational causes of disease in the working population and their offspring. They are also used to determine the incidence and prevalence of acute and chronic effects from work-related exposures to toxic and hazardous substances;
(3) conducts epidemiolcgical research for input to criteria for standards for the control of occupational health hazards;
(4) provides (upon request and on a self-initiated basis) technical assistance demonstrations, and consultation on technical matters pertaining to occupational safety and health to other Federal agencies, State and local agencies, other technical groups, unions, employers, and employees.

These responsibilities are conducted in three functional areas: Surveillance Branch, Hazard Evaluations and Technical Assistance Branch, and Industrywide Studies Branch. Statistical and computer expertise, along with medical (clinical) support services are provided within the Division by the Support Services Branch.

Functional areas, the accomplishments and unsolved problems during January - September 1976, and direction of future research are discussed below.

HAZARD EVALUATIONS AND TECHNICAL ASSISTANCE

Approximately 55 man-years of internal NIOSH personnel, under DSHEFS coordination, are expended in the area of hazard evaluations and technical assistance on an annual basis.

Health Hazard Evaluations

NIOSH has been engaged, since 1971, in the Health Hazard Evaluation Program, which was developed to implement the provisions of Section 20(a)(6) of the Act.

The regulation which describes the conditions and procedures whereby NIOSH conducts this program is found in 42 CFR Part 85. The regulation is applicable to requests received from any employer or authorized representative of employees in establishments covered by the Act.

During the period January 1 through September 30, 1976, there were over 80 Health Hazard Evaluation Toxicity Determination Reports completed and distributed. Forty-seven of these identified toxic or potentially toxic exposures

under the conditions found. A full listing of these reports (incorporating the establishment investigated and chemical substances evaluated, with the determinations of toxicity (+) or nontoxicity (-)) is presented in Appendix A.

Technical Assistance

Industrial hygiene, engineering, medical, and nursing assistance was furnished to Federal, State, and local agencies (as well as to industry and other groups). This was to aid them in their specific needs, such as in recognizing, evaluating, and controlling existing or potential health hazards.

Appendix B provides a listing of the completed "technical assistance" efforts from January 1 through September 30, 1976. As illustrated by this summary, a major effort was expended for assistance to other Federal agencies.

Future Directions of the Hazard Evaluations and Technical Assistance Programs

At the conclusion of September 1976, the Hazard Evaluations and Technical Assistance Programs were actively pursuing 102 legislatively mandated health hazard evaluations and 51 technical assistance projects.

In view of the limited manpower and dollar resources available to the programs, it was determined to limit response to other Federal agencies' requests. It would be limited to health hazard evaluations and technical assistance for those complex problems that require the special expertise and capabilities of NIOSH.

A comprehensive plan to improve the Hazard Evaluations and Technical Assistance Programs was enacted in April 1976. Operating procedures implemented under this plan are being carefully scrutinized. As part of this plan, additional medical manpower (such as from the CDC Epidemic Intelligence Service Program and professional service contracts) is being obtained to enhance the quality and timeliness of the responses. This plan also calls for more universal distribution and advertisement of the reports (e.g., National Technical Information Service [NTIS] availability, notification of availability through NIOSH publication lists, and technical journal announcements). In addition, the larger use of the information in the final reports for NIOSH surveillance activities is being contemplated. Improvements in the relationship with OSHA, concerning their use of the information in the reports, are being proposed and will be initiated through detailed exchange of the data at NIOSH/OSHA "monthly working group" meetings.

SURVEILLANCE (HEALTH)

The two subprograms within the surveillance program of DSHEFS are structured to access and organize information on causes (hazard surveillance) and results (illness effects surveillance) of occupational disease.

Project efforts within the programs are directed toward the early detection of occupational disease (malignant and nonmalignant), or the potential for its occurrence, and prevention through education and development of controls.

In the 1976 reporting period, a Task Force on Surveillance was established to provide recommendations for the future direction of the program. The Task Force deliberations are being augmented by requesting input from industry spokesmen, labor representatives, other government agencies, and members of the occupational health and safety community.

Hazard Surveillance

The National Occupational Hazards Survey (NOHS), initiated in 1972, provided the basis for much of this activity during the reporting period. Data gathered during on-site investigations of approximately 5,000 plants were organized and prepared in accessible form. The acquisition of a data base management system, in conjuction with appropriate projection algorithms, will permit utilization of the data to establish the types of hazards associated with a particular industry or occupation, conditions of intended control measures, and the development of national statistics describing numbers of workers exposed to a particular hazard.

A project effort, which accompanied the NOHS, involved an extensive effort to resolve trade name products (which were observed during the survey) into chemical components. Over 10,000 manufacturers of trade name products were contacted for product formulations. Currently, about 45,000 products have been satisfactorily resolved into specific chemical constituents, and effort continues to effect resolution of all trade name products noted during NOHS. As the additional data is received, the NOHS data base will be updated to present as complete and accurate a picture, as possible, of worker exposure to occupational hazards.

A related and supportive project addressed the task of assembling a hazard data base (a system of accessing detailed information on particular hazards).

Future activities include extensive dissemination of NOHS results, maintenance of an updated trade name product ingredients file, and investigation of new surveillance techniques, including the construction of sampling models for industrial hazard data. Attention will be directed toward the development of efficient systems to collect, analyze, and disseminate information in a timely and efficient manner.

Illness Effects Surveillance

The illness effects surveillance consisted of focusing upon the various indices of worker health, particularly the identification and assessment of unusual morbidity and mortality patterns of disease as they relate to occupation. Data describing the types and incidence of occupational diseases and deaths were collected, analyzed, and disseminated. In addition, epidemiologic research directed at selected occupational cohorts or work environments was conducted.

The occupational and cause-of-death information on death records of 300,000 Washington State males (age 20+) for the years 1950-1971 was analyzed. A detailed cause of death analysis (160 causes) was published for each of 194 occupational classes. The complete report was published in August 1976 as a three-volume NIOSH Technical Report (76-175 A,B, & C).

A "Study of Cancer in Relation to Occupation," completed in September 1976, identified the following correlations between occupation and cancer: leather workers/bladder cancer, dairy farmers/bladder cancer, hairdressers and cosmetologists/genital cancers. Results of the study have been assembled for publication and are currently under review.

In addition to these epidemiological research efforts, considerable effort has been devoted to establishing occupational health data retrieval systems. Recently completed is a computer file which includes data from the National Cancer Institute publication "U.S. Cancer Mortality by County: 1950-1969." The file includes observed numbers of deaths and age-adjusted death rates for each race and sex group, by cancer site, for the total U.S. population and for every U.S. county and State. From this information, expected numbers of cancer cases were calculated using U.S. rates and state rates along with standardized mortality ratios (SMR's). Each SMR was analyzed for statistical significance. This information is stored in the computer and can be retrieved in specified tabular form. This automated retrieval system has recently been used in:

(1) assessing death rates and SMR's for leukemia in counties with plants producing styrene-butadiene rubber and other allied products, and
(2) producing tables on mortality for selected cancer sites in counties identified with substantial numbers of persons employed in the leather and leather products industry.

In response to a nationwide concern over the possible association of leukemia with the manufacture of styrene-butadiene rubber, a symposium was organized on April 30, 1976. This allowed industry and labor, as well as appropriate scientists, to present timely input.

In evaluating information gained from special sources, NIOSH completed two investigations of cancer clustering. One involved brain tumor cases at a steel mill in Wheeling, West Virginia. The other was a follow-up mortality analysis of a chemical plant for the State of Maryland. Another cancer investigation involving possible clustering of pancreatic cancer in a chemical plant in Massachusetts is still under way.

INDUSTRYWIDE STUDIES

In compliance with the Act, NIOSH pursues a continuing program of industrywide research studies, the objectives of which are to:

(1) determine the health experience of current or former workers,
(2) evaluate the occupational environment in terms of stressful agents present, degree of exposure, sources of contaminants, and controls presently employed,
(3) develop, to the extent possible, an exposure/response relation between each agent, or combination of agents, and incidence of specific diseases or biological changes that may lead to disease,
(4) design sampling methods and environmental survey strategies that will characterize the environment as it relates to the health of individuals, and
(5) devise medical examination procedures for detecting the effects, in employees and their offspring, of acute or chronic exposures to harmful agents. The emphasis is on detection of early, preclinical changes or on methods to identify susceptible individuals.

A regulation to assist in conducting industrywide studies, and to identify NIOSH and employer responsibilities during such studies, was proposed in the Federal Register in June 1975 and was promulgated in October 1976. It applies not only to NIOSH industrywide studies [Section 20 (a)(7) of the Act], but to all NIOSH activities that are covered under Section 20 of the Act, except for the health hazard evaluations and grant activities. (Existing regulations 42 CFR Part 85 and 42 CFR Part 87, respectively, already cover these excepted subjects.)

Occupational populations selected for study and the degree to which health effects are measured are governed, within the limits of available personnel and funds, by:

(1) the level of suspicion concerning possible adverse health effects resulting from occupational exposures,
(2) the feasibility of recovering information of the required validity on occupational exposures and health effects, either by study of existing records, or by detailed environmental, medical, and biostatistical studies,
(3) the size of the population that is potentially affected, and
(4) the potential severity of adverse health effects.

Investigations are sometimes limited to gross analyses of health effects (e.g., mortality patterns) where data resources such as records of employment, occupational exposures, or health status are available.

In-depth studies are undertaken where a review of the available information suggests that serious health hazards exist, but where the existing data resources are inadequate. Sufficient information to determine health effects of exposure to a toxic agent may be obtained from workers in a facility if the group is large enough for statistically meaningful analyses. In other instances, the population and environments of several plants in a particular industry, or of workers in different industries having a similar exposure, may have to be pooled to obtain definitive data.

Environmental Investigations

Environmental investigations are primarily designed to characterize the types and levels of contaminants and physical agents to which employees are, and have been, exposed. This allows the information to be related to biological effects as determined by medical and biostatistical investigations.

Environmental surveys also evaluate the types and effectiveness of engineering control procedures and work practices to judge industry's ability to meet criteria document recommendations and OSHA standards. Results and recommendations are forwarded to management and union representatives, and to appropriate health and labor agencies.

Medical Investigations

Cross-sectional medical studies (each a study of a specific worker population at one point in time) are conducted to:

(1) determine the prevalence and incidence of occupational diseases,
(2) determine and interpret pertinent occupational, medical, and social variables that correlate with occupational disease,
(3) investigate and determine the chronic effects of low-level occupational exposures on various tissues and organ systems,
(4) determine the sensitivity and specificity of various early diagnostic techniques,
(5) delineate disease processes of occupational origin under continued and terminated exposure conditions, and
(6) disseminate public health education concerning disease causation and prevention.

Medical findings, both normal and abnormal, are reported to the examinee and to authorized physicians. Information about the cause, manifestation, course, and clinical features of occupational disease is distributed to management, union representatives, the general medical community involved, and to OSHA.

Biostatistical Investigations

Biostatistical investigations apply statistical techniques to data collected from environmental and medical investigations to define relationships between occupational exposures to particular agents and subsequent disease. A significant part of this program is concerned with analyses of employment and mortality and morbidity data for individuals who have worked in specific occupations and industries. The studies, often, are made of a retrospective cohort, i.e., a group of persons for whom NIOSH has enough health and exposure data for the study of a former time when they had the same occupation.

The biostatistical program often makes use of innovative statistical methods (experimental design, analysis of variance, regression analysis, and other qualitative data analyses). These are used to demonstrate exposure/response phenomena and to elucidate cause/effect relationships between environmental exposures in industry and risk of morbidity or mortality.

In addition, exposure time/response models are being developed to project the risk of disease at selected levels of exposure where direct observation is not possible.

Specific research included studies of nonmalignant disease and occupational carcinogenesis in the metal and fiber industries and from exposures to dust and halogenated hydrocarbon. Special attention was given to problems in the energy industry, to occupational disease associated with women in the work force, and to the offspring of workers. Accomplishments included cohort selection, employee record microfilming, data coding, building of master files, industrial hygiene surveys, worker medical examinations and testing, and data analyses. Individual reports were prepared on all industrial hygiene surveys and walk-through surveys.

NONMALIGNANT DISEASE PROJECTS

As summarized in Appendix C, in 1976, industrywide epidemiological research investigated nonmalignant respiratory, heart, and neurological disease, as well as other diseases. A major cross-sectional medical study, including industrial hygiene, of brick industry workers and granite sheds was completed.

MALIGNANT DISEASE PROJECTS

The following projects were begun in this reporting period (see Appendix D) to study occupationally-induced malignancies:

(1) Investigation, through environmental surveys, of workers exposed to various halogenated hydrocarbons (including vinyl halides, methyl chloride, and benzyl chloride). (To assess in-plant contaminant levels, worker exposures, work practices, and environmental controls.)
(2) Investigation of styrene-butadiene rubber workers through a retrospective cohort mortality study and environmental surveys. (To detect the extent of risk of cancer.)
(3) Investigation of pesticide formulator workers through a retrospective cohort mortality study. (To detect the extent of risk of cancer.)
(4) Investigation of pharmaceutical workers through a cross-sectional medical study. (To detect the extent of risk of miscarriages and birth defects in the offspring of exposed workers.)
(5) Investigation of carbon disulfide workers using retrospective cohort mortality studies. (To evaluate the association between exposures to carbon disulfide and cardiovascular disease.)

The following major projects were completed and results made available during this reporting period:

(1) Steelworkers - see page 43, item 5.
(2) Cross-sectional comparison of cause-specific proportionate mortality with that of the general population for wood-exposed workers from the United Brotherhood of Carpenters and Joiners.
(3) Industrial hygiene assessment of possibility of spontaneous formation of bis-chloromethyl ether.
(4) Cross-sectional medical study of vinyl chloride workers.

Energy Projects

During this reporting period, DSHEFS continued its energy program in industry-wide studies, initiated in calendar year 1975 and discussed in the 1975 Annual Report. Ongoing studies include:

(1) retrospective cohort mortality analyses and environmental surveys of slag wool production workers, clay fiber workers, and sulfuric acid- and sulfate-exposed workers, and
(2) environmental surveys of coal gasification pilot plants. (See Appendixes C and D.) It should be noted that considerable inter-agency cooperation between NIOSH, the Environmental Protection Agency, and the Energy Research and Development Administration was involved in developing the study protocol for the coal gasification study.

Women in the Work Force Projects

A new initiative for the Institute is the study of the teratogenic and mutagenic effects associated with occupational exposures to toxic agents. Although DSHEFS had no mandated program area for the 1976 reporting period, three studies involving other NIOSH program areas covered this important matter of "Women in the Work Force."

Because of evidence of increased risk of miscarriages and anomalies in the offspring of exposed workers (see previous Annual Reports), a criteria document for recommended standards on waste anesthetic gases is being developed. A pilot study to determine the risk of congenital anomalies in lead smelter workers was conducted. These results will be included in the final report on the investigation. Female pharmaceutical laboratory workers are being studied to determine the risk of miscarriages and birth defects related to employment.

Specific Studies

A selection of the industrywide studies that were ongoing in the 1976 reporting period are presented below in order to exemplify the epidemiological evaluation process.

(1) The current OSHA silica standard (0.1 mg/m^3) and the recommended NIOSH standard (50 µg/m^3) have been opposed by the brick manufacturing industry, particularly in North Carolina. Despite industry claims that no excess of silicosis or other chest disease has been discovered in North Carolina for the past 10 years, further review of medical data compiled by the State showed the presence of other chest pathology. Additional study is needed either to justify the use of the current standard or to give further support to the theory of process-specific standards. All medical and industrial hygiene data have been collected and are undergoing analysis.

(2) A contract has been awarded to conduct a retrospective cohort mortality study on viscose rayon workers exposed to carbon disulfide (CS_2). This is generally associated with central nervous system effects and is now thought to increase mortality and morbidity from cardiovascular disease.

(3) A cross-sectional medical and industrial hygiene survey of one lead smelter was conducted to evaluate:

(a) arsenic and cadmium carcinogenicity,
(b) lead and cadmium nephrotoxicity,
(c) lead, as it relates to central and peripheral nervous system damage and/or dysfunction,
(d) sulfur dioxide and sulfuric acid mist, as they relate to both acute and chronic respiratory dysfunction,
(e) cadmium, copper, antimony, nickel, and zinc fumes, as they relate to metal fume fever,
(f) cadmium fume, as it relates to acute pneumonitis and/or acute pulmonary edema,
(g) general respiratory tract irritation, including pulmonary edema,
(h) antimony carcinogenicity,
(i) cobalt, as it relates to chronic interstitial pneumonitis, as well as skin and respiratory allergic reactions, and
(j) arsine, as it relates to massive hemolysis leading to renal failure.

The medical and industrial hygiene data collection was completed and data analyses initiated.

(4) A contract has been developed and awarded to conduct an industry-wide study of coal gasification which will define appropriate industrial hygiene and control technology practices. This is to reduce exposure to polycyclic hydrocarbons (related to coke oven emissions which are associated with excess risk of lung cancer).

(5) A NIOSH contract continued its retrospective cohort mortality study of the steel industry. Tables of mortality by work area were developed for:

(a) steelworkers employed in 1953 followed through 1970,
(b) steelworkers employed in 1961 followed through 1970, and
(c) steelworkers employed in 1953 followed through 1962 (as contrasted with steelworkers employed in 1961 followed through 1970).

The contract has been modified to extend the follow-up period through 1975.

Results of this study have been widely disseminated in the following forms:

(a) a doctoral dissertation,
(b) excerpts from material presented at the OSHA coke oven hearings,
(c) several papers published or awaiting publication in the Journal of Occupational Medicine, and
(d) in the New York Academy of Sciences' publication of the proceedings of the Conference on Occupational Carcinogenesis.

(6) Prompted by animal studies and by recent information from England indicating increased risk of lung cancer, a retrospective cohort mortality and industrial hygiene study of the antimony smelting industry was initiated. The master file for the selected cohort is being established, and the industrial hygiene report for use in identifying worker exposure classification, etc., is being prepared.

(7) A retrospective cohort analysis and industrial hygiene study of rubber workers exposed to benzene was initiated to investigate damage to the hematopoietic system and development of leukemia. Literature searches, walk-through surveys, and cohort selection have been completed. Personnel records were microfilmed and coding of data begun. The industrial hygiene portion of the study was delayed because of the rubber workers' strike.

(8) A final report of a contracted study of bis-chloromethyl ether (BCME), a potent lung carcinogen, is in preparation. Preliminary data indicate that the presence of reactants needed for BCME appeared in low ppm levels in textile finishing operations. No BCME was detected above 0.1 ppb in the textile environment using separate gas chromatography and gas chromatography/mass spectrometer analysis.

(9) Through expert testimony, report preparation, etc., NIOSH has assisted OSHA's efforts to enforce existing talc standards against industry objections. Scientific evidence to support the adequacy of OSHA standards for talc exposure is not, however, conclusive. Cross-sectional medical, retrospective mortality, and industrial hygiene studies are being conducted to determine if talc workers face excess risk of disease and to determine a protective mass standard (in lieu of the present impinger standard) for nonfibrous talc. The studies also are to characterize various commercial talc deposits in the U.S. as to asbestos and free silica content and to develop or evaluate analytical methods for talc in regard to asbestos content. The industrial hygiene surveys of the talc operations in New York and Vermont have been completed and reports are in preparation. The initial phases of the cross-sectional medical study of Vermont talc workers are complete. The mortality studies of New York and Vermont talc workers are progressing; the master files have been developed and acquisition of death certificates has been initiated.

(10) A retrospective mortality study was initiated to evaluate the potential for excess chronic and long-latency occupational disease among pesticide formulators. The contracted study will determine the mortality status of approximately 5,000 workers (employed for a minimum of 12 months prior to 1960). It will be a retrospective study of a cohort of workers who were initially employed as formulators between January 1, 1960, and December 31, 1975.

Future Direction of Industrywide Studies and Surveillance

The direction of this epidemiological research and surveillance in the future will be to:

(1) continue providing input for criteria standards for control of occupational health hazards,
(2) expand the emphasis on occupational cancer surveillance and field studies,
(3) expand surveillance and field research in the rapidly developing energy industries,
(4) provide much needed information on occupational diseases associated with the working woman,
(5) determine the impact of occupational exposures on the offspring of workers, and
(6) implement the recommendations of the Surveillance Task Force.

DIVISION OF BIOMEDICAL AND BEHAVIORAL SCIENCE

In 1976, the Biomedical and Behavioral Applied Research Program continued research within the areas of:

(1) toxicology, physiology and ergonomics,
(2) behavioral and health motivational factors, and
(3) physical and biological agents.

Significant laboratory research programs are under way in the areas of:

(1) occupational carcinogenesis,
(2) teratogenesis,
(3) mutagenesis,
(4) behavioral toxicology,
(5) occupational stress factors, and
(6) general support of Federal occupational health standards.

The NIOSH toxicology program serves as a worldwide clearinghouse for receipt and dissemination of data and applied information on the toxicity of industrial materials. This activity creates an effective rapport among government, industry, and labor organizations which have a vital, mutual interest in toxicologic problems. In 1976, the program utilized a coordinated, multidisciplinary approach in conducting studies. These ranged from evaluations of acute toxic hazards to mechanistic and dose-response studies of industrial disease under controlled laboratory experimentation. Major emphasis was placed upon high production industrial chemicals whose carcinogenic, mutagenic, and teratogenic potentials were unknown.

Inhalation Studies

Long-term inhalation studies were conducted to provide data for the development and modification of criteria for use in the issuance of recommended Federal industrial air standards for chlorobenzene, ethanolamine, nitropropane, cyanogen, a mixture of nitrous oxide and halothane, methyl-n-amyl ketone, three amorphous silicas differing in manufacturing processes, coal slag, and polyvinyl particulate.

The significant findings of these investigations include the following:

(1) Exposure of impregnated female rats to anesthetic mixtures of nitrous oxide and halothane resulted in positive reproductive, embryotoxic, mutagenic, and teratologic effects.
(2) Methyl-n-amyl ketone was assessed as a possible inducer of clinical neuropathy in humans. This was based upon the frank peripheral and central nervous system impairments in animals from repeated exposure to methyl-n-butyl ketone at the current Federal industrial air standard of 100 ppm. However, no neurologic impairments were noted in animals exposed to methyl-n-amyl ketone at either 100 or 1,000 ppm.
(3) Ingestion of high doses (1.6 to 3.0%) of terephthalic acid and dimethylterephthalate by experimental animals resulted in the formation of urinary calculi. Accordingly, 6-month inhalation studies of these terephthalates were performed at a total nuisance dust level

of 10 to 15 mg/m^3 with a respirable dust fraction of 5 mg/m^3. No evidence was found that supported the hypothesis that inhalation of terephthalates results in the formation of renal or bladder calculi or any other pathologic lesions.

Tissue Distribution Studies

Another major effort within the toxicology research program deals with identifying the toxic mechanisms of industrial diseases. This is done by correlating experimental results on animals with clinical and pathologic changes found in workers. A direct correlation was demonstrated between tissue distribution and pathologic changes observed with the suspect carcinogen, 1,2-dibromoethane (ethylene dibromide).

Special Program Support

Exposure limits were defined for 15 chemicals. Exposure to the chemicals could result in the inability to escape from hazardous environments. Also, it could cause chronic or irreversible tissue changes in the event of respiratory equipment failure of up to 30-minutes duration. Forty substances were tested for skin irritation and/or skin sensitization potential, following requests from the NIOSH Hazard Evaluation Program.

Coal Mine Dust Inhalation Study

Statistical analyses of data derived from a 4 1/2-year inhalation study of monkeys exposed to bituminous coal dust have been completed. A comprehensive final report summarizing the numerous biologic indices investigated is being prepared.

Another study was completed on the hazard of coal tar in producing bronchogenic carcinoma and other cancers. Results of an 18-month inhalation study of coal tar aerosols at 10 mg/m^3 reveal lung squamous cell carcinoma in 100% (38/38) of the male rats and 82% (31/38) of the female rats tested. It also revealed an increased incidence of alveologenic carcinoma in two strains of mice. In addition, the coal tar was separated into acid, base, and neutral fractions. Of seven neutral subfractions tested for carcinogenicity, two produced gross skin tumors in mice. There was no evidence, however, of metastasis or invasiveness. Histopathological evaluation of tissues will be performed and a final report prepared.

Heat Stress

A contractural study performed at the University of Alabama was completed in 1976. It compared the heat tolerance of women employed in hot jobs with that of women working in not-hot jobs, and also with the heat tolerance of men employed in hot and not-hot jobs. The results showed that, on the average, women employed in hot jobs tolerate heat better than women employed in not-hot jobs. It also showed that women in hot jobs may tolerate heat as well as men in hot jobs if the stress level is below the threshold Wet Bulb Globe Thermometer (WBGT) values recommended by the OSHA Standards Advisory Committee

on Heat Stress. If the stress level is higher, women may be more prone to reaching higher body temperatures and heart rates which might make them more susceptible to heat illnesses.

The results of a study performed at the Pennsylvania State University do not support the recommendation by the OSHA Standards Advisory Committee on Heat Stress in 1973. The recommendation was that if wind speed at the job site exceeds 300 fpm, a correction of 5-6°F WBGT should be applied to the cut-off points. This means that preventive measures have to be introduced only at 5-6°F WBGT higher exposure levels. This discrepancy may be the consequence of the fact that, in the Pennsylvania study, the subjects were exposed to heat and work wearing the same type of garments that workers wear in most hot jobs. In contrast, in most studies published in the literature, on which the Advisory Committee recommendation was based, the subjects wore only shorts and gym shoes.

Vibration

During 1976, NIOSH continued studies on the hazards associated with exposure to vibration, with main emphasis on assessment of workers' exposure. The significance of this area of research is underlined by the fact that there are about 8 million workers in the U.S. exposed to occupational vibration.

A unique van was designed and constructed for the purpose of monitoring driver exposure to vibration, as well as some of the physiological responses. A field study was conducted to assess the exposure to vibration of heavy equipment operators. The study was conducted with the close cooperation of the International Union of Operating Engineers at their California Training Facility. Fourteen variables were continuously monitored on 16 different vehicles and their operators.

Medical record studies are being continued, particularly to clarify why ischemic heart diseases, diseases of the male genital organs, certain metabolic diseases, and diseases of the bones and joints are occurring in excess among heavy equipment operators.

NIOSH sponsored an International Symposium in Cincinnati on the health hazards associated with operation of pneumatic and electrical hand tools. Participants presented data indicating that workers using these tools are likely to develop circulatory and neurological impairment of the hand. NIOSH is planning a study to identify the extent of this disorder in exposed populations in the U.S., as well as its pathophysiological and exposure characteristics.

Biomechanics of Materials Handling

NIOSH continued studies to establish effective methods for protecting workers from injuries associated with lifting and handling loads. Results from a contractual study indicate that an effective method of limiting injuries of heavy lifting jobs is to assess strength capabilities of workers prior to placement on these jobs.

NIOSH sponsored an International Symposium on Safety in Manual Materials Handling Tasks. Investigators from Great Britain, Sweden, Germany, and the United States presented different methods for establishing effective limits for amounts and frequency of load lifting to prevent injuries.

Stress Measurement

Research was continued for the development of a method for the early detection of detrimental effects associated with an excessive work load. This research was on a work load which implied that the worker was more susceptible to disease and less tolerant to toxic substances and physical agents of the work environment. Experiments performed on human subjects showed that fatigue because of heavy physical work causes a deterioration of homeostatic control over cardiorespiratory functions.

This phenomenon was assessed quantitatively by calculating a Cardiovascular Variance Score (CVS). The CVS can be utilized for identifying jobs which are too strenuous for a worker and for determining whether the rest-time available to the worker is enough for complete recovery. Furthermore, studies can now be undertaken on larger worker populations to determine the long-term health effects of high intensity physical work, using the CVS as an indicator.

Behavioral Toxicology

The effects of carbon disulfide (CS_2) (a solvent used primarily in the manufacture of viscose rayon) on human performance and neurologic function were studied in 139 workers. A comprehensive, neurobehavioral battery of tests was administered to each worker and correlated with CS_2 exposure history. Findings showed workers exposed to CS_2 exhibited:

(1) slowed nerve conduction velocities,
(2) abnormal electrodiagnostic scores,
(3) slowed reaction times,
(4) slowed speed of visual search,
(5) impaired hand dexterity, and
(6) reduction in short-term memory.

The effects of methyl chloride on neurologic function and performance capabilities were studied in 171 workers. (Methyl chloride is a solvent used in the manufacture of synthetic rubber, silicones, and tetramethyl lead.)

A neurobehavioral test battery and a general neurologic examination were given to each worker. Methyl chloride levels within plant air were found to average 34 parts per million (ppm). No adverse effects of methyl chloride were noted in the neurologic examinations. However, workers' performance on tests of time-shared tasks (divided attention) was degraded and the magnitude of arm tremor was found to increase with exposure to methyl chloride.

The potential effects on visual function of a common eye irritant, formaldehyde, was examined in the synthetic garment and wood products industries. A visual function test battery was administered to 50 workers to evaluate acute effects of formaldehyde. In addition, a comprehensive opthalmologic examination was performed on 83 workers to ascertain if chronic exposure to formaldehyde had

caused eye damage. No evidence of either acute or chronic damage to the visual system attributable to formaldehyde was found for formaldehyde levels reaching 1.4 ppm.

The possible interactive effects of perchloroethylene (PCE), Valium, and ethanol were investigated in a controlled, human laboratory study. PCE is a widely used solvent in the drycleaning industry. Subjects were exposed to low concentrations of PCE in combination with either alcohol or Valium (at therapeutic dose levels) and given neurologic examinations and behavioral tests. Although decrements in performance were noted with PCE, alcohol, and Valium, no interactive effects on performance were found for PCE/alcohol or PCE/Valium combinations.

A study of the possible neurobehavioral effects of methyl-n-amyl ketone (MAK), a solvent used in paint, varnish, and adhesives formulations, was completed. Laboratory animals (rats and monkeys) were exposed (for 6 hours per day, 5 days per week, for 1 year) to 0, 100, or 1,000 ppm MAK. No neurotoxic damage occurred at any of the three exposure levels after 1 year of MAK exposure.

Motivational Factors

Questionnaires and site visits were used in surveys of successful safety program practices among five plants designated by the National Safety Council as "best no-lost-time injury plants." Distinctive characteristics associated with superior safety performance were found to be:

(1) strong management commitment to safety,
(2) management control of "total loss" through systems safety methods,
(3) a humanistic approach to supervision,
(4) use of safety information feedback as an incentive for promoting safety consciousness, and
(5) use of special safety emphasis programs.

A NIOSH contract study evaluated the impact of psychological, behavioral, and organizational factors upon the safety performance of coal miners. A sample of 1,000 mine personnel selected from 15 matched pairs of high- and low-accident rate mines was surveyed. The survey covered worker attitudes toward safety and accident causation, use of safety and health equipment, job safety practices, and related occupational safety issues. The data indicated that keeping good safety records, correcting safety hazards in the mine, having miners wear protective equipment, and upholding the company's safety record were more important to management in low-accident mines than to management in high-accident mines. Companies in which workers perceived management as having a great concern for safety did, in fact, have better safety records than those where this was not perceived.

The importance of human factors in safe operation of forklift trucks was the basis for development of a training program concerning hazard recognition for forklift truck operators. This program consisted of an instructor's manual, approximately 500 slides of job hazard sequences, and a description of each hazard sequence.

The effectiveness of positive social reinforcement for increasing the use of personal protective equipment by workers in a shipyard was evaluated. Results indicated that four of the five work crews studied showed a decrease in the rate of eye injuries ranging from 2.5 to 13.4 per 100 workers after reinforcement for wearing eye protection. The experimental group, as a whole, showed an average decrease in eye injury rate of 7.48 per 100 workers. A control group not receiving reinforcement for wearing eye protection showed a slight decrease of 1.16 per 100 workers.

The involvement of human factors in accidents involving fatalities was studied in conjunction with OSHA compliance inspections. This evaluation uncovered four elements common to the mishaps:

(1) inadequate employee supervision,
(2) inadequate employee training in job hazard recognition,
(3) lack of specific safety rules, and
(4) inadequate protection for recognized hazards.

A project designed to investigate the effects of continuous and impact-type noise on nonauditory sensory functions was completed. The continuous noise conditions ranged from 105 to 110 dB(A). The impact sounds were 136 dB in peak level. Different tests of visual, tactile, thermal, and vestibular functions were made under the noise conditions mentioned previously. Several of these sense functions were also incorporated in a simulated work task. When performed under the given noise and quiet conditions, the task revealed no significant differences in performance results. Little evidence was found to suggest concern for nonauditory sensory losses caused by noise conditions meeting hearing conservation limits.

Physical Agents

The Physical Agents Biomedical Applied Research Program develops, improves, and evaluates health criteria for exposure to physical agents via laboratory research, field studies, and critical review of existing standards. Emphasis in 1976 was upon identifying hazards associated with nonsteady state noise and to ionizing and nonionizing radiations.

Noise

Several studies have been undertaken to assess the hazard of noncontinuous noise. One study is a comprehensive, 3-year study (1976-1978) of noise and hearing loss in the paperworking industry. A noise exposure measuring instrument, the "chrono-dosimeter," is worn by selected workers to document their daily noise dose exposures. (The "chrono-dosimeter" was designed by NIOSH and has been submitted for patent.) The office workers serve as nonnoise-exposed controls.

In a laboratory study of noncontinuous noise, groups of chinchillas were exposed to different levels of continuous noise, while other groups were exposed to intermittent noise with a regulated on/off time. Results indicate that it is not only the amount of acoustic energy incident upon the auditory mechanism

that is hazardous, but also the manner in which the acoustic energy is distributed.

A study of the prevalence of impact-impulse noise revealed that about 2.5 million U.S. workers are exposed daily to some noise of this type. Investigations are now underway to improve methods for measuring impact-impulse noise and to determine exposures hazardous to hearing.

A final report on the development of a field test method for evaluating ear plug type hearing protectors under actual working conditions was published (NIOSH 76-181). A field study has begun using the developed procedure and equipment.

As a follow-up to the survey of Hearing Loss in the Coal Mining Industry (NIOSH 76-172), a study has been initiated to investigate the unexpectedly high incidence of middle ear pathologies found in coal miners.

Radiation

Under contract, the world literature published during 1971-1975 related to the carcinogenic properties of ionizing and nonionizing radiation will be reviewed. A state-of-the-art report will be prepared summarizing the pertinent literature. Specific gaps in the present knowledge of radiation carcinogenesis will be identified and recommendations made for future research.

A contract was awarded to provide the results of an ongoing study investigating the potential hazards from welding. In addition to the hazards from airborne contaminants, the welding process is a high-intensity optical radiation source exposing the welder and other workers to ultraviolet (UV), visible, and infrared (IR) wavelengths.

An interim report was received documenting threshold values for corneal and lenticular damage in rabbits in the UV region from 295-335 nm. The contractor's report will be published as a NIOSH Technical Report. Further studies are now under way to extend this work from 340 to 400 nm.

The contract to develop a UV hazard monitor was completed. The instrument is being evaluated to determine its usefulness as a survey meter. The Laser Hazard Classification Guide (NIOSH 76-183), prepared in cooperation with the United States Army Environmental Hygiene Agency, was updated. Approximately 2,500 different models of lasers were classified.

The results of a cooperative study were published (NIOSH 77-105). The findings showed that the doses received by airline personnel in the operation of baggage X-ray systems were far below the limits prescribed by the OSHA regulations. They were close to natural background radiation levels.

Occupational exposure to radio frequency (RF) radiation in the textile, lumber, and plastics industries was measured. At least 70% of the RF power sources monitored exceeded the current RF exposure standards.

Research has been performed to determine the effects of RF radiation on lymphocyte division response in animals and cultures and on RNA and DNA structure. A publication is being prepared describing the results of this study. Future RF research will concentrate on potential teratogenic effects, since most industrial RF sources are operated by women.

Biomedical Support Services

Support services during 1976 included clinical and biochemical service for 25 health hazard evaluations and 10 technical assistance projects. Total analyses performed exceeded 20,000. Evaluations included examination of body fluids for evidence of exposure to organic solvents, metals, pesticides, carbon disulfide, steroids, polychlorinated biphenyls (PCB's), and numerous other mixed exposures.

Analytical methods were developed and used specifically for: volatiles in blood, phenol in urine, hippuric acids in urine, PCB's and kepone in blood, and synthetic estrogens in air. In addition, methods for the analysis of organic tin, polymethylsiloxane, formic acid, and tetrachloro- and trimellitic anhydrides in air were developed.

Laboratory support provided to animal research studies on methyl amyl ketone, terephthalates, polyurethane foam, polyvinyl chloride and bituminous coal dusts, and 2,2-dithiodianiline exposures included evaluation of the clinical and biochemical parameters associated with the biological effects resulting from these exposures. Total analyses exceeded 6,000.

Significant consultation was afforded the development of a clinical chemistry program employed in the Kellogg, Idaho-Bunker Hill Smelter survey and in the evaluation of data collected from approximately 1,000 exposed smelter workers and community controls.

Diagnostic and research pathology services included autopsy of over 2,000 animals, preparation and histologic evaluation of 13,400 tissue slides, and submission of 20 pathology reports to research project directors. Hospital pathologists throughout the United States submitted 20 cases of suspected occupational disease for diagnostic evaluation. In response to a survey of pathologists and thoracic surgeons in the United States, 1,600 physicians responded. They indicated an interest in submitting to NIOSH 12,000 cases per year that are considered to be associated with, or directly related to, industrial exposures or disease. Cases submitted would be for specific chemical element(s) and diagnostic evaluations.

Over 1,400 particle analyses in human and animal tissue samples were completed. Biophysical characterization of the particles was made by scanning transmission electron microscopy, energy dispersive X-ray analysis, and the electron microprobe. Evaluations of this data, as well as that from surface property studies, were made on such materials as asbestos, talc, abrasive blasting materials, and coke oven emissions.

Experimental animal research and comprehensive animal husbandry supporting the service activities and other NIOSH nonhuman research programs included:

(1) continuation of projects on the pathologic effects of abrasive blasting materials,
(2) factors influencing the carcinogenicity of smelter dusts (including sulfur dioxide),
(3) tumor induction by arsenic in rats on nutritionally deficient diets, and
(4) studies on molecular mechanisms in occupational carcinogenesis. These last studies involve:

    (a) inhalation of vinyl chloride,
    (b) ingestion of methylene-bis-orthochloroaniline (MOCA),
    (c) a determination of the chemical structure and stabilities of platinum and beryllium salts with purines, and
    (d) the co-carcinogenic effect of asbestos and benzo-(a)-pyrene (in which it was shown that as little as 0.1 milligram of chrysotile asbestos significantly enhanced the ability of benz (a)-pyrene to induce pleural sarcomas).

Biomedical and Behavioral Applied Research Program Directions

The Biomedical and Behavioral Applied Research Program will be closely keyed to the NIOSH initiatives in carcinogenesis, teratogenesis, and support of standar It will also be keyed to NIOSH initiatives in behavioral and health motivational factors aimed at prompting behavior contributing to reducing occupational health hazard exposures.

APPALACHIAN LABORATORY FOR OCCUPATIONAL SAFETY AND HEALTH

During the last decade, the NIOSH Appalachian Laboratory for Occupational Safety and Health (ALOSH) in Morgantown, West Virginia, has become recognized as the Nation's leading center for the study of occupational respiratory disease, especially that associated with coal mining. For several years, however, ALOSH has conducted a wide spectrum of research in other areas as well. This diversity of research initiatives continued in 1976.

LABORATORY AND CLINICAL INVESTIGATIONS

ALOSH laboratory and clinical investigations during the period January 1, 1976, through September 30, 1976, included both biochemical and microbiological in vitro studies of the effects of inhaled particulates on the lungs. The effects of silica and asbestos inhalation were shown to alter the chemical composition of collagen generated by fibroblasts in tissue cultures. Asbestos was also shown to impair the production of interferon induced by virus infection. Because interferon is thought to be a first line defense mechanism against infection, this finding indicates that asbestos may predispose workers to viral infection. Studies of the respiratory problems of grain handlers were also initiated during this period.

ALOSH research has also included investigation into the physiology of cells in lung tissue. During 1976, the mechanism by which heavy metals affect cell membranes has been further defined. Previous studies have shown that certain heavy metals (mercury, nickel, cobalt, copper, and zinc) alter red cell membrane sodium permeability. During 1976, dose-response curves for several metals have been defined, and further research is continuing with other industrially important metals. Cell physiology studies have also included research in the mechanisms by which foreign substances are removed from alveolar macrophages by phagocytosis. This process is known to be a major defense mechanism of the lung.

ALOSH physiologists have demonstrated an increase in chemiluminescent response of alveolar macrophages when exposed in vitro to increasing concentrations of foreign particles, and that certain metabolic inhibitors can decrease this response. Further studies are underway to attempt to determine the mechanism by which chemiluminescence is induced in macrophages by foreign particles. The studies also are to determine its precise relationship to phagocytosis.

During 1976, ALOSH clinical studies have also included investigation of the physiology of the gas/liquid boundary of the lung. It is known that surfactant, the liquid material lining the alveoli and airways, has a profound effect on the pressure-volume characteristics of the lung. This is because of its effects on the surface tension at the gas/liquid boundary. The liquid material lining the airways and alveoli is directly exposed to any inhaled particles. Therefore, it is possible that one mechanism for alteration in lung function by occupational exposure is a change in character of the surfactant system. It is proposed that future research include the technique of gas trapping in order to study the effect of various inhaled agents on the gas/liquid interface of the lung.

Recent ALOSH clinical investigations have concentrated on determining the effect of occupational exposure on lung function. The researchers used spirometry, submaximal exercise testing, and various tests to measure disease in the lungs and small airways where conventional spirometry does not reveal dysfunction.

Spirometry , the measurement of the breathing capacity of the lungs, continues to be the most widely used method for evaluating the effects of occupational exposures on lung functions. In order for spirometric tests to be reliable, however, they must be reproducible. To help accomplish this task, ALOSH researchers have developed the forced expiratory volume simulator. This is a device which is capable of reproducing both electric signals and gas flows. These flows correspond to flow-volume curves which would be expected from both normal subjects and those suffering from respiratory diseases of varying degrees of progression.

Based on studies using the simulator and data obtained during the national study of coal workers' pneumoconiosis (in which spirometry was performed on more than 9,000 subjects), spirometric guidelines for equipment and technique have been developed. Work is now beginning on similar guidelines for the single breath diffusing capacity test and the closing volume or single breath nitrogen test.

Efforts were continued to determine the most sensitive method for detecting occupationally-induced abnormalities in lung function. Various parameters of the forced expiratory flow-volume curve were measured among four age- and height-matched groups selected from the same cohort of 9,000 working coal miners. Results show that flow rate measurement offers little advantage over

(1) the traditional parameters forced expiratory volume in 1 second (FEV_1) or
(2) the ratio of forced expiratory volume in 1 second to forced vital capacity (FEV_1/FVC) in separating the groups.

It was observed, however, that flows at higher lung volumes were sometimes helpful in differentiating bronchitis from nonbronchitis. In this segment of the study, total lung capacity (TLC) was estimated by examining clinical chest X-rays of the subjects. Results indicate that the smokers among the 9,000 subjects had a higher TLC and residual volume than did the nonsmokers group. Relating flow rates to absolute lung volumes revealed decreased flow rates in smokers at all lung volumes, a fact not apparent from an examination of flows related only to expired volume. This study confirms traditional use of the FEV_1 and the FEV_1/FVC ratio as valuable indices of occupationally-related pulmonary dysfunction. It also suggests, however, that estimation of absolute lung volumes may augment research ability to detect pulmonary impairment.

A computerized system for interpretation of chest X-rays has been developed under NIOSH contract in an effort to reduce the amount of time required in this procedure. ALOSH personnel began work, during 1976, to install and test the system in NIOSH facilities.

Previous studies on nonsmoking coal miners have suggested small airway obstruction and loss of elastic recoil in the lung as possible pathogenetic factors in coal workers' pneumoconiosis. Two lung function tests which have

been found to be useful in detecting small airway dysfunction are the closing capacity and the dynamic compliance tests. It is not yet clear, however, whether pneumoconiosis is a causal factor in producing abnormalities in values in these two tests.

Because complete studies of lung mechanics are not feasible for large groups of workers, another method of early detection is currently being tested. The experiments involve comparing flow rates at low lung volumes in which the subjects breathe a helium/oxygen mixture with flow rates of subjects breathing air. It is thought that comparison of these two flow rates will reveal abnormalities in the small airways of the lungs. This is because, at low lung volumes, resistance appears to come primarily from small airways where flow rates are laminar rather than turbulent.

Because laminar flow is affected by viscosity but not density, helium/oxygen mixtures (which are more viscous but less dense than air) offer data about lung mechanics which are unavailable using conventional methods. If this test is found to be useful, it may lend itself to use in studies of a large number of subjects. It is a test which can easily be repeated after periods of varying exposure to potentially damaging substances in the work environment.

Approximately 250 subjects have been studied using this technique, but data from comparisons of dust-exposed and nonexposed workers have not yet been evaluated.

An ongoing project has been the use of bicycle exercise at submaximal levels:

(1) to determine the applicability of exercise testing to the detection of early impairment of the pulmonary system,
(2) to relate impairment to type and category of pneumoconiosis,
(3) to separate the function of the cardiovascular and pulmonary systems, and
(4) to objectively measure disability.

Using a modification of the Coates method (oxygen consumption vs. heart rate at submaximal exercise levels), approximately 80 subjects have been studied to date. The procedure is noninvasive and requires only the collection of expired gas and the measurement of respiratory and cardiac rates.

ALOSH personnel have also participated in two health hazard evaluations at worksites. In one study, workers exposed to flax dust were given questionnaires (covering respiratory symptoms, smoking history, and job history). They also were given spirometry tests using both air and helium mixtures both before and after a workshift. Dust sampling at the workplace was also performed. The results showed some correlation of decline in flow rates with increased levels of dust exposure. However, there was little overall difference in performance between controls and those exposed to dust.

In a second study, an ALOSH team examined workers exposed to activated charcoal dust. In this case, a survey had been done 3 years previously, and, therefore, longitudinal data are available on certain workers.

EPIDEMIOLOGY STUDIES AND ENVIRONMENTAL INVESTIGATIONS

The largest epidemiology study undertaken during the period January 1 through September 30, 1976, was a study of the health effects of dust and diesel exhaust on noncoal underground miners.

Numerous improvements in ventilation practices in underground mines have been instituted. One aim of the present study is to attempt to determine whether these improvements have reduced the number of cases of silicosis. During the first 9 months of 1976, ALOSH epidemiology teams visited 16 mines in six Western States, one mid-Western State, and one Eastern State. The teams gave respiratory examinations to a total of 4,626 underground miners. An analysis of the data obtained is currently under way.

Epidemiology research during the first 9 months of 1976 also included a mortality study of metal miners in the United States. The study covers 12,800 employed metal miners who were examined by the U.S. Public Health Service in 1958-1961. The purpose of this study is to analyze differences in death rates among sub-groups of these miners. The miners will be analyzed by metal products mined, by category of pneumoconiosis, by occupational exposure to dusts and toxic metals, and by cigarette smoking. During the reporting period, researchers continued their attempt to determine, by searching death certificates, which miners previously examined are now deceased.

Three additional mortality studies are also under way. In one, a study of 2,960 cotton mill workers who worked from 1937 to 1941 in plants in North Carolina, efforts have been initiated to determine the vital status of the workers. In a mortality study entitled "Retrospective Cohort Mortality Follow-Up of Dairymen," performed under contract for NIOSH, approximately 10,000 dairy farmers who were employed for at least 3 years between 1937 and 1958, will be surveyed. At this time, the contractor is in the process of identifying a cohort for study. A third study, "Mortality of Public Utility Employees," will be undertaken in cooperation with the Energy Research and Development Administration (ERDA). It will be conducted jointly with the Tennessee Valley Authority (TVA). In addition to these continuing projects, epidemiology studies will also include several new morbidity projects. These include "Cross-sectional Study of Workers Exposed to Fibrous Minerals," "Health Effects of Sulfur Oxides and Sulfuric Acid, Nitrogen Oxides, and Nitric Acid," "Medical Study of Commercial Divers," "Study of Coal Workers' Pneumoconiosis (Third Round)," "Byssinosis-Study of Secondary Industry Workers," and "Pulmonary Function Standards Study." A new mortality study, entitled "Mortality Among Oil Shale Workers," will also be initiated during this period.

During 1976, a number of environmental investigation projects currently under way at NIOSH were reassigned to the newly-created Environment Investigations Branch, and a number of new studies were planned. The following is a summary of ALOSH environmental investigations activities.

Environmental Health Surveillance of Grain Handlers

In this surveillance, medical studies will be conducted to extend current medical data. Also, environmental studies will be conducted in an attempt to quantify exposures to grain dusts containing a myriad of materials.

Worker Exposure to Pesticides

A continuing research effort, this study is on behavioral, neurological, and biochemical dose-response relationships. It is designed to determine whether these relationships could serve as early warning indicators of adverse effects on the safety and health of workers in the pesticide formulating industry. Environmental support provided will include complete characterization of the organophosphate pesticide environment to which each worker is exposed.

Coal Gasification

During 1976, NIOSH signed a contract to conduct a study entitled, "Industrial Hygiene Characterization of Coal Gasification Pilot Plants." The study will be performed over a 3-year period beginning June 28, 1976. Each of the 3 years will be devoted to the study of one coal gasification pilot plant.

Energy

During 1976, NIOSH established a contract for "Quick Response Evaluations of Energy Related Occupational Safety and Health Programs." The purpose of this contract is to assist NIOSH in evaluating worker exposure to potentially adverse conditions in energy related industries.

Fibrous Minerals

In an effort to identify industries in which respiratory disease may be prevalent, comprehensive walk-through surveys have been made of talc, wollastonite, attapulgite, and mineral wool operations.

Cotton Dust Exposure -- Secondary Processing

During 1976, a project was initiated to study health effects of workers exposed to cotton dust in secondary processing procedures, such as textile weaving and garnetting.

SO_2/NO_2 - Sulfur Oxides/Nitrous Oxides

NIOSH is conducting research designed to obtain dose-response data on workers exposed to sulfuric acid, sulfur dioxide, nitric oxide, nitrogen dioxide, and nitric acid.

Oil Shale

In an effort to determine the health effects associated with oil shale mining and retorting, a research effort involving a joint agreement between the United States and the Soviet Union has been initiated. A representative has made an initial visit to the Soviet Union to discuss the scope of the agreement.

Diesel Exhaust and Underground Coal Mining

During 1976, NIOSH began a study of coal mines which use diesel engines in underground mining. Four mines will be selected for a detailed evaluation of diesel emission exposures. The environmental data from these surveys will be used, in conjunction with epidemiologic results, to determine what effect diesel emissions have on coal miner health.

Future Environmental Investigation Projects

Industrial Hygiene Study of Tennessee Valley Authority (TVA) Workers--
A working relationship has been established for the performance of studies relating to the occupational safety and health of TVA employees. In this project an industrial hygiene study of TVA workers in coal fired steam plants will be performed.

Particle and Fiber Analysis--
NIOSH will attempt to identify and quantify particles and fibers within the respirable size range. The initial emphasis will be on dusts of coal, fibrous minerals, grain, and cotton.

Blue Collar Control Group Study--
A small population of industrial blue collar workers will be identified and their exposures to potential respiratory hazards will be evaluated. Environments in which workers receive only minimal exposures will be selected. Once a work environment has been established as "free of exposure," its blue collar, nonexposed workers will be examined by ALOSH field teams. Then they will be used as a control group for ALOSH epidemiology projects.

SAFETY RESEARCH BRANCH

Accidents typically involve many interrelated behavioral as well as physical factors. Therefore, a logical first step is to attempt to isolate specific problem areas using various surveillance techniques. Subsequent technological investigations, then, can lead to educational aids and control measure recommendations. Controls are directed principally toward prevention.

However, recognizing that mechanical accidents may still occur despite all preventive efforts, particularly in extra-hazardous occupations, some personal protective equipment, in addition, may be required. The groundwork for initiating this extensive safety program has been firmly laid. The various projects already initiated within the organization can be categorized specifically as either surveillance, prevention, or protection efforts.

Surveillance

Surveillance projects involve gathering, evaluating, and utilizing accident or injury data. This is to enable the identification of information and technologic gaps, establish research priorities, and measure program impact. The following

are examples of current projects in this area:

(1) Evaluation of injury data reported on OSHA 101 Forms--
This project involves an indepth review of the OSHA injury reporting system with a view to determining its adequacy for fulfilling NIOSH safety surveillance system requirements.
(2) Factors in successful occupational safety programs--
This project is an attempt to identify those aspects of successful safety programs that can be applied on a wider scale.
(3) Occupational burns--
This research provides for gathering and evaluating existing data on injuries relative to occupational burns. Safety Research Branch personnel will participate in a national occupational burns conference to identify areas in which follow-up action is needed.

Prevention

Prevention projects provide safety guidance and information to specific occupational groups through detailed studies into preventive control measures which can be implemented to improve safety. The following are examples of these projects:

(1) Causal factors in selected worker accidents--
These studies are aimed at identifying and controlling those factors responsible for high injury incidence rates in specific occupations.
(2) Safety work practices documentation--
This effort produces work practices criteria and standards on safety for inclusion in the Department of Labor standard setting system.
(3) Behavioral studies in roofing industry--
This project is a detailed study of this high-risk industry to identify unique behavioral, motivational, and psychological factors of consequence to job safety.
(4) Postural stability--
The purpose of this effort is to provide information on a complete range of motions in which postural stability can be maintained under varying conditions in materials handling situations.
(5) Human factors in materials handling--
This work is directed toward providing factors-evaluation of classes of materials handling equipment and an analysis of injury record data associated with the use of the equipment.

Protection

These projects provide for development of criteria for personal protective equipment. Examples of these types of projects include:

(1) Personal protective equipment research--
The overall objective of this project is to develop safety criteria suitable for use as the scientific basis of recommended standards for

the personal protection of workers.

(2) Fire hazards control research—
This effort is designed to review and evaluate the design of prototype fire-fighters' gloves.

In addition to these continuing projects, the Safety Research Branch plans for the initiation of a variety of new projects during the coming year. Examples of these projects include the following:

(1) Safety Information Compendium.
(2) Determination of High-Risk Industries and Occupations.
(3) Causal Factors in Building and Highway Construction.
(4) Causal Factors in Oil and Gas Industry.
(5) Machine Guarding.
(6) Ergonomic Characteristics of High-Risk Jobs.
(7) Initiation of a National Safety Data Surveillance System.
(8) Energy Industry Studies.

TESTING AND CERTIFICATION BRANCH

The Testing and Certification Branch of the Appalachian Laboratory for Occupational Safety and Health tests and approves, or certifies, various personal protective devices and industrial hazard measuring instruments which meet strict regulatory requirements for quality. Thirty-six respirators were approved during the period January 1, 1976, through September 30, 1976. Six gas and vapor detector tube units were certified during the first 9 months of 1976.

NIOSH is preparing additional certification programs in support of occupational safety and health. These include certification of noise dosimeters, direct-reading contaminant-specific gas and vapor meters, charcoal tubes, and personal protective equipment. Amendments to 30 CFR 11 for respiratory approvals are expected. The amendments are to cover single use gas and vapor respirators for specific contaminants, and quantitative dust, fume, and mist respirator facepiece fit tests.

NIOSH also tests other personal protective devices for their conformance to applicable American consensus standards. NIOSH issued reports on tests of welders filter plates and industrial face shields during the period January 1, 1976, through September 30, 1976. Tests were also conducted and results published during the same period on women's safety toe shoes, flexible fitting goggles, safety spectacles, and eyecup goggles. These test reports provide the user with valuable assistance in the selection of protective equipment. The tests indicate to OSHA where problem areas in commercially available personal protective devices exist. They also serve to identify to manufacturers where product quality improvements are necessary.

DIVISION OF TRAINING AND MANPOWER DEVELOPMENT

Those who drafted the Occupational Safety and Health Act of 1970 recognized that available, trained manpower was an important factor in carrying out the purposes of the law. This legislation gave a principal charge to NIOSH, and identified both HEW and DOL responsibilities in manpower development and training. The purposes of this Act will not be accomplished unless trained personnel required to apply the knowledge derived from research and used in promulgated standards are made available through training and manpower development.

Sections of the Act give NIOSH the responsibility to train and develop manpower. Those sections also require that the Secretary of HEW consult in this area with the Secretary of Labor and other appropriate Federal departments and agencies.

An interagency agreement entered into by NIOSH and OSHA states, in general, that the Secretary of Labor has the responsibility to train employers and employees in the recognition, avoidance, and prevention of unsafe and unhealthful working conditions in employments covered by the Act. It also states that the Secretary of Health, Education, and Welfare has the responsibility of increasing the quantity and the professional and technical competence of occupational safety and health (OSH) personnel. These are the personnel whose sole or major responsibilities are in occupational safety and health. The agreement also provides that the training of the government (State and Federal) employees who carry out the responsibilities of the Secretary of Labor under the Act is to be conducted by OSHA with the assistance of NIOSH. Activities have been initiated to enable NIOSH to continually collect, update, analyze, and distribute data on the national OSH manpower situation. These include periodic surveys of industry and government to determine the types and numbers of OSH personnel needed in the future. The rationale for basing estimates of needs primarily on industry demands is that industry represents the largest consumer of OSH manpower.

NATIONAL MANPOWER NEEDS

A nationwide survey was begun in 1976 to collect data on the occupational safety and health personnel workforce. The survey is expected to produce the following information:

(1) the numbers, types, and qualifications of personnel currently employed;
(2) a detailed assessment of the existing use of occupational safety and health workers;
(3) the present and short-run demand for occupational safety and health workers according to occupation/profession, standard industrial classification, and geographical area;
(4) a projection of personnel requirements for 1978 and 1980;
(5) a projection of personnel supply according to supply source and the expected profile of the personnel; and
(6) a forecast of personnel resources through 1990.

Work continued on a project, begun in 1975, to look at alternate sources of manpower resource requirements. To explore additional data bases for estimates of occupational safety and health personnel needs, several professional societies were requested to provide manpower information relevant to one of the six

selected occupational safety and health disciplines which they represent. The disciplines were industrial hygiene, safety engineering, medicine (occupational/industrial), nursing (occupational/industrial), health physics, and fire protection. Manpower data have been received from the American Association of Industrial Nurses, the American Industrial Hygiene Association, the American Society of Safety Engineers, the Health Physics Society, the Society of Fire Protection Engineers, and the American Occupational Medical Association.

The project, started in 1975 to define the training and educational requirements for health and safety practitioners and to develop curriculum guidelines to meet those requirements, has proceeded as programmed. The task/activity analysis survey was recently conducted. The education/experience/training requirements and curricula/career routes for the various levels of technical personnel in the industrial hygiene and safety professions are scheduled.

Efforts have continued to provide professional consultation and technical assistance to academic institutions in helping to establish or expand occupational safety and health educational programs. In addition, contacts during 1976 with secondary school and vocational school students and teachers highlighted the need for career development information focused on the occupational safety and health field. A project was begun in 1976 to produce a career/vocational education guidance packet aimed at the high school graduate. Brochures describing the duties, experience, and educational requirements for the various occupational safety and health professions will be prepared.

Also, a directory of institutions offering courses, associate degree programs, baccalaureate degree programs, and graduate degree programs will be prepared for the career guidance packet.

CONTINUING EDUCATION

The Institute's technical training program continued to operate on a reimbursement for-registration basis. Over 1,000 occupational safety and health practitioners were trained in the 43 courses offered during the period. The short courses ran from 3 days to 2 weeks, and provided 5,300 man-days of training. The trainees included occupational safety and health professionals and paraprofessionals in the following disciplines and sub-disciplines:

(1) occupational medicine,
(2) occupational health nursing,
(3) industrial safety,
(4) laboratory safety,
(5) industrial toxicology,
(6) industrial hygiene,
(7) industrial hygiene chemistry,
(8) industrial hygiene engineering,
(9) occupational environmental law, and
(10) industrial radiation/health physics.

Trainees came from a variety of employers -- 43 percent from Federal agencies, 3 percent from State and local governments, and 54 percent from the private sector. The private trainee group included representatives from private industry, insuranc

carriers, trade unions, power and utility companies, colleges and universities, and private consultants. In addition to the regularly scheduled individual subscriptio courses, special courses were presented to requesting groups (e.g., the Occupation Safety and Health Administration, the U.S. Department of the Army, the Mining Enfor ment and Safety Administration, Cummins Engine, the du Pont Company, Hooker Chemica Monsanto, SCM Corporation, the Florida Industrial Nurses Association, the Florida Technological University, and the University of Washington).

In addition, courses developed by the Institute were presented under joint sponsorship with several outside organizations.

(1) The Recognition of Occupational Health Hazards courses were presented in cooperation with the American Industrial Hygiene Association in six HEW regions.
(2) The Recognition of Accident Potential in the Workplace Due to Physical and Environmental Factors courses were presented in cooperation with the American Society of Safety Engineers.
(3) The Ionizing Radiation and Nonionizing Radiation courses were presented in cooperation with the Boeing Company.
(4) The Industrial Hygiene Chemistry courses were presented in co-sponsorship with the University of Cincinnati.
(5) The Industrial Hygiene Respiratory Protection courses were presented in cooperation with the REECo Corporation.
(6) The Fundamentals of Occupational Health Nursing Practice courses were presented in cooperation with the State of Ohio Department of Health.
(7) The Short-Term Intensive Training in Occupational Safety and Health course were presented in cooperation with Wichita State University.
(8) The Occupational Health Nurse and Employee Mental Health courses were presented in cooperation with five different universities: the University of California, Indiana University, the University of North Carolina, Pennsylvania State University, and the University of Wisconsin.

CURRICULUM DEVELOPMENT

The major activities in course development in 1976 centered around the revision and update of lessons and materials in existing courses. Development continued on courses which were initiated in 1975:

(1) Industrial Hygiene Engineering and Control,
(2) Industrial Hygiene Sampling Strategies,
(3) Industrial Toxicology,
(4) Legal Aspects of the Occupational Safety and Health Act,
(5) Evaluation and Control of Occupational Safety Hazards,
(6) Occupational Medicine for General Practitioners, and
(7) The Occupational Health Lecture Series for Medical Students.

The planning and initial design work was begun for several new courses:

(1) Occupational Health Nursing -- Basic Theory and Update,
(2) Introduction to Occupational Medicine,
(3) Safety Program Design and Management,

(4) Industrial Hygiene Laboratory Quality Control, and
(5) High School Science Teachers' Workshop in Occupational Safety and Health.

The recently completed Recognition of Accident Potential in the Workplace Due to Human Factors course is scheduled for initial presentation.

COOPERATIVE TRAINING AND MANPOWER DEVELOPMENT

Educational and training interactions between the Institute and other Federal agen during 1976, were directed toward implementation of Executive Order 11807 (Occupat Safety and Health Programs for Federal Employees). Technical training was provide to 455 staff members of Federal agencies and to 26 staff members of state and loca government agencies. Courses given in the field at the requesting agency's locati were particularly tailored to meet the requirements of that agency's health and safety program.

NIOSH participated with OSHA and Howard University in presenting a symposium on "Occupational Safety and Health for Minority Colleges." Also, NIOSH continued to co-sponsor, with OSHA, a program initiated in 1975 to develop industrial hygiene centers serving the training/consultation needs of the small business sector.

TRAINING GRANTS

Training grants to educational institutions in 1976 received a budget allocation o $3,000,000. The grants were for programs designed to prepare researchers, adminis trators, teachers, professional practitioners, technologists, and technicians in various occupational safety and health disciplines and subject matter areas. Thes funds were used for the development, maintenance, or expansion of 44 programs, including trainee support at 28 institutions in 25 states.

During 1976, these programs served 954 full-time trainees, 198 of which received trainee support. The fields of study included industrial hygiene, safety management, safety engineering, occupational medicine, occupational nursing, biostatistics, and epidemiology. Training was supported at the paraprofessional or technician level, baccalaureate level, and post-graduate level for research, teaching, and practice.

Approximately 651 trainees not receiving stipend or tuition support received training in one or more courses given in the grant supported programs. In addition, 448 trainees seeking a terminal degree/diploma were trained on a part-time basis. Only 33 received tuition support.

In 1976, 320 students were awarded baccalaureate and graduate degrees from grant supported institutions. Of these graduates, 252 are employed directly in the field of occupational safety and health.

Two short-term continuing education programs in the occupational nursing and industrial hygiene fields were active. A total of 57 people received their training in industrial hygiene and 121 in occupational nursing.

Plans were begun in 1976 to implement the Occupational Safety and Health Educationa Resource Center grant program at five academic institutions. These Centers will

provide a mechanism for combining and expanding existing activities. This is to arrange for coordinated, multidiscipline and multilevel training and continuing education in occupational safety and health under a single grant servicing a geographic region.

GOVERNMENTAL AND NONGOVERNMENTAL COOPERATIVE UNDERTAKINGS

Major efforts in cooperation with other Federal agencies are:

(1) collecting data for mortality studies in cooperation with the Social Security Administration (SSA),
(2) conducting medical surveillance of former asbestos workers at a pipe insulation plant and of former benzidine workers, in cooperation with the National Cancer Institute (NCI),
(3) coordinating industrywide studies with MESA on clay fiber workers, hard-rock gold miners, talc workers, and phosphate fertilizer production workers,
(4) coordinating an industrywide study of coal gasification workers with the EPA and ERDA,
(5) formal and informal cooperation with OSHA, EPA, National Center for Health Statistics (NCHS), Bureau of Census, NCI, Consumer Products Safety Commission (CPSC), Department of the Navy, National Institute of Environmental Health Sciences (NIEHS), Internal Revenue Service (IRS), SSA, and Food and Drug Administration (FDA), as part of the DSHEFS surveillance activities,
(6) developing control techniques to reduce concentrations of anesthetic gases in dental operatories, in cooperation with the National Institute of Dental Research (HEW), and
(7) statistical services provided to the EPA and OSHA by the Statistical Services Branch of DTS.

SERVICES TO OTHER FEDERAL AGENCIES

NIOSH supplied industrial hygiene and medical technical assistance to the IRS, District of Columbia, General Services Administration (GSA), Smithsonian Institution, Federal Reserve Bank, U.S. Department of Treasury, EPA, Coast Guard, and OSHA.

COOPERATION WITH TRADE AND PROFESSIONAL SOCIETIES

Industrywide studies were conducted in cooperation with trade associations and national and local labor unions. Among these were the following:

(1) the X-ray personnal hazard study, conducted in cooperation with the Airline Transport Association,
(2) a study, in cooperation with the American Welding Society, of optical radiation from the various welding processes to assess the potential hazards associated with the processes and the adequacy of prescribed safety procedures,

(3) safety slides, posters, pamphlets, guides, and inspection sheets for users of power tools, all developed in cooperation with the Hand Tool Institute and the Power Tool Institute,
(4) two films on the hazards of grain elevators and rendering plants, with the assistance of the National Association of Grain Elevators and the National Rendering Association,
(5) lectures and talks to trade and professional groups.. and
(6) participation of members of the NIOSH staff on scientific committees and in professional organizations.

INTERNATIONAL COOPERATION

NIOSH cooperation with other nations and international groups during 1976 consisted of:

(1) disseminating NIOSH publications to foreign requesters,
(2) authorizing the Special Foreign Currency Program (PL-480),
(3) exchanging information with the International Agency for Research on Cancer,
(4) planning collaborative research and professional interchanges as a collaborating Occupational Health Center under World Health Organization auspices,
(5) cooperating bilaterally and multilaterally in preliminary planning for occupational safety and health with other countries in such international organizations as:

(a) the World Health Organization,
(b) the International Labor Organization,
(c) the International Social Security Association, and
(d) domestic organizations having strong international ties.

LIAISON ACTIVITIES

NCI

An interagency agreement was developed between the National Cancer Institute (NCI) and NIOSH for cooperative work in the area of occupational carcinogenesis.

Cooperative projects conducted by NIOSH were funded by NCI in the amount of $1 million for the transition quarter, July 1 - September 30, 1976. Efforts will be ongoing to continue this program.

ERDA

NIOSH provided technical consultation in the area of occupational safety and health aspects of energy technologies. This included participation in the ERDA effort to develop an environmental impact assessment for coal research and development technologies. NIOSH also initiated the process of developing an interagency agreement between ERDA and NIOSH dealing with occupational safety and health aspects of energy technologies.

EPA

NIOSH began the second year of a cooperative research program (interagency agreement) with EPA dealing with occupational safety and health aspects of energy technologies. NIOSH continued to work closely with EPA in laying the foundation for cooperative work in the area of toxic substances.

MESA (Mining Enforcement and Safety Administration)

A NIOSH/MESA liaison group met every 2 months in 1976 to consider topics of mutual interest and to initiate action, when appropriate. The group was composed of representatives from the operating programs of both NIOSH and MESA. Technical information was provided on NIOSH projects of interest to MESA, e.g., the studies on talc and on coal workers' pneumoconiosis. Technical information was exchanged to assist in the development of health standards for metal and nonmetallic mines and to address problems in such areas as radiation and noise exposure.

A joint NIOSH/MESA study of the health effects of dust and diesel exhaust on noncoal underground miners was begun.

OSHA

During 1976, NIOSH completed its technical input for the joint NIOSH/OSHA Standards Completion Program by compiling 94 Draft Technical Standards and transmitting them to the Department of Labor. Notices of availability (for public inspection) for 16 of these were published in the Federal Register by the DOL.

Acceptance tests were performed for about 40 OSHA equipment purchase contracts. The maintenance and calibration services provided to OSHA comprise about 80% of the total calibration effort of NIOSH.

National Bureau of Standards

The NIOSH Chemical Reference Laboratory has funded the development, by the National Bureau of Standards, of Standard Reference Materials (SRM's) for samples used by governmental and industrial hygiene laboratories. These SRM's are reliable references for verification of laboratories' calibration standards and analyses.

Instrumentation was developed for NIOSH by the National Bureau of Standards to measure occupational exposure to radio frequency (RF) radiation in the textile, lumber, and plastics industries.

U.S. Air Force School of Aerospace Medicine

Under an interagency agreement, research was performed to determine the effects of RF radiation on lymphocyte division response in animals and cell cultures and on RNA and DNA structure.

Federal Aviation Administration

A cooperative study was conducted on the doses of radiation received by airline personnel in the operation of baggage X-ray systems. Findings showed that these doses were far below the limits prescribed by the OSHA regulations and were close to natural background radiation levels.

OTHER

SPECIAL FOREIGN CURRENCY PROGRAM

The NIOSH Special Foreign Currency Program (SFCP) supplements the domestic program in research directed at establishing objective criteria for occupational health standards. The Program is supported by U.S. owned foreign currencies that have been determined by the Department of the Treasury to be in excess of normal U.S. needs in designated countries. The 1976 NIOSH program includes 6 research agreements in Yugoslavia, 11 in Poland, 2 in Egypt, and 2 in India.

The SFCP activities emphasized research on the recognized occupational health problems of:

(1) chest diseases (asbestosis and pneumoconiosis),
(2) toxic industrial chemicals (lead, mercury, carbon disulfide, and cadmium), and
(3) physical hazards (noise, vibration, heat, and cold).

Also being investigated in projects funded through this program are:

(1) combinations of hazards (noise and vibration, heat and noise, and heat and drugs, for example),
(2) behavioral and motivational problems in safety,
(3) daily variability in tolerance to occupational stresses, and
(4) tests for early detection of potential health effects of toxic agents.

A study under way in Yugoslavia to determine the role of cement dust in lung disease among workers in the cement industry is in its final year. A 4-year comparison was made of changes in lung function among the workers exposed to cement. It showed a 7 to 16% decrease in forced vital capacity and in the 1-minute forced expiratory volume. The control, nonexposed workers, showed no decrease. Adverse respiratory signs and symptoms also were more frequent among the cement workers. The data collected so far in the study support the concept that exposure to cement dust is an occupational hazard. It may lead to chronic, nonspecific lung disease, including deterioration in respiratory function and an increase in adverse respiratory signs and symptoms. These data are directly applicable to NIOSH development efforts in criteria for standards.

AVAILABILITY OF GRANTS INFORMATION

Under the provisions of Section 20(a)(1) of the Act, NIOSH has an active grants section to assist in carrying out the functions of the Institute. It is for support of research, experiments, demonstrations, and studies related to occupational safety and health. The governing regulation is 42 CFR Part 87, Grants for Research and Demonstrations Relating to Occupational Safety and Health.

All information concerning grants may be obtained from: NIOSH, Grants Management Office, Parklawn Building, 5600 Fishers Lane, Room 8-29, Rockville, Maryland 20857.

APPENDICES

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 *

SUBSTANCE(S)	TOXICITY DET.**	COMPANY & LOCATION	HHE REPT. NO.
Abietic and pimaric acids (condensed hydrocarbons) and a- and b-pinene (volatile hydrocarbons)	+	Evans Products Company Missoula, Montana	73-110-279
Acetone, aliphatic naphtha butyl alcohol, ethylene glycol monethyl ether acetate, isopropyl alcohol, methyl isobutyl ketone, n-butyl acetate, toluene	+	Custom Furniture & Cabinets, Inc. Post Falls, Idaho	75-146-254
Air contaminants (solvents)	-	Department of Anesthesia Northwestern University Medical School Chicago, Illinois	76-15-108
Airborne asbestos fibers	+	Pittsburgh Plate Glass Ind. Mt. Zion, Illinois	75-192-110
Airborne particulate and epichlorohydrin	-	Western Electric Company Reading, Pennsylvania	74-10-258

* A complete list of Health Hazard Evaluations is available from: The National Technical Information Service, Springfield, Virginia 22151

** + - Toxic or potentially toxic
- - Not toxic
+,- = Toxic or potentially toxic under circumstances or conditions observed

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 10, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Total airborne particulate matter and trimellitic anhydride	+	Cook Paint and Varnish Company Kansas City, Missouri	74-111-281
Chromic oxide, stannous octoate, and organic vapors (methyl ethyl ketone, methyl isobutyl ketone, toluene, and xylene)	-		
Aldehydes, toluene, methyl ethyl ketone (MEK), and phenol	-	Unitog Company Warrensburg, Mo.	75-143-333
Particulate lint fibers	+		
Aliphatic hydrocarbons and isopropyl alcohol	-	Litho Art, Inc. New York, New York	75-105-100
Ammonia, beryllium, chromic acid, lead, methyl ethyl ketone, fume, nitric acid, nuisance dusts, oil mists, sodium hydroxide, toluene diisocyanate (TDI) 1,1,1-trichloroethane, 1,1,1-trichloro 1,2,2, trifluoro ethane, welding fumes, mahogany wood dust, wood dust, and operation in the print shop, dark room, and lapping area	-	Federal Products Corporation Providence, Rhode Island	75-158-299

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Arsenic, lead, mercury, and bismuth	-	Hedstrom Union Company Bedford, Pennsylvania	75-8-263
Asbestos	-	ACF Industries Amcar Division Milton, Pa.	76-4-110
Asbestos and fibrous glass	-	Penn Central Transportation Company Philadelphia, Pennsylvania	75-121-281
Barium ferrite, lead, and nuisance dust	-	B. F. Goodrich Company Koroseal Division Marietta, Ohio	75-24-273
Benzene, carbon monoxide, hydrogen chloride, and vinyl chloride	-	Columbus Products Corporation Columbus, Ohio	76-29-122
Benzene, bis-chloromethyl ether, 2,6-ditert-butyl-p-cresol (BHT), carbon monoxide, formaldehyde, hydrogen chloride, hydrogen cyanide, nuisance particulate, phthaletes, styrene, and vinyl chloride	-	Welch Plastics and Manufacturing Company Columbus, Ohio	76-28-132
PVC - ABS regrind particulate	+	Welch Plastics and Manufacturing Company Columbus, Ohio	76-28-132

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Benzene, chlorobenzene, vinyl chloride, and airborne particulate containing trace amounts of lead	+,- -	General Electric Company Silicone Products Department Waterford, New York	74-107-279
Beryllium dust	+	Kawecki Berylco Industries, Inc. Reading, Pennsylvania	75-87-280
Butyl cellosolve acetate, ethyl cellosolve, methyl cellosolve, hydrochloric acid, sulfuric acid, heptane, toluene, butyl-acetate, ethyl alcohol, isopropyl alcohol, ethyl acetate, xylene, toluene diisocyanate (TDI), tin oxide, lead fumes, methyl chloride, 1,1,2-trichloro 1,2,2-trifluoroethane, naphtha, fibrous glass dust, and ammonia	-	The Foxboro Company Highland Plant East Bridgewater, Massachusetts	75-180-111
Camouflage netting	+	A & S Tribal Industries Poplar, Montana	75-135-128
Anti-mildew agents - Pb chromate, Sb, Sn, cellosolve, vinyl acetate, vinyl chloride	-	A & S Tribal Industries Poplar, Montana	75-135-128

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Carbon disulfide	-	FMC Corporation Front Royal, Virginia	75-172-317
Carbon tetrachloride and carbon disulfide	-	Cargill Elevator - Terminal 4 Portland, Oregon	76-13-316
Grain dust and mathathion	+	Cargill Elevator - Terminal 4 Portland, Oregon	76-13-316
Coal tar and petroleum tar vapors	+	Protecto Wrap Company Denver, Colorado	75-13-265
Crystalline silica, benzene, methyl cellosolve acetate, and lead	+	Cooper Union School of Art New York, New York	75-12-121
Lithotine, mineral spirits, benzine, toluene, xylene, acetone, acetic acid, nitric acid, styrene, wood dust, copper, tin, and zinc	-	Cooper Union School of Art New York, New York	75-12-121
Dimethylethylamine (DMEA), crystalline free silica, methylene bisphenyl isocynate (MDI)	+	Morris Bean and Company Yellow Springs, Ohio	74-110-306
Formaldehyde and phenol	-	Morris Bean and Company Yellow Springs, Ohio	74-110-306

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 10, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Dust containing cotton	+	Synter Fabrics, Inc. Williamsport, Pennsylvania	76-18-288
Dusting powders	-	Fibreboard Corporation Stockton, California	75-181-287
Fibrous glass	-	The Celotex Corporation Charleston, Illinois	75-78-264
Fibrous glass, dried binder dust, phenol, formaldehyde, and ammonia vapors	-	Owens-Corning Fiberglas Corp. Newark, Ohio	74-86-269
Free silica	+	Owens-Corning Fiberglas Corp, Newark, Ohio	74-86-269
Flax dust	+	Olin Corporation Pisgah Forest, North Carolina	75-104-325
Formaldehyde	+	Corhart Refractories Louisville, Kentucky	75-180-285
Phenol, methylene diphenyl diisocyanate (MDI), phenylpropylpyridine, benzene, xylene, toluene, and petroleum distillates	-	Corhart Refractories Louisville, Kentucky	75-180-285

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Free silica	+	Wheeling Pittsburgh Steel Corp. Steubenville, Ohio	74-9-271
Iron oxide fume, carbon monoxide, and sulfur dioxide	-	Wheeling Pittsburgh Steel Corp. Steubenville, Ohio	74-9-271
Free silica, iron oxide, nuisance dust, and oil mist	-	Republic Steel Corporation Cleveland, Ohio	75-129-275
Fumed silica powders and mica	+,-	S.W.S. Silicone Corporation Division, Stauffer Chemical Company Adrian, Michigan	75-181-101
Herbicide (Weed-B-Gon)	+,-	Classic Chemical Company Camden, New Jersey	75-2-282
Hexane, acetone, ethyl acetate, methyl ethyl ketone, isopropanol, ethanol, methyl isobutyl ketone, toluene, and butyl acetate	+	B-W Footwear Company, Inc. Webster, Massachusetts	75-190-114
Inorganic mercury	+	Roy K. Yaeger, D.D.S. Lititz, Pennsylvania	76-69-123
Inorganic mercury	-	G. A. Riddell, D.D.S. Cody, Wyoming	76-45-113

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE (S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Inorganic mercury	+	Jay Instruments & Specialty Co, Cincinnati, Ohio	76-49-312
Iron oxide	+	Transportation Products Division National Steel Corporation Portage, Indiana	74-60-255
Iron oxide and carbon monoxide	+	Electromotive-Division GMC (Plant 2) Chicago, Illinois	73-185-256
Carbon monoxide, ozone, and nitrogen dioxide	-	Electromotive-Division GMC (Plant 2) Chicago, Illinois	73-185-256
Iron oxide, isopropropyl alcohol plus aromatic naphtha, and xylene plus aromatic naphtha	+	Steiger Tractor, Inc. Fargo, North Dakota	75-30-266
Oil mist, trichloroethane, molybdenum, total dust	-	Steiger Tractor, Inc, Fargo, North Dakota	75-30-266
J2 and JR epoxy resin	+	Westinghouse Electric Corp. East Pittsburg, Pennsylvania	75-147-118
1,1,1-trichloroethane, lead, tin, alcohol based flux, naphtha,and xylene	-	Westinghouse Electric Corp. East Pittsburg, Pennsylvania	75-147-118
Mercury	-	Phillip J. Haram, D.D.S. Laramie, Wyoming	75-198-291

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Mercury	-	Paul W. Fleming, D.D.S. Casper, Wyoming	76-2-292
Mercury	-	Harold A. Macon, D.D.S. Riverton, Wyoming	76-11-293
Mercury	+	J. A. Devine, D.D.S Cheyenne, Wyoming	76-6-294
Mercury	-	Martin Marietta Company Baltimore, Maryland	75-186-102
Mercury	-	Bruce W. Weatherwax, D.D.S. Tarrington, Wyoming	75-196-290
Methylene dianiline, methylene bis (4-cyclohexyl isocyanate), methylene chloride, 1,1,1-trichloroethane, nitric acid, cyanides, hydrochloric acid, sodium hydroide, nickel, chromium, and trichloroethylene	-	General Electric Company Waynesboro, Virginia	74-129-268
Methyl ethyl ketone, acetone toluene, methyl cellosolve, diazonium salts, azo dyes, and nuisance dusts	-	GAF Office Systems Division Johnson City, New York	74-136-284

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE (S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Silica dust	+	GAF Office Systems Division Johnson City, New York	74-136-284
Misc. rubber mfg. chemicals Carbon monoxide, PAPI, 1,1,1-trichloroethane, potassium hydroxide, and sodium hydroxide	+	Goodyear Tire & Rubber Co. St. Marys, Ohio	74-7-270
Nickel and cadmium dusts	+	Marathon Battery Company Waco, Texas	74-16-272
Nitrous oxide and halothane	+	Winchester Hospital Winchester, Massachusetts	75-151-259
N-methyldicyclo-hexylamine (MCHA)	+	Storage Technology Corporation, Inc. Louisville and Broomfield, Colorado	75-25 and 75-163-305
Methylene bisphenyl isocyanate (MDI), lead, antimony, arsenic, nickel, chromium, formaldehyde, methyl methacrylate, and organic solvents	-		
Oil mist	-	C.S. Brainin Company Mt. Vernon, New York	75-97-257

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 10, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Oil mist	+	National Standard Company Carbondale, Pennsylvania	75-153-315
Oil mist	+	Western Gear Corporation Jamestown, North Dakota	76-23-319
Methyl isobutyl ketone (MIBK), butyl cellosolve, methanol, toluene, methyl ethyl ketone (MEK), methylene chloride, xylene, normal butyl acetate, aluminum, lead, zinc, chromium, nitric acid, and hydrochloric acid	-	Western Gear Corporation Jamestown, North Dakota	76-23-319
Particulate polycyclic organic matter (PPOM) as cyclohexane solubles	+	Western Roofing Company, Sellers & Marquis Roofing Company, A. J. Shirk Roofing Company, and the Quality Roofing Company; A Joint Venture Kansas City, Missouri	75-194-324
Particulate polycyclic organic matter and benzo(a)pyrene (BAP)	+	Kaiser Aluminum and Chemical Corp. Ravenswood, West Virginia	74-25-267
Fluorides, manganese, and iron oxide	-	Kaiser Aluminum and Chemical Corp. Ravenswood, West Virginia	74-25-267
Particulate polycyclic organic matter (PPOM) and polynuclear aromatic hydrocarbons (PAH)	+	Sellers and Marquis, A. J. Shirk, Western, and Quality Roofing Companies Lenexa, Kansas	75-102-304

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Fibrous glass asphalt	-	Sellers and Marquis, A. J. Shirk, Western, and Quality Roofing Companies Lenexa, Kansas	75-102-304
Perchloroethylene and sodium hydroxide	+	The Foxboro Company Foxboro, Massachusetts	75-197-289
Lead, nuisance dust, oil mist, welding fumes, fluorides, zinc chloride, MEK, epoxy resin, and mercury	-		
Captan, perchloromethyl, mercaptan, chlorine, and imide	+,-	Calhio Chemical, Inc. Perry, Ohio	74-91-296
Petroleum distillates, acetone, toluene, methyl ethyl ketone, and hexane	-	Frontier Airlines Denver, Colorado	75-189-277
Phenol, formaldehyde, isopropyl alcohol, triethylamine, ethylene glycol monoethyl ether, isopropylacetate, and N-propylacetate	+,-	Formica Corporation Cincinnati, Ohio	75-145-327

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 10, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Polyvinyl chloride smoke and fumes and organic solvents	+	Campbell Plastics, Inc. Schenectady, New York	73-123-298
Vinyl chloride	-	Campbell Plastics, Inc. Schenectady, New York	73-123-298
Polyvinylpyrrolidone, ethanol, isobutane, and Freon 11	-	Radiant Lady Beauty Salon, Inc. Denver, Colorado	75-128-262
PVC cement	-	Water Well Drilling Companies Western Tennessee	75-168-309
Silica	+	Blaw Knox Foundry and Mill Machinery, Inc., Warwood Plant Wheeling, West Virginia	74-97-286
Phosphine, metal fumes (Mn, Ni, Fe_2, O_3, Cr), and calcium oxide	-	Blaw Knox Foundry and Mill Machinery, Inc., Warwood Plant Wheeling, West Virginia	74-97-286
Sodium hydroxide and butyl cellosolve	-	Roberts Diesel Service Garden City, Georgia	75-101-261
Solvents, cleaners, and fungal organisms	-	Cincinnati Enquirer Cincinnati, Ohio	75-187-129
Styrene	-	New York Telephone and Telegraph Company New York, New York	75-178-295

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Sulfur dioxide, formaldehyde phenols, and heavy metals (cobalt, lead, manganese, tin, and vandium)	-	Rycraft, Inc. Corvallis, Oregon	76-38-126
Sulfuric acid	-	Adolph Coors Company Brewery Warehouse Golden, Colorado	76-26-120
Toluene, cadmium, iron oxide fumes, and combined exposures to isopropanol, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK)	+	Heath Engineering Company Fort Collins, Colorado	75-79-131
Vinyl chloride, plasticizers, aldehydes, cyanide, butadiene, and acrylonitrile	-	Goodyear Tire & Rubber Co. Gadsden, Alabama	74-120-260
Welding fumes and gases	+	Fairbanks Weighing Division Colt Industries St. Johnsbury, Vermont	75-109-110-112-114-274
Cyanide, hydrochloric acid, nitric acid, nickel, hexavalent chromium, sodium hydroxide, lead, and nuisance dust	-	Fairbanks Weighing Division Colt Industries St. Johnsbury, Vermont	75-109-110-112-114-274
Wood dust	+	Masonite Corporation Evendale, Ohio	75-19-276
Formaldehyde and phehol	-	Masonite Corporation Evendale, Ohio	75-19-276

APPENDIX A

HEALTH HAZARD EVALUATION TOXICITY DETERMINATION REPORTS - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

SUBSTANCE(S)	TOXICITY DET.	COMPANY & LOCATION	HHE REPT. NO.
Xylene and dimethylformamide	-	The Wood Shed Belle Mead, New Jersey	76-35-101
Xylene, dimethylformamide, benzene, and toluene	-	Chem Clean Hudson Falls, New York	76-57-107
Zirconium and hafnium	+	Amax Specialty Metals Parkersbury, West Virginia	74-78-297

APPENDIX B

TECHNICAL ASSISTANCE - JANUARY 1 - SEPTEMBER 30, 1976

TA No.	Establishment	Substance(s)	Report Date
76-17	Internal Revenue Service	CO, NO, SO_2, O_3, NO_2, and ventilation	2/3/76
76-32	District of Columbia	Asbestos	2/12/76
76-34	GSA	Asbestos	2/18/76
76-12	NIOSH-Morgantown	Noise, solvents Pb, Cd, and ventilation	3/3/76
76-30	Smithsonian Institution (NZP)	Asbestos	3/3/76
76-23	Blue Bird Bus Body Company Fort Valley, Ga.	Noise	4/8/76
76-24	Ward School Bus Mfg. Company Conway, Arkansas	Noise	4/5/76
76-26	Carpenter Body Works Mitchess, Indiana	Noise	4/5/76
76-27	Wayne Corporation	Noise	4/5/76
76-29	Tool Steel Gear & Pinion Co.	Carbon monoxide, Stoddard solvent, amines, metal dust/fumes, noise, and lead	4/15/76
76-49	HEW South Portal Building Washington, D.C.	Asbestos	4/8/76
76-51	Columbus Industries	Methylene chloride	4/15/76

APPENDIX B

TECHNICAL ASSISTANCE - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

TA No.	Establishment	Substance(s)	Report Date
76-22	NIOSH Facility Salt Lake City, Utah	Safety & industrial hygiene survey	5/11/76
76-39	Smithsonian Institution Washington, D.C.	Asbestos, noise, and solvents	5/13/76
76-41	International Paper Co. Cincinnati, Ohio	Solvents, noise, and carbon monoxide	5/28/76
76-48	Federal Reserve Bank of Cleveland Cleveland, Ohio	Lead	6/25/76
76-56	Linden Chlorine Products, Inc. Linden, New Jersey	Mercury	6/22/76
76-35	GSA Field Supply Service New Bedford, Mass.	Asbestos	7/14/76
76-37	U.S. Dept. of Treasury Washington, D.C.	Carbon monoxide	7/13/76
76-38	EPA Building Cincinnati, Ohio	Air contaminants	7/13/76
76-40	National Science Foundation Washington, D.C.	Asbestos	7/8/76
76-43	JFK Building - GSA Boston, Mass.	Asbestos	7/1/76
76-44	U.S. Coast Guard Station Dental Clinic	Mercury	7/1/76

APPENDIX B

TECHNICAL ASSISTANCE - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

TA No.	Establishment	Substance(s)	Report Date
76-45	PHS Hospital Boston, Mass.	Mercury	7/2/76
76-52	GSA Firing Range Chicago, Ill.	Carbon monoxide	7/10/76
76-55	General Mills Duluth, Minn.	Phostoxin grain fumigant	7/30/76
76-57	Eight Port Grain Elevator Companies Superior, Wisc.	Safety & chemicals for treating grain	7/28/76
76-67	Justice Center Shooting Range Cleveland, Ohio	Lead	7/20/76
76-72	Treasury Department Customs Mail Branch New York, N.Y.	Noise	7/15/76
76-82	U.S. Coast Guard Training Center Alameda, Calif.	Lead	7/23/76
76-83	Bohn & Snead, Inc. Dayton, Ohio	Fibrous glass	7/23/76
76-86	South HEW Building Washington, D.C.	Warfarin (rat poison)	7/29/76
76-75	State of New Mexico Law Enforcement Academy Santa Fe, New Mexico	Lead/ventilation	8/17/76

APPENDIX B

TECHNICAL ASSISTANCE - JANUARY 1 - SEPTEMBER 30, 1976 (continued)

TA No.	Establishment	Substance(s)	Report Date
76-68	Ortho Pharmaceutical, Inc. Dorhoo, Puerto Rico	Synthetic steroids	9/30/76

APPENDIX C

Industrywide Epidemiologic Research Studies of Nonmalignant Diseases

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
DUST EXPOSURES					
Granite and brick industry workers	Silica	Nonmalignant respiratory disease	A. Examination of current brick workers by means of X-ray, pulmonary function tests, and medical questionnaires	A. Cross-sectional medical study of pulmonary abnormalities to examine annual decrements in function at known exposure levels[1]	A. Confirmation of previous indications of an excess risk and the quantification of that risk
			B. Brick manufacturers and granite sheds	B. Industrial hygiene and air sampling surveys[1]	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
OTHER INDUSTRIES AND EXPOSURES					
Longshoremen*	Physical activity	Cardiovascular and other disease	Existing medical and employment files of International Longshoremen's Union	Retrospective cohort study utilizing life-table method to examine cause-specific mortality according to category of physical activity	Exploratory research into possible association between on-the-job exposure and death from certain causes

[1] Study results available in this reporting period
* Study being conducted under NIOSH Contract No. 99-72-058

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
Antimony smelter workers	Antimony	Malignant respiratory diseases	Employment files of smelters	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Exploratory research into the association between on-the-job exposure and disease manifestation
				B. Industrial hygiene and air sampling surveys	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Beryllium production workers	Beryllium	Berylliosis and malignant respiratory disease[1]	A. Employment files of beryllium production plants	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Evaluation of postulated association between beryllium exposure and lung cancer
			B. Beryllium case registry	B. Investigation of causes of new beryllium diseases*	B. Discovery of previously unsuspected ill effects from low levels of exposure

[1] Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated
* Study being conducted under NIOSH Contract No. 99-73-49

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
Lead smelter workers	Lead, arsenic, cadmium, and other contaminants	Malignant and nonmalignant diseases[1]	A. Employment files of of lead smelters	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Evaluation of association between lead smelter exposures and occupational disease
			B. Examination of currently employed workers	B. Cross-sectional medical study of prevalence of abnormalities, utilizing X-rays, pulmonary function tests, sputum cytology, urine and blood tests, and medical questionnaires (including pilot study on determining congenital anomalies in the offspring of exposed workers)	B. Determination of health status of lead smelter, and assessment of association between on-the-job exposure and disease manifestation
			C. Lead smelters	C. Industrial hygiene and air sampling surveys	C. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls

[1] Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
Steelworkers*	Coal tar pitch volatiles and a variety of other exposures	Malignancies and other causes of death[1]	Employment files of seven plants in Allegheny County, Pa.	Retrospective cohort study utilizing life-table method to examine cause-specific mortality according to different work areas and job classification[2]	Initial analyses directed toward identifying association between job exposure and disease manifestations with data capable of exposure-response relationship analysis
Uranium mill workers	Thorium 120	Malignancies of lymphatic system	Employment files of uranium companies	Retrospective cohort study utilizing life-table method to examine cause-specific mortality	Confirmation of previous indication of an excess risk and the quantification of that risk
Uranium miners	Radon daughters	Malignant respiratory disease	A. Physical examination and annual census of uranium industry and radon daughter measurements	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Determination of exposure-response relationship between radon daughters and lung cancer risk
			B. Annual sputum cytology examination	B. Regression analyses of atypical sputum and cumulative radiation exposure	B. Determination of diagnostic value of sputum cytology as an early detector of cancer

[1] Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated
[2] Study results available in this reporting period
* Study being conducted under NIOSH Contract No. 99-71-32

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
FIBER INDUSTRY AND DUST EXPOSURES					
Asbestos products workers	Asbestos	Asbestosis, lung cancer, mesothelioma, and other neoplasms	A. Examination of formerly employed workers	A. Medical surveillance utilizing X-rays, pulmonary function tests, sputum cytology, and medical questionnaires	A. Evaluation of effect of early diagnosis and medical intervention on a high-risk population
			B. Employment files of asbestos production plants	B. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	B. Evaluation of association between asbestos exposure, cigarette smoking, and malignant respiratory disease
Clay fiber workers[1]	Clay fibers	Nonmalignant and malignant respiratory disease[2]	A. Employment files of clay fiber producers	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Evaluation of hypothesized association between clay fiber exposure and nonmalignant and malignant respiratory disease
			B. Clay fiber producers	B. Industrial hygiene and air sampling surveys	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls

[1] Study conducted as part of energy program

[2] Study conducted primarily for investigation of carcinogenic effects, however, nonmalignant effects also evaluated.

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
Hard rock gold miners	Asbestos, arsenic, and radon daughters	Malignant respiratory disease	A. Employment files of mining companies	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality*	A. Determination of the extent of lung cancer risk associated with low levels of asbestos, radon daughters, and arsenic
			B. Hard rock gold mines	B. Industrial hygiene and air sampling	B. Assessment of mine contaminant levels, worker exposures, work practices, and environmental control
Slag wool production workers[2]	Slag wool	Nonmalignant and malignant respiratory disease[1]	A. Employment files of slag wool plants	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Evaluation of hypothesized association between slag wool exposure and nonmalignant and malignant respiratory disease
			B. Slag wool plants	B. Industrial hygiene and air sampling surveys**	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Talc workers	Asbestos, silica, tremolite, and other minerals	Nonmalignant and malignant respiratory disease[1]	A. Company employment files	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Exploratory research into the association between on-the-job exposures and disease manifestation

[1] Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated
[2] Study conducted as part of energy program
* Study being conducted under NIOSH Contract No. 210-76-0200
** Study being conducted under NIOSH Contract No. 210-75-0120

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
			B. Examination of currently employed talc mine and mill and industrial workers, utilizing X-rays, pulmonary function tests, sputum cytology, and medical questionnaires	B. Cross-sectional medical study of prevalence of pulmonary abnormalities*	B. Determination of health status of talc workers and assessment of association between on-the-job exposure and disease manifestation
			C. Talc mines and mills and talc users	C. Industrial hygiene and air sampling surveys	C. Characterization of components of talc and assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Woodworkers	Wood dust	Malignancies of nasal pharynx, reticuloendothelial system, and other sites	A. Death benefit file of United Brotherhood of Carpenters	A. Cross-sectional comparison of cause-specific proportionate mortality with that of general population[1],**	A. Exploratory research into the association between on-the-job exposures and disease manifestation
			B. Employment files of pulp, paper, and plywood companies	B. Retrospective cohort study utilizing life-table method to examine cause-specific mortality***	B. Exploratory research into the association between on-the-job exposures and disease manifestation

[1] Study results available in this reporting period
* Study being conducted under NIOSH Contract No. 210-75-0005
** Study being conducted under NIOSH Contract No. 210-75-0016
*** Study being conducted under NIOSH Contract No. 210-75-0166

APPENDIX B

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
HALOGENATED HYDROCARBONS EXPOSURES					
Benzyl chloride workers*	Benzyl chloride	Malignancies	Benzyl chloride manufacturers and users	Industrial hygiene and air sampling surveys	Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Bis(chloromethyl) ether workers	Bis(chloromethyl) ether	Malignancies, especially of the lung	Textile manufacturing plants	Industrial hygiene and air sampling[2],**	Assessment of possibility of spontaneous formation of bis(chloromethyl)ether, of worker exposures, and of appropriate sampling methods
Epichlorohydrin workers***	Epichlorohydrin	Malignancies	Epichlorohydrin manufacturers and users	Industrial hygiene and air sampling surveys	Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Fluorinated hydrocarbon workers***	Fluorinated hydrocarbons	Malignancies and heart disease[1]	Fluorinated hydrocarbon manufacturers and users	Industrial hygiene and air sampling surveys	Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Methyl chloride workers****	Methyl chloride	Malignancies	Methyl chloride manufacturers and users	Industrial hygiene and air sampling surveys	Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls

1 Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated
2 Study results available in this reporting period
* Study being conducted under NIOSH Contract No. 210-76-0050
** Study being conducted under NIOSH Contract No. 210-75-0056
*** Study being conducted under NIOSH Contract No. 210-75-0064
**** Study being conducted under NIOSH Contract No. 210-75-0058

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
Polychlorinated biphenyl workers	Polychlorinated biphenyls	Malignant diseases	A. Employment files of polychlorinated biphenyl production and user plants	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Exploratory research into the association between on-the-job exposures, and disease manifestation
			B. Polychlorinated biphenyl production and user plants	B. Industrial hygiene and air sampling surveys	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Trichloro-ethylene workers	Trichloroethylene	Malignancies	A. Employment files of trichloroethylene manufacturers and users	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Evaluation of postulated association between trichloroethylene exposure and malignant diseases
			B. Trichloroethylene manufacturers and users	B. Industrial hygiene and air sampling	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Vinyl halides workers*	Vinyl halides	Malignancies and other diseases[1]	Vinyl halide manufacturers and users	Industrial hygiene and air sampling surveys	Assessment of in-plant contaminant levels, worker exposure, work practices, and environmental controls
Workers in vinyl chloride monomer plants, vinyl chloride polymerization plants, and polyvinyl chloride fabrication plants	Vinyl chloride gas and polyvinyl chloride dust	Angiosarcoma of the liver, other malignancies, and nonmalignant disease[1]	Examination of former and current vinyl chloride workers, using SMA-12, liver scans, X-rays, pulmonary function tests, and medical questionnaires	Cross-sectional study of prevalence of malignant and nonmalignant disease[2]	Determination of health status of workers

[1] Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated
[2] Study results available in this reporting program
* Study being conducted under NIOSH Contract No. 210-75-0064

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
OTHER INDUSTRIES AND EXPOSURES					
Benzene workers	Benzene	Diseases of the hematopoietic system	A. Employment files of benzene manufacturers and users	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Exploratory research into the association between on-the-job exposures and disease manifestation
			B. Benzene manufacturers and users	B. Industrial hygiene and air sampling surveys	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Chemical plant workers[2]	Sulfuric acid and sulfates	Chronic respiratory disease and lung cancer[1]	A. Employment files of industrial plants	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Evaluation of speculated association between sulfuric acid and sulfate exposure and respiratory disease
			B. Chemical plants	B. Industrial hygiene and air sampling surveys	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Coal liquefaction and gasification workers[2] *	Coal tar pitch volatiles, coal dust, and other contaminants	Malignant and nonmalignant respiratory diseases[1]	Coal conversion plants	Industrial hygiene and air sampling surveys	Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls

[1] Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated
[2] Study conducted as part of energy program
* Study being conducted under NIOSH Contract No. 210-76-0160

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
Dentists*	X-radiation, mercury, and anesthetics	Leukemia and lymphatic malignancies, suicides, and disease of the nervous system[1]	Records of the American Dental Association	Retrospective cohort study utilizing life-table method to examine cause-specific mortality	Exploratory research into the association between on-the-job exposures and disease manifestations
Dye manufacturing workers	Benzidine, 3,3' dichlorobenzidine, and beta naphthylamine	Malignancies of urinary tract	Followup and medical examination of formerly employed workers	Medical surveillance	Evaluation of effect of early diagnosis and medical intervention on a high-risk population
Painting tradesmen**	Asbestos, silica, talc, solvents, resins, etc.	Chronic respiratory disease, prenarcotic and neurological problems, and malignancies[1]	A. Examination of currently employed painting tradesmen, by means of X-rays, pulmonary function tests, sputum cytology, urine, lead and neurological tests, and medical questionnaires	A. Cross-sectional medical study of prevalence of respiratory and neurological disease	A. Exploratory research into the association between on-the-job exposures and disease manifestation
			B. Employment files of industry and study records of labor unions	B. Retrospective cohort utilizing life-table method to examine cause-specific mortality	B. Exploratory research into the association between on-the-job exposures and and disease manifestation
			C. Industrial and commercial operations	C. Industrial hygiene and air sampling surveys	C. Assessment of contaminant levels, worker exposures, work practices, and environmental controls

[1] Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated

* Study being conducted under NIOSH Contract No. 210-73-0073

** Study being conducted under NIOSH Contract No. 210-75-0120

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
Pesticide formulator workers*	Pesticides	Malignant diseases	Employment files of selected plants	Retrospective cohort study utilizing life-table method to examine cause-specific mortality	Exploratory research into the association between on-the-job exposures and disease manifestation
Pharmaceutical workers	Pharmaceuticals	Miscarriages and birth defects	Examination of currently exposed workers	Cross-sectional comparison of incidence of miscarriages and birth defects	Exploratory research into the association between on-the-job exposures and disease manifestation
Phosphate fertilizer production workers	Phosphoric acid, ammonia, radon daughters, and other contaminants	Respiratory cancer	A. Employment files of phosphate fertilizer plants	A. Cross-sectional comparison of cause-specific proportionate mortality with that of general population	A. Exploratory research into possible association between on-the-job exposures and death from specific causes
			B. Phosphate fertilizer plants	B. Industrial hygiene surveys	B. Assessment of in-plant contaminant levels, worker exposures, and environmental controls
Printing tradesmen**	Carbon black, oil mist, PCBs, CS_2, solvents, and other contaminants	Malignant and nonmalignant diseases[1]	A. Employment files of selected plants	A. Retrospective cohort study utilizing life-table method to examine cause-specific mortality	A. Exploratory research into the association between on-the-job exposures and disease manifestation
			B. Industrial and commercial operations	B. Industrial hygiene and air sampling surveys	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls

[1]Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated
*Study being conducted under NIOSH Contract No. 210-76-0173
**Study being conducted under NIOSH Contract No. 210-75-0020

APPENDIX D

Industrywide Epidemiologic Research Studies of Occupational Carcinogenesis (continued)

Occupational Group	Suspected Agents	Biologic Response Under Investigation	Source of Data	Type of Study	Implications for Occupational Health
Styrene-butadiene rubber workers	Styrene-butadiene, benzene, other organic compounds	Malignancies	A. Employment files of industry and study records of labor unions	A. Retrospective cohort utilizing life-table method to examine cause-specific mortality	A. Exploratory research into the association between on-the-job exposures and disease manifestation
			B. Stryrene-butadiene manufacturers and users	B. Industrial hygiene and air sampling surveys	B. Assessment of in-plant contaminant levels, worker exposures, work practices, and environmental controls
Viscose rayon workers*	Carbon disulfide	Cardiovascular disease and malignancies[1]	Employment files of industry and study records of labor unions	Retrospective cohort utilizing life-table method to examine cause-specific mortality	Exploratory research into the association between on-the-job exposures and disease manifestation

[1] Study conducted primarily for investigation of carcinogenic effects; however, nonmalignant effects also evaluated
* Study being conducted under NIOSH Contract No. 210-76-0106

APPENDIX E

NIOSH BUDGET AUTHORITY
(Dollars in thousands)

	Fiscal Year		
	75	76	77
Surveillance	1,600	2,500	2,400
Criteria Documentation	4,000	3,500	5,700
Industrywide Studies	3,400	8,000	6,000
Laboratory Research and Services	11,999	13,100	17,800
Coal	4,300	4,400	4,400
Technical Assistance	3,400	3,400	4,300
Manpower Development	3,200	4,100	6,100
Program Direction	2,100	2,100	2,100
TOTAL	33,999	41,100	48,800