NIOSH

THE FEDERAL COAL MINE HEALTH PROGRAM IN 1975

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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SIXTH ANNUAL REPORT
OF
HEALTH ACTIVITIES
UNDER THE
FEDERAL COAL MINE HEALTH AND SAFETY ACT
OF 1969

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SUMMARY

The National Institute for Occupational Safety and Health discharges certain duties of the Secretary of Health, Education, and Welfare mandated by the Federal Coal Mine Health and Safety Act of 1969 (P.L. 91-173). These duties include periodic examinations of coal miners, extensive research in pulmonary disease, setting occupational health standards in the coal mining industry, and paying for postmortem examination of miners and former miners. Although the activities of the coal mine health and safety program are centered at Morgantown, W. Va., much of the work is done in Cincinnati, Ohio.

Funds to conduct the coal mine safety and health program in calendar year 1975 were available from fiscal year 1975 and 1976 allocations of $4,900,000 and $4,400,000, respectively. In addition, funds in the amount of $3,582,000 were available from a FY 1974 allocation designated as a one-time, 3-year expenditure to establish facilities for diagnosis and treatment of respiratory impairments of active and inactive coal miners.

Medical service programs conducted under the Act provide physical examinations, including a chest roentgenogram, for working miners and post-mortem studies of miners or former miners. Costs of the physical examinations usually are borne by the coal mine operator. Autopsies, conducted with the consent of the widow or next of kin, are paid for by the Department of Health, Education, and Welfare.

Based on the single chest X-ray of each man participating in the second round of examinations (56,575 men) (July 1973-March 1975), lung cancer was suspected in about 750 men, marked emphysema was reported in more than 3,500, and evidence of tuberculosis, usually inactive, appeared in more than 3,000. For the year 1975, the corresponding number of cases of serious disease other than pneumoconiosis was, of course, much smaller: cancer was suspected in about 40 miners; marked emphysema, in more than 530; and tuberculosis, in slightly more than 250.

During 1975, reports from 390 autopsies were submitted for evaluation. Deaths, frequently attributable to more than one cause, resulted primarily from heart disease, lung disease, and cancer.

Research directed to improving the health of coal miners was divided into five broad categories: early diagnoses, epidemiological studies, infectious disease studies, laboratory investigations, and toxicologic studies. In their efforts to detect inception of pulmonary disease in the small airways, NIOSH researchers studied the value of frequency dependence of dynamic compliance, flow volume curves, and the use of helium-oxygen mixture in the flow volume curve.

The National Study of Coal Workers' Pneumoconiosis has been the major epidemiological study. Corollary studies included a survey on the respiratory status of surface coal miners. Results of the survey suggested that surface mining is not likely to cause statistically significant development of coal workers' pneumoconiosis or clinically significant respiratory impairment. Mortality studies indicated miners in excessive numbers die from conditions associated with complicated pneumoconiosis, obstructive airway disease, and cigarette smoking.

Infectious disease research was directed to: evaluating the interactions of mineral dusts and infectious agents on immune or defense mechanisms of the lung; assessing the susceptibility of miners, other workers, and the families of both to repeated infectious disease; and developing techniques for identifying and treating persons who are or who might become susceptible to repeated respiratory tract infections. Laboratory studies were focused on dust-caused physical changes in the lung that disturb the normal mechanics of pulmonary function.

Conclusions on the toxicologic impact of the standard for permissible exposure to coal dust (2 mg/m3) may be derived from critical interpretations of histologic, cardiopulmonary, and biochemical investigations on animals. In other experiments, several species of animals developed skin and pulmonary tissue tumors after being exposed to coal tar, and acetylcholine was observed to cause depolarization of dogs' normal, smooth airway muscle. Micelle solutions of trace metals are still being evaluated for interactions with living cells, and studies are continuing with more heavy metals to complement the data already obtained that describe the dose-response relationship of mercury, nickel, copper, cobalt, and zinc on cell membranes.

Interagency activities related to the coal mine health program involved the Food and Drug Administration, the Department of Labor, the Coal Mine Health Research Advisory Committee, the Interim Compliance Panel, and the Department of the Interior. The Food and Drug Administration's Bureau of Radiological Health gave NIOSH access to expertise in producing high-quality chest roentgenograms. The Department of Labor regularly participated in discussions about safety equipment and gave financial support to a NIOSH contract with the American College of Chest Physicians for the preparation of a manual on the management of occupational respiratory disease in miners.

The Testing and Certification Laboratory certified 11 gas and vapor detector tube units, approved 7 personal sampler units for coal mine dust and 94 respiratory protective devices, and tested samples of safety-toe shoes and safety hats. In addition to recommending the regulations for certification of equipment, NIOSH will publish a design guide that will provide anthropometric data on the range of facial variability in the working population. This guide should help manufacturers improve the fit of face pieces for respiratory equipment. Other substantive achievements included

improved testing of gas masks and chemical cartridge respirators, the laboratory evaluation of activated carbon as a respirator sorbent, and field evaluation of a NIOSH-designed, hydraulically powered, supplied-air respirator.

The Department of the Interior joined NIOSH in several programs through the Mining Enforcement and Safety Administration (MESA) and the Bureau of Mines. Of these, the most notable were the studies on noise and hearing, mine rescue and escape apparatus, and quality assurance of commercial equipment available to the working miner.

The Los Alamos Scientific Laboratory, University of California, a prime contractor of the Energy Research and Development Administration, cooperated in the development of a direct-reading, portable coal-mine-dust sampling unit that will give aerodynamic size distributions for coal dust. The contractor also prepared reports on previous filter loading and coal dust studies.

CONTENTS

INTRODUCTION

ADMINISTRATION

Under the Federal Coal Mine Health and Safety Act of 1969 (P.L. 91-173), as amended (P.L. 92-303), the Secretary of Health, Education, and Welfare has several unique responsibilities concerning coal mines and coal miners. Except for Title IV, Black Lung Benefits, the Secretary's duties are carried out by the National Institute for Occupational Safety and Health (NIOSH). Current activities of the coal mine health and safety program are centered at Morgantown, W. Va., although much of the work is done at Cincinnati, Ohio.

SCOPE

The coal mine is a constantly changing underground chamber or group of chambers that impose many health hazards on persons who work underground or are exposed to coal dust and processing operations. Pneumoconiosis, chronic bronchitis, and obstructive airway disease have been observed more frequently among miners than among many other workers.

Gases such as nitrogen dioxide, carbon monoxide, and carbon dioxide are a by-product of blasting. The likelihood that hazardous concentrations of these gases will accumulate or that oxygen deficiency will occur in the mines has now been reduced considerably. Sufficient ventilation to dilute or dispel the gases and to control respirable dusts is a stringent requirement of the Act.

Excessive or uncontrolled noise resulting in loss or impairment of hearing is an urgent, universal health problem shared by miners. Exposure to lubricants, hydraulic fluids, and roof bolt cements (probably epoxy resins) can pose problems such as dermatitis. Among miners working in thin seams of coal, knee injuries (hemorrhagic bursitis or cellulitis) are not uncommon. The use of diesel engines underground is becoming more common. As this change occurs, attention must be given to diseases which result from inhalation of diesel engine exhaust. These and other increasingly pervasive problems will be discussed.

The coal mine health and safety program comprises numerous activities and disciplines, including epidemiologic studies; periodic medical examinations for working coal miners; payment for autopsies performed on miners and former miners; clinical research into pulmonary diseases, pathology, immunology, genetic susceptibility, infectious diseases, physiology, and biochemistry; development of special instrumentation; and biostatistics. The program provides the working miner and the personal physician with (a) information to help protect the miner's health and to extend working life,

(b) evidence of disease when present to permit the miner to obtain rights under the Act, and (c) postmortem information, which frequently assists the miner's widow to obtain benefits.

The research projects are intended to facilitate the following:

1. Early detection of disease.

2. Discovery of genetic or other factors that can be used in preemployment screening to recognize persons more likely to develop serious occupational respiratory disease.

3. Development of a quantitative scale for reporting pneumoconiosis in the postmortem lung and relating this information to chest roentgenograms made during life. This information should help radiologists make more reliable roentgenographic interpretations.

4. Discovery of the mechanisms and causative agents involved in occupational respiratory diseases commonly found in underground coal miners.

FUNDING

The Congress recognized the Institute's responsibilities by providing--within the total appropriations--allocations of $6,138,000 for fiscal year 1972 and $5,317,000 for fiscal year 1973. Of the $9,100,000 allocated for fiscal year 1974, $5,518,000 was allotted for the usual programs, and $3,582,000 was a one-time, 3-year expenditure for the development of clinical facilities. These facilities were established for the diagnosis and treatment of respiratory and pulmonary impairments in active and inactive coal miners as authorized by section 427(a) of the Black Lung Benefits Act of 1972 (P.L. 92-303).

From the funds for clinical facilities, grants totaling $2,382,000 were awarded for clinical facilities for coal miners in Pennsylvania, West Virginia, Virginia, eastern Kentucky, Alabama, Tennessee, Illinois, and Ohio. All grant programs operated in 1975 with examinations and services being provided to approximately 10,000 miners.

The remaining $1.2 million of the one-time allocation for clinical facilities was awarded under contract to provide all the labor, facilities, and equipment to expand the existing capacity to deliver high quality clinical services and to provide an outreach program for treatment of respiratory illnesses.

These services are being delivered in underserved, coal-producing regions in States with populations of more than 500 (but with fewer than 3% of the total number of) active and inactive coal miners. Clinics are established or are being expanded in Indiana, western Kentucky, Arkansas-Oklahoma, Colorado-New Mexico, Utah-Wyoming, and Missouri-Kansas. The six clinics now operating provide examinations and services to 742 miners.

Usual annual allocations for fiscal years 1975 and 1976 were $4,900,000 and $4,400,000, respectively. Because the Interim Compliance Panel (ICP) was phased out in June 1975, the allocation for fiscal year 1976 was slightly less than that for fiscal year 1975. Allocations by major classes of expenditures for the fiscal year period 1972-1976 are shown in Table 1.

TABLE 1. Dollar Allocation by Major Classes of Expenditures, FY 1972-76 (in thousands)

Classes of Expenditures	1972		1973		1974		1975		1976	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Support of Interim Compliance Panel and Advisory Council	280	3	295	6	270	3	170	3	0	0
Medical Examinations and autopsy program	1,266	21	1,712	32	2,050	23	1,530	31	1,000	23
Clinical and rehabilitation research	2,051	33	1,741	33	1,567	17	1,360	28	1,100	25
Engineering research (including testing and certification)	1,131	18	500	9	600	7	780	16	1,200	27
Laboratory research (e.g., Biochemistry, Toxicology)	1,410	23	1,069	20	1,031	11	1,060	22	1,100	25
Development of clinical facilities*	-	-	-	-	3,582	39	-	-	4,400*	-
Total	$6,138	100	$5,317	100	$9,100	100	$4,900	100	$ 8,800	100

* One-time allocation to be expended over a 3-year period.

MEDICAL SERVICE PROGRAMS

Section 203 of the Federal Coal Mine Health and Safety Act of 1969 authorizes two medical service programs at no cost to the coal miner or family.

1. A program of medical examinations. This program includes a chest roentgenogram for working miners in or at underground coal mines and has been conducted on two concurrent schedules--one voluntary and the other mandatory, with the difference for the individual miner determined by the date of initial employment in the coal mining industry. Costs are ordinarily borne by the coal mine operator.

2. Autopsy program. An autopsy of a deceased miner or former miner is conducted with the consent of the widow or next of kin and is paid for by the Secretary of Health, Education, and Welfare.

These two programs are among the most widely known under the Act.

MEDICAL EXAMINATIONS

In a cyclic roentgenogram program, each miner engaged in coal mining when the law was enacted on December 30, 1969, was offered an opportunity to have a chest roentgenogram. Three years thereafter, the miner was afforded the opportunity to have a second roentgenogram; subsequent examinations are to be given at intervals not exceeding 5 years.

A mandatory program, overlapping the voluntary program, was established for miners employed for the first time after enactment of the law. It requires that these new miners be given a medical examination, including a chest roentgenogram, at the time of first employment and again 3 years later. Should the roentgenogram made at the end of the third year show evidence of pneumoconiosis, a third examination is made 2 years thereafter. Some of these exams already should have taken place.

The first round of roentgenograms was completed December 30, 1971. The second round began July 27, 1973, and ended March 31, 1975 (Table 2).

Concurrent with the second round of roentgenograms, about 9,000 miners at 36 selected mines across the United States participated in the National Study of Coal Workers' Pneumoconiosis. This study included, in part, the same roentgenographic examination given all other miners as part of the second round of examinations under section 203 of the Act (Table 3). The study was funded by NIOSH.

TABLE 2. X-ray Findings, Second Round of Coal Workers' Examinations (arranged by or for operators)
(July 27, 1973-March 31, 1975)

State	Miners examined			Category of pneumoconiosis, %*				
	Years in mining		Total					
	≤5	>5		0	1	2	3	Complicated
Alabama	547	621	1,168	85.3	12.4	1.5	0.3	0.6
Colorado	820	397	1,217	93.5	4.4	1.6	0.1	0.4
Illinois	2,163	2,431	4,594	87.2	10.6	1.7	0.1	0.4
Iowa	28	23	51	82.4	15.7	2.0	0.0	0.0
Kentucky	6,895	4,043	10,938	91.6	7.0	1.1	0.1	0.2
Maryland	8	6	14	85.7	7.1	7.1	0.0	0.0
New Mexico	1	22	23	60.9	30.4	4.3	4.3	0.0
Ohio	2,998	477	3,475	97.2	2.3	0.3	0.0	0.2
Pennsylvania, Bituminous	5,411	5,057	10,468	83.5	11.9	3.2	0.5	0.9
Pennsylvania, Anthracite	32	118	150	54.7	25.3	14.0	2.7	3.3
Tennessee	150	155	305	84.9	10.8	2.3	0.7	1.3
Utah	547	234	781	93.3	5.5	1.0	0.0	0.1
Virginia	2,782	1,819	4,601	91.2	7.5	1.1	0.0	0.2
Washington	1	11	12	91.7	8.3	0.0	0.0	0.0
West Virginia	10,876	7,808	18,684	87.4	9.1	2.7	0.3	0.5
Wyoming	78	16	94	98.9	0.0	1.1	0.0	0.0
Total Bituminous	33,305	23,120	56,425	88.5	8.7	2.1	0.2	0.5
Bituminous and Anthracite	33,337	23,238	56,575	88.4	8.8	2.1	0.2	0.5

*Totals may not be exactly 100 because of rounding.

TABLE 3. X-Ray Findings, Second Round of Coal Workers' Examinations (National Study of Coal Workers' Pneumoconiosis) July 1973-February 1975

State	Miners examined*			Category of pneumoconiosis, %**				
	Years in mining		Total					
	≤5	>5		0	1	2	3	Complicated
Alabama	245	21	266	93.2	5.3	1.1	0.0	0.0
Colorado	215	5	220	96.4	2.7	0.9	0.0	0.0
Illinois	342	102	444	97.1	2.5	0.2	0.0	0.2
Kentucky	907	701	1,608	86.1	11.8	1.6	0.2	0.3
Ohio	345	16	361	95.8	0.8	2.5	0.8	0.0
Pennsylvania, Bituminous	1,406	371	1,777	83.8	11.9	1.9	0.1	2.1
Pennsylvania, Anthracite	187	55	242	64.9	19.4	4.9	2.1	8.7
Tennessee	65	59	124	98.4	1.6	0.0	0.0	0.0
Utah	698	65	763	94.0	3.3	2.4	0.0	0.4
Virginia	542	413	955	92.0	4,8	1.6	0.5	1.0
West Virginia	1,966	347	2,313	91.0	6.1	1.6	0.1	1.3
Total Bituminous	6,731	2,100	8,831	89.9	7.3	1.6	0.2	1.0
Bituminous and Anthracite	6,918	2,155	9,073	89.2	7.7	1.7	0.2	1.2

*Participation in study was 73.1 % of the coal workers to whom the examination was offered.

**Totals may not be exactly 100 because of rounding.

Except for those hired after December 30, 1969, employees at underground coal mines were voluntary participants in the medical service program. Roentgenographic data from all sources for the period of the second round examination were combined to determine the prevalence and severity of pneumoconiosis among working miners (Table 4).

TABLE 4. X-ray Findings, Second Round of Coal Workers' Examinations (All Groups combined)

State	Miners examined: Years in mining ≤5	Miners examined: Years in mining >5	Miners examined: Total	Category of pneumoconiosis, %*: 0	1	2	3	Complicated
Alabama	792	642	1,434	86.8	11.1	1.4	0.2	0.6
Colorado	1,035	402	1,437	93.9	4.1	1.5	0.1	0.3
Illinois	2,505	2,533	5,038	88.1	9.9	1.6	0.1	0.4
Iowa	28	23	51	82.4	15.7	2.0	0.0	0.0
Kentucky	7,802	4,744	12,546	90.9	7.6	1.2	0.1	0.2
Maryland	8	6	14	85.7	7.1	7.1	0.0	0.0
New Mexico	1	22	23	60.9	30.4	4.3	4.3	0.0
Ohio	3,343	493	3,836	97.1	2.2	0.5	0.1	0.2
Pennsylvania, Bituminous	6,817	5,428	12,245	83.6	11.9	3.0	0.4	1.1
Pennsylvania, Anthracite	219	173	392	61.0	21.7	8.4	2.3	6.0
Tennessee	215	214	429	88.8	8.1	1.6	0.5	0.9
Utah	1,245	299	1,544	94.6	4.4	1.7	0.0	0.2
Virginia	3,324	2,232	5,556	91.3	7.0	1.2	0.1	0.3
Washington	1	11	12	91.7	8.3	0.0	0.0	0.0
West Virginia	12,842	8,155	20,997	87.8	8.8	2.6	0.3	0.6
Wyoming	78	16	94	98.9	0.0	1.1	0.0	0.0
Total Bituminous	40,036	25,220	65,256	88.7	8.5	2.0	0.2	0.6
Bituminous and Anthracite	40,255	25,393	65,648	88.5	8.6	2.0	0.2	0.6

*Totals may not be exactly 100 because of rounding.

Combining examination results from the mandatory and voluntary programs affects the prevalence rates. The men given mandatory examinations are almost always younger, and presumably healthier, than those in the voluntary program.

Since the conclusion of the second round of examinations on March 31, 1975, the Receiving Center at the Appalachian Laboratory for Occupational Respiratory Diseases (ALFORD) has received 16,573 examination reports, the bulk of which (13,889) were of men who have become underground coal miners in recent years (Table 5). These are the only examination reports required between rounds of general examinations. Table 5 shows the prevalence of pneumoconiosis among the miners examined since the end of the second round.

TABLE 5. X-ray Findings Since Close of Second Round of Coal Workers' Examinations
(April 1-December 31, 1975)

State	Miners examined			Category of pneumoconiosis, %*				
	Years in mining		Total					
	≤5	>5		0	1	2	3	Complicated
Alabama	183	20	203	96.1	2.9	0.0	0.0	0.0
Colorado	236	150	386	92.8	6.0	1.0	0.0	0.3
Illinois	467	49	516	98.3	1.7	0.0	0.0	0.0
Indiana	29	14	43	97.7	2.3	0.0	0.0	0.0
Kentucky	2,543	539	3,082	96.9	2.8	0.3	0.0	0.0
Maryland	0	1	1	100.0	0.0	0.0	0.0	0.0
New Mexico	1	22	23	65.2	26.1	8.7	0.0	0.0
Ohio	2,324	241	2,565	98.4	1.4	0.1	0.0	0.1
Pennsylvania, Bituminous	2,047	354	2,401	95.9	3.4	0.6	0.0	0.1
Pennsylvania, Anthracite	15	36	51	69.6	23.5	7.8	0.0	0.0
Tennessee	89	34	123	90.2	8.1	0.8	0.0	0.8
Utah	323	39	362	99.5	0.6	0.0	0.0	0.0
Virginia	902	259	1,161	95.6	3.9	0.4	0.0	0.1
West Virginia	4,730	926	5,656	96.8	2.7	0.3	0.0	0.1
Total Bituminous	13,874	2,648	16,522	96.8	2.8	0.3	0.0	0.1
Bituminous and Anthracite	13,889	2,684	16,573	96.7	2.9	0.4	0.0	0.1

*Totals may not be exactly 100 because of rounding.

Data compiled from the first and second rounds of examinations and from reports of examinations submitted during calendar year 1975 show some positive changes since the enactment of the Federal Coal Mine Health and Safety Act. During round 1, pneumoconiosis was found in 16.0% of those examined. The corresponding value in round 2 was 11.4%. However, review of the work histories of the miners examined reveals an increase in the number who have had 5 or fewer years of mining experience. These miners were usually healthy young men, most of whom had recently also been given a preemployment physical examination paid for by the prospective employer.

These same data reflect a trend toward lower (less severe) categories of pneumoconiosis. Presumably the improvement is the result of the lowered respirable dust exposure of the new miners who may constitute 40% or more of the current work force.

The findings concerning pneumoconiosis are reported to both the miner and the personal physician. Other potentially important findings, including those of suspected abnormalities, are reported to the physician designated by the miner, and the miner is advised to consult the physician. The findings from a single X-ray examination are very often only an indication of a possible abnormality. In many instances, further investigation is necessary before a definitive diagnosis can be reached.

Based on the single chest X-ray of each man participating in the entire second round (July 1973 to March 1975) of examinations, lung cancer was suspected in about 750 men, marked emphysema was reported in more than 3,500, and evidence suggestive of tuberculosis, usually inactive, appeared in more than 3,000. The corresponding number of cases of serious disease other than pneumoconiosis found from April through December 1975 is, of course, much smaller: cancer was suspected in about 40 miners; marked emphysema, in more than 530; and tuberculosis, in slightly more than 250.

Stringent requirements for high quality roentgenograms from participating medical facilities in the Coal Mine Health and Safety Program have resulted in improved roentgenography for all purposes in coal mining areas of the United States. This improvement is evidenced by the fact that B readers found 3% of the X-rays unreadable during the first round of examinations and 2.3% unreadable during the second round.

AUTOPSY SERVICE

The autopsy report is frequently used to establish whether the miner had pneumoconiosis. If so, survivors may be entitled to black lung benefits. Data obtained during autopsy are also invaluable for research.

During 1975 reports of 390 autopsies were submitted for evaluation and to provide information about eligibility of the miner's survivors for black

lung benefits. According to the death certificates and pathologists' reports, certain principal or contributing causes of death occurred sufficiently often to warrant recognition. Because death was frequently attributable to more than one cause, the percentages total more than 100.

Cause of Death	Percent of Cases
Heart disease	63
Lung disease*	54
Cancer:	
Lung	14
Other primary sites	11
Other causes	17

*Includes chronic bronchitis, emphysema, pulmonary fibrosis, and pneumoconiosis.

RESEARCH

NIOSH research on the health of coal miners has concentrated on the effects of inhalation of coal dust on the respiratory system. The work done at the Appalachian Laboratory for Occupational and Respiratory Diseases in Morgantown, W. Va., includes epidemiological investigations (principally the National Study of Coal Workers' Pneumoconiosis) and basic laboratory investigations of physiological, immunological, and biochemical mechanisms involved in lung injury. In addition, the Division of Laboratories and Criteria Development in Cincinnati, Ohio, studies the toxicology of coal dust. The 1975 studies are reported here.

EARLY DIAGNOSIS

Early diagnosis of lung disease has been a major concern of NIOSH for many years. Routine pulmonary function tests indicate abnormalities of lung function only after the disease process is probably irreversible. Consequently, NIOSH investigators have been developing methods to detect airway disease before it becomes manifest clinically by either respiratory symptomology or routine pulmonary function studies.

Early recognition of lung disease depends on detecting its inception in the small airways. These small airways make up only 10% to 15% of the total airways within the lung. Therefore, no matter what method is used to determine total airway resistance, small airway disease probably would not be detected. Resistance in the small airways could double or triple without a significant change in total airway resistance.

With this concept in mind, NIOSH researchers have been studying the value of frequency dependence of dynamic compliance and flow volume curves. The premise of the compliance study is that in small airway disease a progressively smaller portion of the lung is ventilated as frequency of breathing is increased. If the airways are narrowed by disease, air enters and leaves the affected regions more slowly, resulting in decreasing dynamic compliance as the rate of respiration increases.

Another method currently under study for early detection of small airway disease is the use of HeO2 mixture in the flow volume curve. HeO2 mixture is not as dense as room air and will give much higher peak flows because a less dense gas flows much faster in turbulent type airways. NIOSH researchers are using the concept that helium, although less dense, is a more viscous gas that enables detection of changes in the small airways when the flow is laminar and more dependent on viscosity.

Air and helium flow volume curve tests are being conducted on control groups and coal miners. Results of these tests are stored in a digital computer

where they can be superimposed at a later date to find differences that will aid in detection of early small airway disease. The flows occurring at low lung volumes, in which the patient's effort is a small factor, seem to be the important portion of these flow volume curves.

Distribution of ventilation within the small intrapulmonary airways determines the lung's ability to exchange the respiratory gases, carbon dioxide and oxygen. Although many methods--including those with radioactive gases--have been used to measure this evenness of ventilation, scientists at NIOSH have been most interested in the single-breath nitrogen test. This examination, when properly administered, is reproducible and is most applicable to the large populations required in field studies. NIOSH investigators have been assessing the measurements in an effort to simplify and reduce the necessary calculations. The closing volume determination, single-breath nitrogen test, is made on all persons in both the flow volume study groups and the dynamic compliance study group.

Exercise studies have been valuable in determining the amount of work an individual can accomplish. NIOSH scientists have developed a technique using a bicycle ergometer. A patient is subjected to various levels of work while simultaneous measurements of carbon dioxide and oxygen, in addition to the heart rate and the respiratory rate, are made.

Recently the exercise testing data have been recorded by computer so that instantaneous results from several persons can be studied in a short period. The examination is done at submaximal effort to enable the work capacity to be determined without a maximal strain on the cardiovascular system and, thereby, lower the risk to the examinee.

EPIDEMIOLOGICAL STUDIES

National Study of Coal Workers' Pneumoconiosis

The National Study of Coal Workers' Pneumoconiosis (NSCWP) began in 1969, was repeated in 1972, and will be repeated at 5-year intervals. The study was designed to accomplish the following.

1. Determine the prevalence of the disease in U.S. working coal miners.

2. Observe the progression of the disease from serial (periodic) chest X-rays.

3. Investigate the interrelationship of dust exposure and other factors to the progression of coal workers' pneumoconiosis.

In the first study (1969-71), 31 underground coal mines were visited, and 9,076 coal miners were examined. In the second study (1972-75), 36 mines were visited, and 9,073 men were examined, with 4,492 men participating in both surveys.

Each miner was examined by a team that traveled to the mine at which the participant was employed. The examination included a smoking and occupational history, a questionnnaire on respiratory symptoms, a posteroanterior and a lateral chest roentgenogram, and a simple test of lung function. The miners represented widely separated geographical regions, worked different kinds of coal seams, and used diverse mining methods. Each mine had a working life expectancy of at least 10 years and employed at least 100 miners.

Results published during 1975. Previous studies have not shown a relationship between severity of simple coal workers' pneumoconiosis, diagnosed from roentgenograms, and the ventilatory capacity as determined by the forced expiratory volume in 1 second (FEV_1) and the forced vital capacity (FVC). This apparent lack of relationship between X-ray and pulmonary function findings results from coal dust responsible for pneumoconiosis being deposited in the alveoli and in distal airways less than 2 millimeters in diameter, whereas increases in the airflow resistance of these airways may not significantly affect the FEV_1 or the FVC.

The flow volume curve procedure has been suggested as a means to detect disease in the small airways because it permits measurement of expiratory flow at both high and low lung volumes. To derive additional information about the effects of coal dust on the small airways, the maximal expiratory flow volume curves of 6,014 working coal miners have been analyzed. The influence of age, height, weight, underground exposure, and cigarette smoking on maximal expiratory flows at 75%, 50%, 25%, and 10% of forced vital capacity, as well as on peak flow, was analyzed.

Age and cigarette smoking had a highly significant effect on flows at all lung volumes. Prolonged underground exposure also had a significant effect on the flow rates at high lung volume, especially among nonsmokers.

Although previous work has shown that miners have lower flows than comparable age-matched controls, in this study neither the category of coal workers' pneumoconiosis nor major work area had any detectable effect on flow rates in excess of what usually may be attributable to the miner's age, height, weight, and number of years worked underground. The decrement in flow rates at high lung volumes associated with prolonged underground exposure, when considered in conjunction with the absence of an effect on flows with increasing severity of coal workers' pneumoconiosis (as determined by roentgenograph), suggests that the decrement is caused by dust-induced bronchitis.

The shape of the opacities seen on the roentgenogram may be influenced by factors other than coal dust. Smoking, bronchitis, age, and years of underground exposure were all associated with the irregularly or linearly shaped opacities, whereas years of underground exposure was the only factor associated with round opacities. Among smokers, ventilatory capacity was lower among men whose roentgenograms revealed irregular opacities than among men whose roentgenograms showed rounded or no opacities. These observations, however, were based on the interpretations of only one radiologist and, therefore, further study is under way.

Work continued in 1975. The second survey of the NSCWP was completed in February 1975. All roentgenograms taken during the second round have been interpreted by at least one radiologist. All of the roentgenograms from both rounds and those made after the second round closed will be interpreted by at least three radiologists, and a consensus reading should be established by the end of the calendar year 1976. Preliminary results show that the prevalence of coal workers' pneumoconiosis was between 10% and 13% in the second study in contrast to 30% in the first. Since approximately half of the miners from the first round did not participate in the second round, differences in prevalence are influenced by the difference in the samples.

Serial roentgenograms for those miners who participated in both studies are also being interpreted by a panel of radiologists. Interpretation of these roentgenograms should be complete by the end of fiscal year 1977, and estimates of progression over the two 5-year periods between studies will then be determined.

Dust exposure data have been obtained from two agencies in the Department of the Interior -- the Bureau of Mines and the Mining Enforcement and Safety Administration. These data are still being compiled, and plans have been made to correlate this information with the biological information from the roentgenogram investigations.

Work is continuing on the comparison of the respiratory status of several population groups which have been surveyed by the U.S. Public Health Service. They include the underground miners described in the NSCWP, surface miners studied by the U.S. Public Health Service (see below), and nonminers studied in Morgantown, W. Va., since 1969.

Respiratory Status of U.S. Surface Coal Miners

During 1972-73, the U.S. Public Health Service conducted a survey of the respiratory status of surface coal miners. Eight mines were selected, and 1,438 miners were examined. Selection of each mine was predicated on its having a working life of at least 10 years and a work force of at least 100 miners. The mines were located in Pennsylvania, Ohio, Indiana, Illinois,

Kentucky, and Alabama. The method and type of examination were the same as in the NSCWP.

Chest roentgenograms of 59, or 4%, of the miners in the survey showed evidence of coal workers' pneumoconiosis, but roentgenograms of 1% (less than 14), showed category 2 or more severe coal workers' penumoconiosis. Of 1,171 miners who had never worked underground, only 31, or 2-1/2%, showed roentgenographic evidence of coal workers' pneumoconiosis. Comparision of the results of the survey with those of the NSCWP suggests that the occupation of surface mining is not likely to cause statistically significant development of coal workers' pneumoconiosis or clinically significant respiratory impairment.

Mortality of U.S. Coal Miners

Three cohorts of coal miners are being studied to determine death rates for all causes and for chronic respiratory diseases. Cohorts (a) and (b) are Appalachia-wide samples of 2,550 employed miners and 1,180 ex-miners, respectively, from bituminous mining areas (mortality obtained for 1963-71), and cohort (c) is about 3,700 coal miners examined at two large hospitals in West Virginia during 1965-71 when they applied for compensation for pneumoconiosis (mortality obtained for 1965-74).

Protocol for this study entails analyzing and correlating data from the autopsy reports from all three groups with related data derived from chest roentgenograms, reports of lung function tests, death certificates, other clinical data, and occupational histories. A correlative study was conducted to determine the accuracy and similarity of the cause of death as shown on the death certificate and the cause of death shown on the autopsy report. Data for the study were acquired by obtaining official death certificates from the State in which the miner died and comparing the death certificate with the corresponding autopsy report received through the autopsy service program.

Earlier findings in 1974 for cohorts (a) and (b) indicated excess mortality associated with complicated pneumoconiosis, obstructive airway diseases, and cigarette smoking. Estimates are now being prepared of the completeness of diagnoses of cardiopulmonary diseases reported on death certificates by comparing them with the same diagnoses reported on standardized autopsy reports for 1,300 coal miners from the National Coal Workers' Autopsy Study. These data will be tabulated in the near future.

INFECTIOUS DISEASE RESEARCH

Common colds, viral or bacterial pneumonia, influenza, and other infections of the respiratory tract are serious threats to persons with chronic lung diseases who work in dusty environments. One disease may weaken the lungs

and predispose the miner to another disease; the damage, therefore, may be compounded to drastically alter the ability of the lungs to function normally.

NIOSH's coal mine health research includes the following objectives:

1. Evaluating the interactions of mineral dusts (coal dust, asbestos fibers, and others) and infectious agents on immune or defense mechanisms in the lung.

2. Assessing the susceptibility of workers and miners, their families, and other selected members of the community to repeated infectious diseases (relapses).

3. Developing techniques for finding, immunizing, and treating persons who are or might become susceptible to repeated infections.

Information attained by research is intended to be helpful in reducing respiratory disability in workers.

Impact of Mineral Dusts on Cellular Defense

In assessing the interactions of infectious agents and mineral dusts on cellular immune mechanisms, NIOSH scientists have determined that a basic defense mechanism, the production of interferon, was reduced when cell cultures were treated with dust. Interferon, a protein produced by cells as a defense against infectious agents, has the ability to restrict pathogenic activities.

In addition to coal dust, five different asbestos fibers will also depress interferon production and, therefore, make cells more vulnerable to infection. When coal dust, asbestos fibers, or cells are first treated with the chemical poly (4-vinylpyridine-N-oxide), the ability of mineral dust to depress interferon production is neutralized.

Current research efforts are continuing to (a) determine the basic mechanisms by which interferon production is reduced by mineral dusts, (b) examine other chemical compounds that may neutralize the pathogenic activities of mineral dusts, and (c) investigate human serum -- mineral dust interactions on cell defense mechanisms. Higher level models, including experimental animals, will be used to assess the consequences of interferon depression by mineral dusts and of its amelioration by chemical compounds such as polymers.

Hemophilus influenzae in Diagnosis of Bronchitis

Chronic bronchitis is the most prevalent and rapidly increasing chronic disease among workers. In the first round of the NSCWP, a little more than 36% of the miners examined were considered bronchitic by the British standard, which provides that the miner probably has bronchitis if the miner persistently produced phlegm or has a persistent cough at least 3 months of the year. In the second round, 41% of the examinees were considered bronchitic.

The most severe stages of chronic bronchitis are characterized by persistent sputum production and spirometrically measurable obstruction of the larger airways. The effectiveness of preventive efforts and chemoprophylaxis in the remission of earlier stages of the disease can only be estimated subjectively.

Because diseased bronchial linings are highly susceptible to ubiquitous, normally harmless infectious agents (that is, noncapsulated Hemophilus influenzae, Pheiffer's bacillus), the severity of chronic bronchitis may be reflected by increased levels of serum antibodies to H. influenzae. Some chronic bronchitics suffer repeated injections from this microorganism. A quantitative serologic test may better define the intermediate stages of influenza and may enable identification of persons who would benefit most from treatment (to prevent relapse or reinfection), particularly during episodes of acute infection.

In the project, efforts have been centered on isolation and preparation of a specific antigen (H/1), in pure form, from concentrated whole organisms of H. influenzae. This antigen will be evaluated for use in a quantitative serologic test of the severity of the effects of the early stages of chronic bronchitis in workers.

Respiratory Infections Survey

Viruses are generally believed to induce respiratory complications in persons with underlying lung disorders. A short-term longitudinal survey was conducted to learn the incidence of viral respiratory disease in a West Virginia coal mining community during one winter.

The respondents encompassed a stratified population with an expected greater-than-usual susceptibility to underlying respiratory disease, coal workers' pneumoconiosis. Inclusion of all adults in the home made it possible to assess the communicability of viral agents. Furthermore, the community structure was such that attack rates of persons in two generally defined occupations (coal mining and nonmining) could be compared. Participants were selected to provide pre- and postwinter blood samples and to answer questionnaires about respiratory symptoms and coal workers'

questionnaires about respiratory symptoms and coal workers' pneumoconiosis. The study included 92 miners and their wives and 60 nonminers and their wives.

The sera were tested for antibodies against four strains of influenza virus, three types of parainfluenza virus, and against adenovirus. Analysis of the results of tests against influenza virus strains indicates an infection rate of less than 7% for any one segment of the population. Analysis of the remaining data is not yet complete.

Analysis of data from questionnaires revealed the following:

1. More miners than nonminers had symptoms of chronic bronchitis.

2. The number of symptoms reported was the same for wives of miners as for wives of nonminers.

3. Avoidance of influenza immunization was higher among women than men.

4. Closed-end questions concerning breathlessness were answered with a high degree of consistency; open-end questions concerning smoking (pack-year) were answered with a variable degree of consistency.

Additional serum samples were tested for rheumatoid factor and antinuclear antibodies (ANA). In the course of determinations of ANA, baby hamster kidney (BHK 21/C13) was found to be more sensitive for detecting and titering the antibodies than either tissue sections of baby hamsters or seven other established cell lines tested. When analyses of questionnaire and serologic data are completed, a profile of the viral and respiratory disease experience during one winter in a coal mining community will be available.

LABORATORY INVESTIGATIONS

Genetic Factors and Phenotyping

Studies on a possible association between a genetically linked serum protein and predisposition to chronic obstructive pulmonary disease have been continued. The protein in question is an inhibitor of proteolytic enzymes. The enzymes are believed to be involved in hydrolytic destruction of lung tissue resulting in qualitative changes noted in some pulmonary disease processes. The genetically linked serum protein is referred to as a proteinase inhibitor.

Although previous investigators had been primarily concerned with titers (serum levels) of proteinase inhibitor(s), NIOSH scientists have emphasized phenotyping. Genetic polymorphism of this serum protein has revealed many genetic variants that can be identified by a time-consuming and cumbersome phenotyping procedure, hardly feasible for screening large populations. With this obstacle in mind, biochemists at NIOSH have been concentrating on development of a new and simpler assay system that possibly could be correlated to some genetic variants.

The system that has been developed is based once again on serum titers, but it uses a different proteolytic enzyme for the standard. The system can readily be used in an industrywide screening program. At this time, the procedure is undergoing evaluation for specificity and range determinations for normal and genetically deficient sera samples.

Another method of determining genetic makeup is the technique known as "histocompatibility loci typing." An epidemiologic survey of about 300 randomly selected coal miners in three areas of Pennsylvania (eastern, central, and western) was conducted to ascertain whether there is a genetic predisposition for the development of coal workers; pneumoconiosis. Analysis of results suggests that certain persons are at high risk of acquiring the disease whereas others demonstrate a resistance to the disorder.

Connective Tissue Syntheses--Cell Culture

Syntheses of major biological constituents of lung are being studied through the use of cell cultures. Primarily the study relates to the ability of human lung fibroblast cells to function in the presence of environmental particulates: coal dusts, asbestos, silica, and similar substances.

Apparently the cells can, at a much lower rate, synthesize connective tissue components--so essential to the physiological integrity of an organ such as the lung. However, the lower rate of synthesis may result from a decrease in cell population. Apparently the metabolic processes involved in cell division have decreased when cells are grown in the presence of various

dusts. With a decrease in the number of viable cells, there is an apparent quantitative decrease in the synthesis of connective tissue components. The components themselves, however, as previously noted do not appear to be altered either in a chemical or physical sense. These studies are continuing with cell cultures being exposed to other particulates found in the work area.

Respirable Dust in Human Lungs

Specimens of lung tissue received through the autopsy program have been used for the analysis of respirable dust in human lung. Understanding the deposition of coal mine dust in the lungs and its clearance from them is a significant step in the prevention of coal workers' pneumoconiosis.

The mechanisms by which certain dusts are retained in or cleared from the lung are not clearly understood. The lung has special cells, macrophages, that have an important function in the removal of dust from the lungs. When these macrophages are injured by certain types of dust, they die, releasing proteolytic enzymes and the dust, which subsequently causes further lung damage. Studying the effects of coal dust on these macrophages is an important aspect of this research.

The primary purpose of this research is to evaluate the material in coal dust that, by association, may be directly responsible for the pathological changes in the structure of the lungs. The project has been designed to characterize the respirable dust particles in human lung tissue associated with specific pathological lesions in coal workers' penumoconiosis.

The particles are being observed by use of light microscopy, scanning and transmission electron microscopy, image analysis techniques, and X-ray fluorescence microanalysis. The particles are characterized by size, shape, and chemical composition. Particles found in the lung tissue at non-pathologic sites are also being studied by the same method and for the same characteristics. This study is designed to indicate which materials in the coal dust--such as silica, silicates, asbestos, pyrite, calcite, mica, and kaolin--are primarily associated with pathological changes.

A portion of this research is devoted to studying the effects of cigarette smoking on the bronchi's clearance of coal dust from the lungs. A major objective is to determine a method by which the effect of coal dust and the effect of cigarette smoking on the incidence of coal workers' pneumoconiosis can be separately assessed. During this research new techniques have been developed so that lung tissue surrounding the dust can be removed and the residual dust can be studied without artifacts.

In another project related to particle deposition, scientists learned to tag uniformly sized (0-2 micron) respirable particles with radioactive material

that could be detected by using scintillation cameras. This method will be useful because modeling experiments that are used to explain particle deposition and clearance in the human lung have not been exact. Such impreciseness has been caused by examining particles that varied widely in size.

Although the results of these experiments would be applicable to coal workers' pneumoconiosis, they would also be expected to relate to all other occupational respiratory diseases in which an insult resulted from the inhalation of particles.

Lung Ventilation and Perfusion

During 1975, experiments were carried out in an attempt to show the functional relationships between ventilation (airflow) and perfusion (blood flow) in specific regions of the lung. In obstructive airway disease related to occupational respiratory diseases, many possible factors may cause changes in these lung parameters. One or more factors may be the primary determinate of the human disease condition. This project has been focused on performing experiments in series in which a different parameter has been changed in each experiment so as to observe the response in dog lungs. Experiments have not yet been completed, and, therefore, no definite conclusions can be stated.

Lung Pathogenesis in Coal Workers' Pneumoconiosis

A series of experiments was conducted on the premise that coal dust interferes with the surfactant system in the lung. A liquid surface covers all the alveoli and airways throughout the lung, and this surface is the first barrier for toxic materials to cross. Surface tension in the intact lung of this air-liquid boundary has never been measured. Changes in the surface tension of this interface exert a profound effect on the pressure-volume relationships of the lung, and these changes would be expected to have a great effect on lung functions, such as closing volume, closing capacity, and frequency dependence of compliance.

NIOSH physiologists have, therefore, initiated a series of experiments that will enable them to measure the intact surface tension in animal lungs. Using the knowledge gained from these experiments, the scientists can then extrapolate to the human lung and begin to postulate the specific effects of toxic agents on the lung.

This research is particularly important because the initial stages of any lung disease are subtle, and the overall changes that are measured in early lung disease are minute. Of the 300 million alveoli in the lungs, initially only a few are affected. As the number of affected alveoli increases, overall lung structure and function begin to deteriorate. Not until an

appreciable number of these alveoli have deteriorated is it possible to detect clinical changes in lung structure and function. These experiments may lead to tests for detection of early lung disease that are much more sensitive and selective than those now in use.

DEVELOPMENT OF DIAGNOSTIC STANDARDS FOR COAL WORKERS' PNEUMOCONIOSIS

Materials received through the autopsy service program have also been used in the development of diagnostic standards for coal workers' pneumoconiosis. The purpose of this research is to develop a set of comparative standards for pathologists to rely on in diagnosing and determining the stages of coal workers' pneumoconiosis and associated conditions. These standards are being developed by using a correlation of roentgenograms, observed pathological conditions, and analysis of the dust in the lung. No such standards currently exist.

Consultations were held with pathologists who were experts in pneumoconioses and lung research. During 1975 a preliminary report was made to the Coal Mine Health Research Advisory Committee. A contract has been entered into with the College of American Pathologists and the American Society of Clinical Pathologists to assist in the development of these standards. When completed, these standards will be a means of improving the reliability and accuracy of the diagnosis of coal workers' pneumoconiosis, and they will serve as a model of diagnostic standards for other respiratory diseases. The standards for coal workers' pneumoconiosis will ultimately be published for dissemination to pathologists involved in its diagnosis.

TOXICOLOGIC STUDIES

A primary function of the Toxicology Branch, Division of Laboratories and Criteria Development, in Cincinnati, is the development of criteria for recommending, or validating, the control of worker exposure to limits of contaminants in industrial air. During the last weeks of 1975, a major milestone toward this objective was accomplished--the completion of daily exposures of experimental animals to bituminous coal dusts at the Federal coal mine dust exposure standard of 2 milligrams of respirable dust per cubic meter of air (2mg/m3). This long-term inhalation exposure study, with progress updated in annual reports since 1971, was initiated to accomplish the following objectives:

1. Determine comparative toxicologic activity of coal dusts associated with high (Pennsylvania coal) and low (Utah coal) prevalence of coal workers' pneumoconiosis.

2. Determine the toxicologic effect of a superimposed, repeated, intermittent peak concentration on the constant exposure level from Pennsylvania coal dust associated with a high incidence of disease.

3. Develop criteria applicable to substantiating the Federal standard for bituminous coal dust.

In evaluating this research over the last 5 years, the most important observation has been the repeatedly exhibited, obstructive defects of the small airways in the majority of subhuman primates (Cynomolgus monkeys) exposed to the coal dusts. This observation has been correlated with histopathology of lung tissue from some of the same exposed animals in terms of an increased amount of bronchial smooth muscle. Through forthcoming critical interpretations of 15 model cardiopulmonary function evaluations, histologic alterations, and biochemical indices, it may be possible to derive significant conclusions on the toxicologic impact of the present 2 mg/m3 bituminous coal dust standard in experimental animals.

During 1975, the results of this study were reported at a Workshop on the Health Effects of Coal and Oil Shale Mining, Conversion, and Utilization, co-sponsored by the Department of Environmental Health, University of Cincinnati; the National Institute of Environmental Health Sciences; and NIOSH. The study was reported again at the 6th Annual Conference on Environmental Toxicology sponsored by the University of California, Irvine, under contract to the U.S. Air Force Aerospace Medical Laboratory, Wright-Patterson Air Force Base, Ohio. Cardiopulmonary function data from the study were published in the Journal of Applied Physiology, Vol. 39, No. 3, September 1975: "Maximum Expiratory Flow-Volume Studies on Monkeys Exposed to Bituminous Coal Dust." Results published in this paper were presented to the Coal Mine Health Research Advisory Committee in addition to data developed from another coal dust inhalation study on ventilatory function in germ-free and conventional rats (summarized in the 1974 Annual Report).

Response of Smooth Airway Muscle to Acetylcholine

The response of dogs' normal smooth airway muscle to the drug acetylcholine (ACh) has been tested. The initial objective of these experiments was to study the mechanism by which ACh causes the muscle to contract, a common complication in occupational bronchitis.

ACh causes a slow, sustained depolarization of the muscle that persists as long as the drug is present. During the initial part of the contraction, the membrane potential does not change; calcium ions are released from the membrane that then becomes depolarized, and calcium ions move into the cell from the extracellular fluid.

Trace-Metal Binding

In the past year, ALFORD has evaluated the possibility that trace metals can, for example, form micelles similar to colloidal suspensions. As such, the chemical reactivity of the metal is not altered, but the reactivity is

capable of being transported in the body. A few of these micelle solutions have been prepared and are being evaluated for interactions with biological constituents. For the most part, extracellular proteins are not affected, but cellular membranes may be. The studies are continuing.

Many trace metals have a well-defined physiological function, whereas others are highly toxic at similar concentrations. Some are carcinogenic. Furthermore, some trace metals can be both beneficial and toxic within a fairly narrow range of concentrations. The cause and effect relationship between environmental trace elements and the pathogenesis of a disease is highly complex, and only in recent years has it been fully appreciated. The complexities involve the means of transport and interactions of the metal with biological constituents.

Effects of Heavy Metals on Red Blood Cells

NIOSH physiologists continued their studies on the effects of heavy metals on living cells. In 1974 they had determined that these metals affect the membrane of red blood cells by greatly increasing the cell's sodium permeability. Mercury, nickel, cobalt, and copper exert their effects by combining the sulfhydryl groups, and zinc exerts its effect by reacting with the protein portion of the membrane.

During 1975 additional data were obtained to describe the dose-response relationship. Mercury, nickel, and copper affect cell membranes in concentrations as low as 0.001 millimoles per liter. Dose-response relationships for mercury, nickel, and cobalt can all be described by a mechanism in which two heavy metal ions bind to one protein site in the membrane. With zinc the relationship is one heavy metal ion per protein site. Studies are continuing with other heavy metals to ascertain their cellular effects.

INTERAGENCY ACTIVITIES

During 1975, NIOSH continued to coordinate its coal mine health activities with other agencies for their joint advantage and to prevent undesirable duplication of effort. Goals of these activities were effectively accomplished with the Food and Drug Administration, the Department of the Interior, the Department of Labor, the Coal Mine Health Research Advisory Committee, the Interim Compliance Panel (ICP), and the Energy Research and Development Administration in conjunction with its prime contractor, the Los Alamos Scientific Laboratory, University of California.

FOOD AND DRUG ADMINISTRATION

Through an interagency agreement with the Food and Drug Administration's Bureau of Radiological Health, NIOSH has contributed to the support of a program at the X-ray Science and Engineering Laboratory of Oregon State University. This arrangement has given NIOSH access to expertise for producing high-quality chest roentgenograms necessary for reliable diagnosis of pulmonary illnesses.

Another major service has been advice to NIOSH on how facilities producing unsatisfactory roentgenograms can improve their diagnostic X-ray techniques so as to qualify for NIOSH certification and participation in the medical examination program authorized by Section 203 of the Federal Coal Mine Health and Safety Act of 1969. The laboratory staff also advises on other technical problems, such as the effectiveness of specific X-ray film and intensifying screen combinations, and the proper processing of exposed film.

A research project at the laboratory is the development of a device that will indicate to technologists acceptable film quality. The device superimposes an image on the film in an area where it will not compromise the integrity of the roentgenogram. The device will be used to assure high-quality roentgenograms and to indicate necessary re-X-rays while the miner is still available at the clinic.

DEPARTMENT OF LABOR

The Department of Labor through its Occupational Safety and Health Administration (OSHA) has contributed, by means of an interagency transfer of funds, to the support of a NIOSH contract with the American College of Chest Physicians for the preparation of a manual. The manual, directed primarily to physicians, is on the management of occupational respiratory disease in coal miners.

OSHA participates regularly with NIOSH in discussions on personal protective equipment and industrial hazard measuring devices for general use. Improvements in these devices are being sought for use in mining.

COAL MINE HEALTH RESEARCH ADVISORY COMMITTEE

The Coal Mine Health Research Advisory Committee, as specified by the Federal Coal Mine Health and Safety Act of 1969, was established in 1970 to advise the Secretary of Health, Education, and Welfare on matters involving or relating to coal mine health research. The committee, as now constituted, consists of the Director, Bureau of Mines, or delegate; the Director, National Science Foundation, or delegate; the Director, National Institutes of Health, or delegate; and 14 additional members appointed by the Secretary of Health, Education, and Welfare (see Appendix D for list of members).

The Committee met three times during 1975: March 20 and June 27 in Rockville, Md., and October 23 in Morgantown, W. Va. They reviewed progress of coal mine-related health research projects under way in NIOSH, provided comments and advice to NIOSH staff scientists on the planning and conduct of research, and recommended emphasis on specific subjects for future research. Special attention was given to the following subjects:

1. The autopsy program mandated by the Federal Coal Mine Health and Safety Act of 1969.

2. Preliminary reports about the second round of X-ray examinations during the National Study of Coal Workers' Pneumoconiosis.

3. Progress on the development of computer-assisted X-ray reading for diagnosing coal workers' pneumoconiosis.

4. Status report of research projects at the Appalachian Laboratory for Occupational Safety and Health.

5. Development of a classification system for lung abnormalities associated with coal workers' pneumoconiosis.

6. Correlation studies of X-ray, pulmonary function, and pathological conditions suggestive of coal workers' pneumoconiosis.

7. Results from studies of coal miners' pulmonary function in which flow volume loops were used to detect small airway disease.

Three research grants were recommended for approval, and five were recommended for disapproval.

INTERIM COMPLIANCE PANEL (ICP)

Continuing support was provided to the ICP by NIOSH during 1975 under the terms of an agreement negotiated between the Office of the Secretary, Department of Health, Education, and Welfare, and the Interim Compliance Panel in September 1970. The agreement provided for the assignment of personnel, payment of salaries and related costs, and payment of 40 percent of all other costs incident to ICP operations.

Respirable Dust Standard

The Federal Coal Mine Health and Safety Act of 1969 requires that effective December 30, 1972, each operator of an underground coal mine will continuously maintain the mine atmosphere to which each miner is exposed at or less than 2.0 milligrams of respirable dust per cubic meter of air. The Act provides, however, that an operator may apply for temporary relief if the standard cannot be met and that the ICP can issue a temporary noncompliance permit. The permits will allow a maximum average respirable dust level of 3.0 mg/m3 of air for no longer than 12 months, with renewals authorized through December 30, 1975.

As of January 1, 1975, only one permit was still in force. When that permit expired on June 30, 1975, the Panel notified the Congress that the ICP docket for the coal mine dust standard had been completed.

Standard for Electric Face Equipment

In accordance with Section 305 (a)(2) of the Act concerning electric face equipment, the ICP panel granted a total of 751 initial permits for noncompliance, effective March 30, 1974, for periods from 1 to 12 months. The regulations allow mine operators to file for renewal of noncompliance permits until March 30, 1976.

On January 1, 1975, 183 permits for noncompliance with the standard for electric face equipment were in force. During calendar year 1975, the panel received 175 applications for renewal permits to operate equipment in 34 mines. Renewal permits were granted for 169 items of face equipment and denied for 6 others. Forty renewal permits were in force on December 31, 1975.

DEPARTMENT OF THE INTERIOR

Noise and Hearing

NIOSH and the Mining Enforcement and Safety Administration (MESA), Department of the Interior, began a joint effort to ensure future

availability of sound level meters and noise dosimeters designed to withstand the rugged use to which they are subjected in mining activities. These instruments will undergo certification tests by NIOSH at Morgantown.

In cooperation with the Bureau of Mines (BOM), Department of the Interior, a comprehensive report entitled "Survey of Hearing Loss in the Coal Mining Industry" was completed in 1975. Results of this research program provide information for documenting the incidence and degree of hearing impairment among coal miners.

Previous investigations have established that exposure to continuous high intensity noise can produce hearing loss, but considerably less evidence is available on the relative hazard of exposure to noise that fluctuates in intensity and duration. Coal mining noise varies almost continuously and is, therefore, considered less damaging to the natural hearing mechanism than continuous noise at the same level.

Thus, a survey was initiated to test the hearing of men working in underground coal mines and to determine the prevalence of hearing impairment, if any, that could be attributed to mining noise. The study was conducted with the cooperation and assistance of the Bureau of Mines, the United Mine Workers of America, and the Bituminous Coal Operators Association.

BOM personnel surveyed noise levels at 11 mines randomly selected by NIOSH to represent various noise levels encountered in coal production. Hearing surveys were then arranged at the same mines. Miners participated on a voluntary basis, and they were asked to complete a questionnaire, to have their ears examined otoscopically, and to submit to a hearing test. Information sought for this purpose included history of employment, military service, nonoccupational noise exposure, recent noise exposure, and relevant medical history including otoscopically observable ear abnormalities. The miners were classified by occupational codes based on the BOM noise surveys and by 10-year age groups.

The hearing of all the miners was poorer than that of a representative sample of a cross section of the general, unscreened population of the United States. Results indicate that the hearing of middle-aged coal miners is comparable to that of people at retirement age in the general population.

A group of miners, whose only known noise exposure was in the mining industry, was found to have poorer hearing than workers not exposed to occupational noise. The differences were greatest for those over age 35, in whom, presumably, the years in the mining environment were having a measurable effect. When the hearing of the screened group was compared with groups of workers with known noise exposures obtained through NIOSH research projects, it was found that the hearing levels of miners were equivalent to

those of workers in other industries who had been subjected to noise levels between 90 and 95 dBA.

Correlation of hearing loss with noise exposure was rendered difficult because of factors that cause variations in noise exposures over a working lifetime. These variations included job mobility, changing mining operating procedures, and new or different equipment.

One special analysis of the hearing data indicated that the use of recreational firearms apparently adds relatively little to the effects from long-term exposure to coal mining noise. Middle-aged nonshooting miners had hearing levels no better than those considered to be heavy shooters. Another subject that prompted special concern was the abnormalities discovered during the otoscopic examination. An unexpected, seemingly inordinate, number of miners have a visible anomaly within the ear canal or on and behind the ear drum. A NIOSH study is under way to examine the prevalence and causes of outer and middle ear disorders in coal miners.

The report recommends that new studies be undertaken to identify and quantify the risks caused by mining noise and that hearing conservation programs be made more effective with frequent tests of the working miner's hearing used as a tool for evaluating such programs.

Air Sampling Instruments

NIOSH, MESA, and BOM began revising requirements for approval of coal mine dust personal sampler units and of gas and vapor sampling instruments for use in coal mines. Modifying the specifications will be a continuing program to ensure a commercial supply of reliable instruments. Improved, readily available instruments will help both the operators and the miners to realize a safer working environment.

Personal Protective Equipment

Under BOM research contracts, MESA, NIOSH, and BOM continued development and evaluation of mine rescue breathing apparatus and mine escape breathing apparatus. Specifications for these apparatus are written for, and couched in language most familiar to, the coal mining industry.

Approved devices are also in wide demand by firefighters, noncoal miners, quarriers, tunnel workers, and anyone who might enter irrespirable atmospheres routinely or have to escape from them.

Quality Assurance

NIOSH provided quality assurance evaluation of protective devices jointly approved with MESA under testing and approval programs. This evaluation consisted of consultation on development of new regulations and review of existing regulations for approval of protective devices. Field visits have been made to manufacturers to ensure that they are maintaining appropriate quality control during production and that they are producing uniformly high-quality equipment.

The quality assurance program also involves purchasing equipment from dealers' stocks on the open market and carefully evaluating it. This activity has resulted, in some instances, in halting the sale of unsatisfactory and possibly hazardous production runs of devices. Excluding substandard safety equipment from the marketplace is a strong contributing factor to the manufacture of quality items on which the wearer can rely.

Mine Sanitation

The Federal Coal Mine Health and Safety Act of 1969 requires the development and promulgation of suitable regulations covering all aspects of sanitation at or in all coal mines and during all operations at coal mines.

Using the experience gained in developing preliminary requirements over the past several years, NIOSH, after consultation with MESA, has drafted improved, feasible regulations. Adoption of these regulations will prevent health hazards that can arise from inadequate sanitation and include such items as potable water, toilet facilities, washrooms, eating areas, locker rooms, and the proper disposal of wastes and sewage.

Diesel Exhaust

Interest in using diesel-powered equipment in underground coal mines is growing. Among the reasons for this interest is the expected corresponding decrease in the underground use of electric power that, in turn, will reduce the risk of gas (methane) ignitions by electric sparks and the resulting mine fires and explosions.

Standards for the approval of diesel locomotives used in coal mines have existed for many years. These standards could have been modified to extend to other coal mining equipment, but resistance and apprehension of many coal miners have heretofore allowed relatively few diesel engines to be operated in coal mines. BOM standards for the approval of diesel locomotives for use in coal mines are more closely related to safety requirements (fire and explosion) than to the protection of the health of miners. Despite ample information about the constituents of diesel engine exhaust and the general acceptance of air pollution standards, no systematic attempt has previously

been made to evaluate the effects of diesel engine exhausts on workers in mines.

A joint program with the Department of the Interior was formulated in 1974 and finalized in 1975. Under it, BOM and MESA will measure the chemical components of the atmosphere in selected noncoal mines where diesel engines are commonly used and in similar mines with other sources of motive power. Concurrently, NIOSH will offer medical examinations to about 6,000 volunteer noncoal miners, some with and some without exposure to diesel exhaust fumes in the same mines. Fieldwork by both agencies will begin in January 1976 and require about 2 years.

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

The Los Alamos Scientific Laboratory, University of California, has been working under a NIOSH interagency agreement pursuant to the University's contract with the Energy Research and Development Administration.

During 1975 such cooperative work included (a) development of a direct-reading, portable, coal mine dust sampler unit that will give aerodynamic size distributions for coal dust and (b) preparation of a final report on previous filter loading and coal dust chamber studies.

AIR SAMPLING AND PERSONAL PROTECTIVE EQUIPMENT ACTIVITIES

TESTING AND CERTIFICATION

The NIOSH Testing and Certification Laboratory (TCL) at Morgantown, W. Va., certified 11 gas and vapor detector tube units. Seven coal mine dust personal sampler units and 94 respiratory protective devices are currently approved by TCL. This equipment is designed for use in coal mines and other industries. Three approvals on coal mine dust personal sampler units were withdrawn by NIOSH when the applicant failed to produce units that conformed with the drawings and specifications on which the certifications were based.

TCL tested samples of safety-toe shoes and safety hats and issued reports on the results. The tests showed significant lack of conformity of these shoes and hats with currently accepted standards: 30% of the shoes and 86% of the hats tested failed to meet performance criteria of applicable American National Standards Institute standards.

New regulations for certification of direct-reading gas and vapor meters, solid sorbent tubes, sound level meters, and safety hats were prepared for publication. NIOSH purchased samples of approved and certified devices on the market; these were subsequently subjected to dimensional evaluation and performance testing. Except for the coal mine dust personal sampling units, no serious lack of conformity with approval and certification regulations was noted. However, several manufacturers were advised to increase their quality control sampling levels when minor variations from the criteria for approval and certification were found.

COAL MINE DUST SAMPLING

The NIOSH coal mine air sampling program consists primarily of research and development of air sampling equipment and methods. The objective of this program is to provide a better means of evaluating the coal workers' exposure to respirable dust and to provide realistic and reliable methods of sampling air in the coal mine to ensure compliance with statutory standards. Contracts, interagency research agreements, and NIOSH intramural research and development have been used to achieve this objective.

Under an interagency agreement between NIOSH and the Energy Research and Development Administration, the University of California's Los Alamos Scientific Laboratory developed a standard test coal dust. The dust has a mass mean aerodynamic diameter of 1.65 ± 0.25 micrometers and will be used by NIOSH in conjunction with its instrument evaluation program. Only limited quantities of the dust are presently available to other laboratories; feasibility of its commercial production is being investigated.

A report resulting from a University of Minnesota evaluation of the performance of a coal mine dust personal sampler unit raised questions about sampler leakage around the vortex finder. The manufacturer of the sampler corrected the problem after being made aware of it.

MESA and the NIOSH TCL assessed the effect of the uniform rate of weight loss by cassettes used in one manufacturer's coal mine dust personal sampler units. This weight loss occurred while the unused cassettes were in storage, and the deterioration of the cassettes affected the results of weighing samples of coal mine dust obtained by MESA. A public hearing to withdraw certification was held, and certification of the units was withdrawn. Subsequently NIOSH certified a new unit manufactured by the same company, which used cassettes made of a different material.

Information on the certification program was provided for a position paper in response to requests by the National Bureau of Standards and the General Accounting Office.

NIOSH joined the Energy Research and Development Administration in an agreement to support research for aerosol sampling at the Los Alamos Scientific Laboratory. This research included investigating the effects of loading of the cyclone and the filters used in the coal mine dust personal sampler unit and determining the effect of aerosol electrostatic charge on particulate penetration through the system. The scientists concluded that long-term air samples of high concentrations of dust may be underestimated because of loading. The aerosol charge does not appear to either impair or improve the collection efficiency of the sampler.

RESPIRATORY PROTECTION

Section 202 (h) of the Act requires that mine operators provide respirators for miners exposed to coal mine dust whenever the concentration of respirable dust exceeds the established standard. Under section 204, miners must be provided respirators when they are exposed for short periods to hazardous gas, dust, fumes, or mist.

Under a continuing interagency agreement with the Energy Research and Development Administration and the Los Alamos Scientific Laboratory, an applied research and development program is under way to improve coal miners' acceptance of respirators by developing more effective standards for approving them. Improved methods and equipment to be used in testing respirators for approval have been developed. These new performance criteria are intended to improve the fit and comfort of the facepiece and the effectiveness of dust, fume, and mist filters.

A unique feature of the new method of testing will be the requirement to test each respirator on a selected panel of men and women with head and facial structure common to approximately 95% of the U.S. working population. To help respirator manufacturers conform with the new measurements, NIOSH will publish a design guide that will provide anthropometric data on the range of facial variability inherent in the working population. This guide must be accommodated in the sizing and design of respirators.

A manual is being developed to help industry establish acceptable respirator programs. It will be directed to industrial hygienists and professional safety personnel responsible for establishing and administering programs to foster use of respirators in industry.

Other substantive research projects are the development of improved methods and equipment for approval testing of gas masks and chemical cartridge respirators, the laboratory evaluation of activated carbon as a respirator sorbent, and the field evaluation of a hydraulically powered, supplied-air respirator. This respirator, developed by NIOSH, is designed to be mounted on an underground mining machine and to supply cleaned air to the machine operator. The project is being carried out in cooperation with BOM, Department of the Interior.

CONTRACT	210-76-0103
CONTRACT PERIOD	9/17/75 - 9/16/76
FUNDS TO DATE	$26,000
FY 75 FUNDING	$26,000
PROJECT OFFICER	John Hankinson
TITLE	Construction of a Forced Expiratory Volume Simulator
ABSTRACT	Construct, evaluate, and furnish a forced expiratory volume simulator suitable for comparing various models and types of spirometers and flow measuring devices generally used in clinical studies.
CONTRACTOR	Novatek, Inc., Burlington, Mass.

CONTRACT	CDC-99-74-60
CONTRACT PERIOD	06/19/74 - 11/30/75
FUNDS TO DATE	$144,160
FY 75 FUNDING	$0
PROJECT OFFICER	William Kroes
TITLE	Data Base for Psychological Job Stress and Health
ABSTRACT	Ascertain prevalence of health problems resulting from psychological job stress factors by means of a retrospective study of morbidity records for workers employed in all major occupations in Tennessee.
CONTRACTOR	Tennessee Department of Mental Health, Nashville, Tenn.

CONTRACT	210-75-0074
CONTRACT PERIOD	6/27/75 - 5/26/76
FUNDS TO DATE	$57,080
FY 75 FUNDING	$57,080
PROJECT OFFICER	Alan Gudeman
TITLE	Field Evaluation of the Performance of Self-Contained Breathing Apparatus used by Fire Fighters
ABSTRACT	Obtain information on the required protection factor and air volume requirement necessary for protection of fire fighters wearing demand-type, open-circuit self-contained breathing apparatus and evaluate the approval performance requirements for this apparatus.
CONTRACTOR	IIT Research Institute, Chicago, Ill.

CONTRACT	210-75-0072
CONTRACT PERIOD	6/27/75 - 2/26/77
FUNDS TO DATE	$226,814
FY 75 FUNDING	$226,814
PROJECT OFFICER	William H. Kroes
TITLE	Health Consequences of Shiftwork
ABSTRACT	Ascertain the nature and extent of shiftwork practices in American industry and identify the physical and mental health consequences, positive and negative, of shiftwork. Guidelines as to optimum shift scheduling and recommended procedures for the most effective adjustment to shiftwork will be based on the results of this study.

CONTRACTOR	Stanford Research Institute, Menlo Park, Calif.
CONTRACT	HSM-99-73-22
CONTRACT PERIOD	4/1/73 - 10/31/75
FUNDS TO DATE	$95,674
FY 75 FUNDING	$17,995
PROJECT OFFICER	Alexander Cohen
TITLE	Effects of Noise on Nonauditory Sensory Functions and Performance
ABSTRACT	Evaluate key measures of visual, tactile, thermal, kinesthetic, and vestibular sensory functions and sensibilities as they may be affected by exposures to industrial-type noises; and examine aspects of response accommodation.
CONTRACTOR	University of Louisville Foundation, Inc., Louisville, Ky.
CONTRACT	210-75-0035
CONTRACT PERIOD	6/25/75 - 10/24/75
FUNDS TO DATE	$9,675
FY 75 FUNDING	$9,675
PROJECT OFFICER	Terry L. Henderson
TITLE	Analysis of Parametric Relationships between Noise

Exposure and Hearing Loss

ABSTRACT	Provide 30 chinchilla behaviorally trained to yield auditory thresholds. After a period of noise exposure by NIOSH, the contractor shall determine post noise auditory exposure thresholds, kill the animals, and remove and evaluate their cochleas.
CONTRACTOR	University of Tennessee, Knoxville, Tenn.

CONTRACT	210-75-0055
CONTRACT PERIOD	4/22/75 - 2/21/76
FUNDS TO DATE	$13,348
FY 75 FUNDING	$13,348
PROJECT OFFICER	Derek E. Dunn
TITLE	Cochlear Surface Preparation and Evaluation
ABSTRACT	Following a period of noise exposure, 30 guinea pigs will be killed and parts of their ears removed, processed, and examined.
CONTRACTOR	University of Tennessee, Knoxville, Tenn.

CONTRACT	210-75-0049
CONTRACT PERIOD	6/24/75 - 6/23/76
FUNDS TO DATE	$57,400
FY 75 FUNDING	$57,400

PROJECT OFFICER	David H. Groth
TITLE	Trace Elemental Analyses of Biological and Chemical Samples
ABSTRACT	Quantitative analysis of samples of biological tissue, diets, chemical compounds, and minerals for one or more specified elements.
CONTRACTOR	University of Missouri, Columbia, Mo.
CONTRACT	210-75-0050
CONTRACT PERIOD	6/26/75 - 6/25/76
FUNDS TO DATE	$58,223
FY 75 FUNDING	$58,223
PROJECT OFFICER	David H. Groth
TITLE	Histopathologic Evaluation of Animal Tissue from Coal Tar Studies
ABSTRACT	Examine histopathologically and evaluate tissues from animals (exposed by inhalation to coal tar) in a manner that will permit comparison of the toxic effects among all groups of animals.
CONTRACTOR	Pathology Services Associates, Belmont, Calif.
CONTRACT	HSM-99-71-022
CONTRACT PERIOD	06/30/71 - 06/30/76

FUNDS TO DATE	$692,832
FY 75 FUNDING	$69,551
PROJECT OFFICER	Harlan Amandus
TITLE	Followup Study of Three Coal Mining Communities in West Va.
ABSTRACT	Followup the people who were studied approximately 6 years ago in Mullens and Richwood, West Va., by Dr. I. T. T. Higgins. Mortality as well as prevalence, incidence, progression, and remission of chronic respiratory disease will be studied.
CONTRACTOR	University of Michigan, Ann Arbor, Mich.

CONTRACT	HSM-99-72-133
CONTRACT PERIOD	06/30/72 - 04/30/76
FUNDS TO DATE	$409,025
FY 75 FUNDING	$0
PROJECT OFFICER	John Hankinson
TITLE	Analysis of Maximal Expiratory Flow-Volume Curves Based on an Analytical Model of Lung Mechanics
ABSTRACT	Develop, refine, test, and validate an analytical (mathematical) model of the mechanical properties of the lungs in order to understand the determinants of the maximal expiration flow-volume curve.
CONTRACTOR	Mayo Foundation, Rochester, Minn.

CONTRACT	HSM-99-72-151
CONTRACT PERIOD	06/30/72 - 12/31/75
FUNDS TO DATE	$165,156
FY 75 FUNDING	$10,000
PROJECT OFFICER	William Kroes
TITLE	Attitudinal Factors Affecting Coal Miner Safety and Health
ABSTRACT	Examine, by means of a survey, the attitudes and motivations of coal mine personnel that influence coal miners' acceptance and participation in established safety and health practices.
CONTRACTOR	Westinghouse Electric Corporation, Columbia, Md.

CONTRACT	HSM-99-73-004
CONTRACT PERIOD	10/02/72 - 10/31/75
FUNDS TO DATE	$844,694
FY 75 FUNDING	$165,424
PROJECT OFFICER	Larry F. Boyce
TITLE	Information Processing System for the Coal Miner Medical Examination Program
ABSTRACT	Provide suitable means to process medical data relative to chest X-rays for coal miners.
CONTRACTOR	West Virginia University, Morgantown, W Va.

CONTRACT	HSM-99-73-80
CONTRACT PERIOD	6/30/73 - 12/31/75
FUNDS TO DATE	$160,912
FY 75 FUNDING	$0
PROJECT OFFICER	Joseph Costello
TITLE	Mortality Among Coal Miners Covered by the United Mine Workers of America Welfare and Retirement Fund
ABSTRACT	Clarify the extent of health problems associated with employment in coal mines through an examination of mortality patterns among persons covered by the United Mine Workers of America Welfare and Retirement Fund.
CONTRACTOR	University of Pittsburgh, Pittsburgh, Pa.

CONTRACT	HSM-99-73-92
CONTRACT PERIOD	06/30/73 - 05/26/76
FUNDS TO DATE	$408,583
FY 75 FUNDING	$197,473
PROJECT OFFICER	Earle P. Shoub
TITLE	Automated Chest X-ray Classification
ABSTRACT	Develop prototype software support systems for the automatic scanning and computer classification of the profusion and extent of coal workers' pneumoconiosis as shown in

chest roentgenograms.

CONTRACTOR	University of Southern California, Los Angeles, Calif.
CONTRACT	CDC-99-74-25
CONTRACT PERIOD	06/27/74 - 06/26/76
FUNDS TO DATE	$20,736
FY 75 FUNDING	$0
PROJECT OFFICER	James H. Donnelly
TITLE	Software Service and Support for PDP-12 Time Share Multiprogramming System
ABSTRACT	Develop a three-user core-resident multiprogramming system to allow two real-time online data acquisition jobs and one program development or editing job to execute simultaneously on a PDP-12 central processor with minimal modification to existing programs.
C ONTRACTOR	West Virginia University, Morgantown, W. Va.
C ONTRACT	CDC-99-74-36
CONTRACT PERIOD	06/26/74 - 06/26/77
FUNDS TO DATE	$1,200,000
FY 75 FUNDING	$0
PROJECT OFFICER	Jack Butler

TITLE	Coal Miners Respiratory Clinic Program
ABSTRACT	Provide all the necessary labor, facilities, and equipment to expand the capacity to deliver high quality respiratory clinic services to underserved coal producing regions in States with less than 3 percent, but with concentration of more than 500, of the Nation's active and inactive coal miner population, excluding the States of Pennsylvania, Ohio, Virginia, West Virginia, and Appalachian Regional Commission designated counties in Kentucky, Tennessee, Alabama, and Illinois.
CONTRACTOR	United Mine Workers of America, Washington, D.C.
CONTRACT	CDC-99-74-112
CONTRACT PERIOD	06/26/74 - 03/31/76
FUNDS TO DATE	$9,760
FY 75 FUNDING	$0
PROJECT OFFICER	Earle P. Shoub
TITLE	Administration of Roentgenographic Interpretation Proficiency Evaluation Scheme
ABSTRACT	Provide for testing and evaluating the reading characteristics and proficiency of 50 potential "B" readers for the NIOSH coal miner X-ray examination program.
CONTRACTOR	Johns Hopkins University, Baltimore, Md.
CONTRACT	210-75-0009
CONTRACT PERIOD	12/5/74 - 6/30/75
FUNDS TO DATE	$10,350

FY 75 FUNDING	$10,350
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretation of Chest Roentgenograms ("B" Readings)
ABSTRACT	Provide for definitive interpretation of up to 1,000 chest X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 when the first interpretation is made by an "A" reader.
CONTRACTOR	West Virginia University, Morgantown, W. Va.

CONTRACT	210-75-0010
CONTRACT PERIOD	11/14/74 - 6/30/76
FUNDS TO DATE	$13,050
FY 75 FUNDING	$13,050
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretation of Chest Roentgenograms ("B" Readings)
ABSTRACT	Provide for definitive interpretation of up to 1,000 chest X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 when the first interpretation is made by an "A" reader.
CONTRACTOR	Dr. R. Brent Harrison, Charlottesville, Va.

CONTRACT	210-75-0011

CONTRACT PERIOD	11/14/74 - 6/30/76
FUNDS TO DATE	$13,500
FY 75 FUNDING	$13,500
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretation of Chest Roentgenograms ("B" Readings)
ABSTRACT	Provide for definitive interpretation of up to 1,000 chest X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 when the first interpretation is made by an "A" reader.
CONTRACTOR	Dr. Joseph C. Furnary, Baltimore, Md.

CONTRACT	210-75-0012
CONTRACT PERIOD	11/15/74 - 6/30/76
FUNDS TO DATE	$15,750
FY 75 FUNDING	$15,750
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretation of Chest Roentgenograms ("B" Readings)
ABSTRACT	Provide for definitive interpretation of up to 1,000 chest X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 when the first interpretation is made by an "A" reader.
CONTRACTOR	Dr. Clinton W. Stallard, Newport News, Va.

CONTRACT	210-75-0013
CONTRACT PERIOD	11/18/74 - 6/30/76
FUNDS TO DATE	$17,100
FY 75 FUNDING	$17,100
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretation of Chest Roentgenograms ("B" Readings)
ABSTRACT	Provide for definitive interpretation of up to 1,000 chest X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 when the first interpretation is made by an "A" reader.
CONTRACTOR	Dr. Joseph Rosenstein, Saranac Lake, N. Y.

CONTRACT	210-75-0014
CONTRACT PERIOD	11/29/74 - 6/30/76
FUNDS TO DATE	$17,550
FY 75 FUNDING	$17,550
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretation of Chest Roentgenograms ("B" Readings)
ABSTRACT	Provide for definitive interpretation of up to 1,000 chest X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 when the first interpretation is made by an "A" reader.
CONTRACTOR	Dr. Leonard J. Bristol,

Saranac Lake, N. Y.

CONTRACT	210-75-0015
CONTRACT PERIOD	12/2/74 - 12/1/75
FUNDS TO DATE	$53,040
F Y 75 FUNDING	$53,040
PROJECT OFFICER	Earle P. Shoub
TITLE	Task Force on Pneumoconiosis
ABSTRACT	Develop a task force on pneumoconiosis to improve the quality of radiographs taken under the NIOSH coal workers' examination program; conduct a "B" reader conference to maintain the capability of the medical review employed by NIOSH for the coal workers' pneumoconiosis X-ray examinations; and conduct a conference at the end of round two of the X-ray program that will review the procedures used and results found.
CONTRACTOR	American College of Radiology, Chevy Chase, Md.

CONTRACT	210-75-0018
CONTRACT PERIOD	1/10/75 - 7/9/76
FUNDS TO DATE	$39,521
FY 75 FUNDING	$26,438
FY 76 FUNDING	$13,083
PROJECT OFFICER	Earle P. Shoub

TITLE	Preparation of a Physicians' Manual for the Treatment of Respiratory Diseases of Miners
ABSTRACT	Form a committee of physicians who are recognized authorities on respiratory diseases to develop a manual for use of the primary physicians treating coal miners with occupational respiratory diseases.
CONTRACTOR	American College of Chest Physicians, Park Ridge, Ill.
CONTRACT	210-75-0058
CONTRACT PERIOD	6/26/75 - 7/25/76
FUNDS TO DATE	$71,166
FY 75 FUNDING	$71,166
PROJECT OFFICER	Jeff I. Kamin
TITLE	Development of Criteria and Test Methods for Eye and Face Protective Devices
ABSTRACT	Develop criteria and test methods for eye and face protective devices, supported by engineering and experimental data, in the areas of ballistics and optics.
CONTRACTOR	American Optical Corporation, Southbridge, Mass.

APPENDIX B. COAL MINE HEALTH INTERAGENCY AGREEMENTS IN 1975

AGREEMENT	NIOSH-IA-72-12
FUNDS TO DATE	$0
PROJECT OFFICER	Robert H. Schutz
TITLE	Respirator Testing
ABSTRACT	Defines roles and relationships of NIOSH and MESA in the testing and certification of respirators for use in coal mines.
AGENCY	Mining Enforcement and Safety Administration, Washington, D.C.

AGREEMENT	NIOSH-IA-75-07
FUNDS TO DATE	$5,000
FY 75 FUNDING	$5,000
PROJECT OFFICER	David L. Bayliss
TITLE	Address Data and Last Filing Date
ABSTRACT	Provides approximately 50,000 last filing dates and addresses to be used in occupational health epidemiological studies.
AGENCY	Internal Revenue Service, Washington, D.C.

AGREEMENT	NIOSH-IA-75-08
FUNDS TO DATE	$80,000
FY 75 FUNDING	$80,000
PROJECT OFFICER	Robert H. Schutz
TITLE	Performance of Respirator Fit Tests by Los Alamos Safety Laboratory for NIOSH
ABSTRACT	Perform laboratory facepiece fit tests to determine the validity of the test panel concept for possible incorporation in 30 CFR Part 11.
AGENCY	Energy Research and Development Administration, Washington, D.C.

AGREEMENT	NIOSH-IA-75-14
FUNDS TO DATE	$100,000
FY 75 FUNDING	$10,000
PROJECT OFFICER	Thomas T. Luginbyhl
TITLE	Computer Program to Generate WLN for NIOSH Toxic Substances List
ABSTRACT	Develop computer programs for the interconversion of connection matrix representatives of organic chemical structures to the Wiswesser Line Notation.
AGENCY	Environmental Protection Agency, Washington, D.C.

AGREEMENT	NIOSH-IA-75-32
FUNDS TO DATE	$50,000
FY 75 FUNDING	$50,000
PROJECT OFFICER	David Smith
TITLE	Development of Respirator Cartridge and Canister Test Methods
ABSTRACT	Perform laboratory tests to evaluate various testing and certification approval schemes for organic vapor respirators and gas masks.
AGENCY	National Aeronautics and Space Administration, Washington, D.C.

AGREEMENT	NIOSH-IA-75-36
FUNDS TO DATE	$11,000
FY 75 FUNDING	$11,000
PROJECT OFFICER	William E. Murray
TITLE	Classification of Laser Systems
ABSTRACT	Classify, according to the systems specified in the proposed rulemaking of the Occupational Safety and Health Act, all laser devices and systems employed in industrial, medical, and scientific applications but not prototype or research lasers not commercially available.
AGENCY	Laser Microwave Division, U.S. Army Environmental Hygiene Agency, Aberdeen Proving Ground, Md.

AGREEMENT	NIOSH-IA-76-01 (NIOSH-IA-74-19)
FUNDS TO DATE	$178,500
FY 75 FUNDING	$ 63,000 (NIOSH-IA-75-13)
FY 76 FUNDING	$ 88,000
PROJECT OFFICER	William H. Bowman, Jr.
TITLE	GSA Data Processing Services
ABSTRACT	Provides ADP services including programming support for NIOSH.
AGENCY	General Services Administration, Washington, D.C.

AGREEMENT	NIOSH-IA-76-05
FUNDS TO DATE	$2,500
FY 76 FUNDING	$2,500
PROJECT OFFICER	Pierre Decoufle
TITLE	Address Data - Last Filing Date Only
ABSTRACT	Provides approximately 25,000 last filing dates to be used in occupational health epidemiological studies.
AGENCY	Internal Revenue Service, Washington, D.C.

APPENDIX B. COAL MINE HEALTH INTERAGENCY AGREEMENTS IN 1975 (Cont.)

AGREEMENT	NIOSH-IA-76-06
FUNDS TO DATE	$6,150
FY 76 FUNDING	$6,150
PROJECT OFFICER	Pierre Decoufle
TITLE	Creation of Disabled Workers Summary File
ABSTRACT	Creates disabled workers file with certain data fields, which are useful for the study of disabled workers by occupation for the years 1969 to 1972.
AGENCY	Social Security Administration, Washington, D.C.

AGREEMENT	NIOSH-IA-76-07 (NIOSH-IA-75-01)
FUNDS TO DATE	$258,000
FY 76 FUNDING	$ 10,000
PROJECT OFFICER	Pierre Decoufle
TITLE	Use of NIH Computer Center Services
ABSTRACT	Provides for on-line computer time, as well as key-punching, batch processing, and computer programming services.
AGENCY	National Institutes of Health, Bethesda, Md.

AGREEMENT	NIOSH-IA-76-09 (NIOSH-IA-74-23)
FUNDS TO DATE	$405,000
FY 75 FUNDING	$130,000 (NIOSH-IA-75-34)
FY 76 FUNDING	$ 40,000
PROJECT OFFICER	Alan K. Gudeman
TITLE	Respirator Test Methods, Respirator Program Guide, and Aerosol Studies and Sampler Development
ABSTRACT	Develop test methods and equipment for respirator leakage tests, facepiece and harness pressure tests, and filter penetration tests; develop a respirator program guide for publication by NIOSH; and develop sampling techniques for particulate filters, techniques for generation of asbestos test atmospheres, new personal dust samplers, and continuous industrial air monitors for particulates.
AGENCY	Energy Research and Development Administration, Los Alamos, N. Mex.

APPENDIX B. COAL MINE HEALTH INTERAGENCY AGREEMENTS IN 1975 (Cont.)

AGREEMENT	NIOSH-IA-76-14 (NIOSH-IA-75-04)
FUNDS TO DATE	$82,500
FY 76 FUNDING	$16,500
PROJECT OFFICER	John F. Bester
TITLE	Grant Review and Approval Services
ABSTRACT	Provides for review and approval services by the National Institutes of Health, Division of Research Grants.
AGENCY	National Institutes of Health, U.S. Public Health Service, Bethesda, Md.
AGREEMENT	NIOSH-IA-76-15 (NIOSH-IA-71-08)
FUNDS TO DATE	$66,000
FY 75 FUNDING	$11,000 (NIOSH-IA-75-17)
FY 76 FUNDING	$11,000
PROJECT OFFICER	Alexander Cohen
TITLE	Support for Committee on Hearing, Bioacoustics, and Biomechanics
ABSTRACT	Provides for NIOSH support for the activities of the Committee on Hearing, Bioacoustics, and Biomechanics which in turn will provide NIOSH with technical assistance including promoting exchange of research information, research planning to meet future operational problems, and applying available scientific information in the solution of current NIOSH operation problems.
AGENCY	Office of Naval Research, Washington, D.C.

AGREEMENT	NIOSH-IA-76-16 (NIOSH-IA-71-10)
FUNDS TO DATE	$335,000
FY 76 FUNDING	$ 25,000
PROJECT OFFICER	Earle P. Shoub
TITLE	Partial Support of the X-ray Science and Engineering Laboratory at Oregon State University
ABSTRACT	Provides NIOSH support for the continuation of the X-ray Science and Engineering Laboratory project at Oregon State University in return for consultation and assistance on NIOSH problems in the area of X-ray technology.
AGENCY	Bureau of Radiological Health, Food and Drug Administration, Rockville, Md.

APPENDIX C. COAL MINE HEALTH RESEARCH GRANTS AWARDED IN CALENDAR YEAR 1975

GRANT NUMBER	NAME, INSTITUTION, PROJECT TITLE	FY 75	FY 76
	OCCUPATIONAL RESPIRATORY DISEASE		
TOXICOLOGIC			
OH 00322-08	John M. Peters, Harvard University, Boston, Mass., "Health Hazards of Di-Isocyanates."		49,736
OH 00356-05	Robert Christian, University of Cincinnati, Cincinnati, Ohio, "Cellular Response to Coal Dust In Vitro (CWP)."		72,742
MORPHOLOGIC			
OH 00352-06	Eugene D. Robin, Stanford University, Palo Alto, Calif., "Lung Cell Function in Health and Disease."	97,507	
DIAGNOSTIC			
OH 00360-05	Robert Burrell, West Virginia University, Morgantown, West Va., "Immune Injury in Occupational Respiratory Diseases."	38,946	
OH 00596-01	Thomas A. Massaro, University of Wisconsin, Madison, Wis., "V/Q in Occupational Lung Disease: Basic Development."		7,575
	PHYSICAL AGENTS		
OH 00350-05	Wallace D. Ward, University of Minnesota, Minneapolis, Minn., "Damage-Risk Criteria for Intermittent Noise Exposures."	50,861	
OH 00364-04	Donald Henderson, State of New York Upstate Medical Center, Syracuse, N. Y., "The Effects of Impulse Noise on Auditory System."	94,992	

GRANT NUMBER	NAME, INSTITUTION, PROJECT TITLE	FY 75	FY 76
OH 00470-03	Douglas D. Reynolds, University of Texas, Austin, Tex., "Vibration Characteristics of the Hand and Arm."		16,841
OH 00479-02	Gregory J. Landrum, University of Dayton, Dayton, Ohio, "Effects of Vibration on Human Comfort and Performance."	69,299	
OH 00583-02	E. E. Kamon, Pennsylvania State University, University Park, Pa., "Evaluation of Stresses of Exposure to Heat."		45,322
	HEAD AND BODY PROTECTION		
OH 00404-02	Alan M. Nahum, University of California, La Jolla, Calif., "Prevention of Accidental Head Injury."	26,207	
OH 00301-03S1	George G. Snively, Snell Memorial Foundation, Inc., North Tarrytown, N. Y., "Head Protection of Industrial Workers."		11,772
	MATERIALS HANDLING		
OH 00514-02	Albert B. Schultz, University of Illinois, Chicago, Ill., "Back Injuries: Mechanical Stresses in the Human Spine."	64,638	
OH 00545-01	M. M. Ayoub, Texas Tech University, Lubbock, Tex., "Determination and Modeling of Lifting Capacity."	50,283	
	ENGINEERING		
OH 00565-01	F. D. Schowengerdt, Colorado School of Mines, Golden, Colo., "Nucleation Properties of Respirable Coal Dust."		92,692

GRANT NUMBER	NAME, INSTITUTION, PROJECT TITLE	FY 75	FY 76
	SHIFT WORK		
OH 00331-07	Elliot D. Weitzman, Montefiore Hospital and Medical Center, Bronx, N. Y., "The Sleep-Waking Cycle and Its Neuroendocrine Correlates."		68,808
OH 00395-01	Donald I. Tepas, St. Louis University, St. Louis, Mo., "The Sleep of Shift Workers."		81,200
	CHEMICAL ANALYSIS		
OH 00415-02	Joseph A. Caruso, University of Cincinnati, Cincinnati, Ohio, "Ultra-Sensitive Methods of Trace Metal Analysis."	17,181	

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APPENDIX E. SELECTED PUBLICATIONS
APPALACHIAN LABORATORY FOR OCCUPATIONAL RESPIRATORY DISEASES

DeNee, P., and Walker, E. R.:	Specimen coating technique for the SEM--A comparative study.	Proc Eighth Ann Scanning Electron Microscopy Symp 1975 p. 255
Castranova, V., and Miles, P. R.:	Modification of amino sites which control Na+ permeability in dog red cells.	Fed Proc 1975, 34:105
Farley, J., and Miles, P. R.:	Effect of extracellular Ca on the response of dog trachealis muscle to ACh and K+.	Fed Proc 1975, 34:3,383
Hahon, N., Simpson, J., and Eckert, H.:	Assessment of virus infectivity by the immunofluorescent and immunoperoxidase techniques.	Clin Microbiol 1975, 1:324
Ortmeyer, C. E., Costello, J., and Morgan, W. K. C.:	Mortality from heart disease in coal miners.	Chest 1975, 67:417
Costello, J., and Morgan, W. K. C.:	Coal workers' penumoconiosis: Its economic impact and prevalence.	Mineral Resources and the Environment, 1975 Appendix to Section III, Cl-69, National Academy Science
Hankinson, J. L., and Rose, Wm. D.:	Automated spirometry system.	Proc San Diego Biomed Symp 1974, p. 13
Make, B., and Lapp, N. L.:	Factors influencing the measurement of closing volume.	Am Rev Respir Dis 1975, 111:749-754
Lapp, N. L., Hankinson, J. L., Amandus, H., and Palmes, E. D.:	Variability in the size of airspaces in normal human lungs as estimated by aerosols.	Thorax 1975, 30:293
Hahon, N., Booth, J. A., and Eckert, H. L.:	Interferon assessment by the immunofluorescent, immunoperoxidase, and hemadsorption cell - Counting techniques.	Arch Viro. 1975, 48:239

Shoub, E. P. :	Overview of coal miners' health findings.	Trans of Sixth Annual Institute on Coal Mining Health, Safety, and Research. Virginia Polytechnic Institute & State University, 1975
Fairman, R. P., Hankinson, J., Imbus, H., Lapp, N. L., and Morgan, W. K. C.:	Pilot study of closing volume in byssinosis.	Br J Ind Med. 1975, 32:235
Petersen, M. R., Lapp, N. L., and Amandus, H. E.:	The relationship of several ventilatory capacities and lung volumes to age and weight.	J Occup Med. 1975, 17:355
Make, B.:	Medical surveillance for occupational respiratory diseases.	J Occup Med. 1975, 17:519
Hahon, N., Eckert, H. L., and Stewart, J.:	Evaluation of cellular substrates for antinuclear antibody determinations.	J Clin Microbiol. 1975, 2:42
Hall, D. R., Lapp, N. L., Reger, R. B., and Seaton, A.:	Small airways disease in coal miners. A longitudinal study.	Bull Physiopathol Respir. 1975, 11: 863-877

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