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FIFTH ANNUAL REPORT
OF
HEALTH ACTIVITIES
UNDER THE
FEDERAL COAL MINE HEALTH AND SAFETY ACT
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SUMMARY

According to recent estimates, there are approximately 1,900 underground coal mines and over 170,000 coal miners employed in the United States. The Federal Coal Mine Health and Safety Act of 1969 authorizes the National Institute for Occupational Safety and Health (NIOSH) of the Center for Disease Control, Public Health Service, Department of Health, Education, and Welfare, to conduct programs related to the health, protection of life, detection of respiratory impairment, and prevention of disease in coal miners and others who work with or around the products of coal mines.

A total of $9,100,000 was appropriated in fiscal year (FY) 1974 for activities carried out in fulfillment of NIOSH responsibilities under the Federal Coal Mine Health and Safety Act of 1969. The FY 1974 total appropriation included a one-time appropriation of $3,582,000 for the operation of clinical facilities for the analysis, examination, and treatment of respiratory and pulmonary impairments in both active and inactive miners. The fiscal year 1975 appropriation total is $4,900,000. This report is concerned with activities during calendar year 1974 even though both FY 1974 and FY 1975 funds are utilized.

Among the coal mine health and safety programs administered by NIOSH are the extensive medical examination services organized and coordinated at the NIOSH Appalachian Laboratory for Occupational Respiratory Diseases (ALFORD) in Morgantown, West Virginia. Here are received and processed chest X-rays of active underground coal miners. After these X-rays have been carefully interpreted by approved X-ray readers, NIOSH informs, through the Department of the Interior, each miner of the results of his X-ray examination.

The examinations carried out in this program are required under the Federal Coal Mine Health and Safety Act of 1969. The Act specifies that all coal mine operators must provide the opportunity for each miner to receive regular and periodic medical examinations which include chest X-rays. Participation in these examinations is voluntary for veteran miners, but mandatory at the time of employment and 3 years thereafter for all new miners. Although the medical examination program under the Act is continuous, NIOSH researchers are directed by the Act to analyze the results of the X-rays at prescribed intervals. The period beginning August 19, 1970, the date of publication of regulations for medical examinations, and ending December 30, 1971, is known as the "first round" of examinations. The results of the X-rays taken during this period were carefully scrutinized, and regulations governing the examinations were revised. A second round of examinations began when the revised regulations became effective on July 27, 1973. X-rays, however, continued to be taken and were received at the ALFORD Receiving Center between the end of the first round and the beginning of the second.

By the end of 1974, the ALFORD Receiving Center had processed 46,896 chest X-rays of active underground coal miners taken in the approximately 17 months during which the second round of examinations had been underway. Although the second round is not complete and no definite estimates of the prevalence of Coal Workers' Pneumoconiosis (CWP) can be made, 5,714--or over 13 percent--of the X-rays analyzed to date have shown some evidence of CWP. Progressive massive fibrosis, known in recent years as complicated CWP, has been observed in 239 cases.

The second round relies heavily on specially tested, proficient readers for final decisions regarding pneumoconiosis. By December 31, 1974, 1,059 physicians ("A" readers) had demonstrated their competence in the use of the UICC/Cincinnati and/or the ILO-U/C Classification Systems for X-rays of pneumoconiosis. The majority of these physicians became qualified "A" readers by attending an American College of Radiology Seminar sponsored by NIOSH. An additional 80 physicians ("B" readers) had passed a special proficiency test for final readers developed for NIOSH at Johns Hopkins University. "A" readers are physicians who make a first X-ray reading which must be reviewed by a "B" physician. The reading made by the "B" physician, whether a first reading of his own or a review of an "A" reader's reading, is a final reading.

NIOSH also conducts a medical examination program under the National Study of Coal Workers' Pneumoconiosis, a study initiated prior to the enactment of the Federal Coal Mine Health and Safety Act of 1969. These medical examinations-- consisting of a chest X-ray, a simple breathing test, and a respiratory symptoms questionnaire--are conducted at the mine sites in special mobile units operated by ALFORD field teams. Mine operators whose employees participate in the National Study of Coal Workers' Pneumoconiosis are considered to have fulfilled their obligation to provide medical examinations under the Act.

The National Study of Coal Workers' Pneumoconiosis, like the service examinations program conducted by NIOSH under the Act, is an on-going project allowing for a periodic review of results and an administrative division of the program into rounds. While these segments of the study do not precisely coincide chronologically with those of the medical examinations taken under the Act, the Study is also currently completing its second round. During 1974, a total of 4,072 underground coal miners were examined under the Study. The preliminary results of the second round examinations taken thus far are discussed in Chapter Three.

By the end of 1974, the National Coal Workers' Autopsy Service had accepted a total of over 1,300 post mortem examinations. Six hundred and twenty-eight of these were accepted during 1974.

Coal mine health research during 1974 included community surveys to determine the prevalence and progression of CWP and to evaluate its impact on the life expectancy of miners, development of biochemical techniques as

a diagnostic aid for the early detection of respiratory impairment prior to the onset of clinically significant irreversible change in the tissues, and investigation of the mechanisms by which lung function is altered by CWP. Other studies were directed toward understanding the possible importance of genetic predisposition or biologic sensitivity in the development of CWP and other occupational respiratory diseases; the relationship of infectious diseases, such as viral infections, to disability in coal miners; and the nature of coal mine dust and the reactions of individual cells and tissues to coal dust.

Figure 1. The NIOSH Appalachian Center for Occupational Safety and Health at Morgantown, West Virginia. Here are housed the Appalachian Laboratory for Occupational Respiratory Diseases and the NIOSH Testing and Certification Laboratory.

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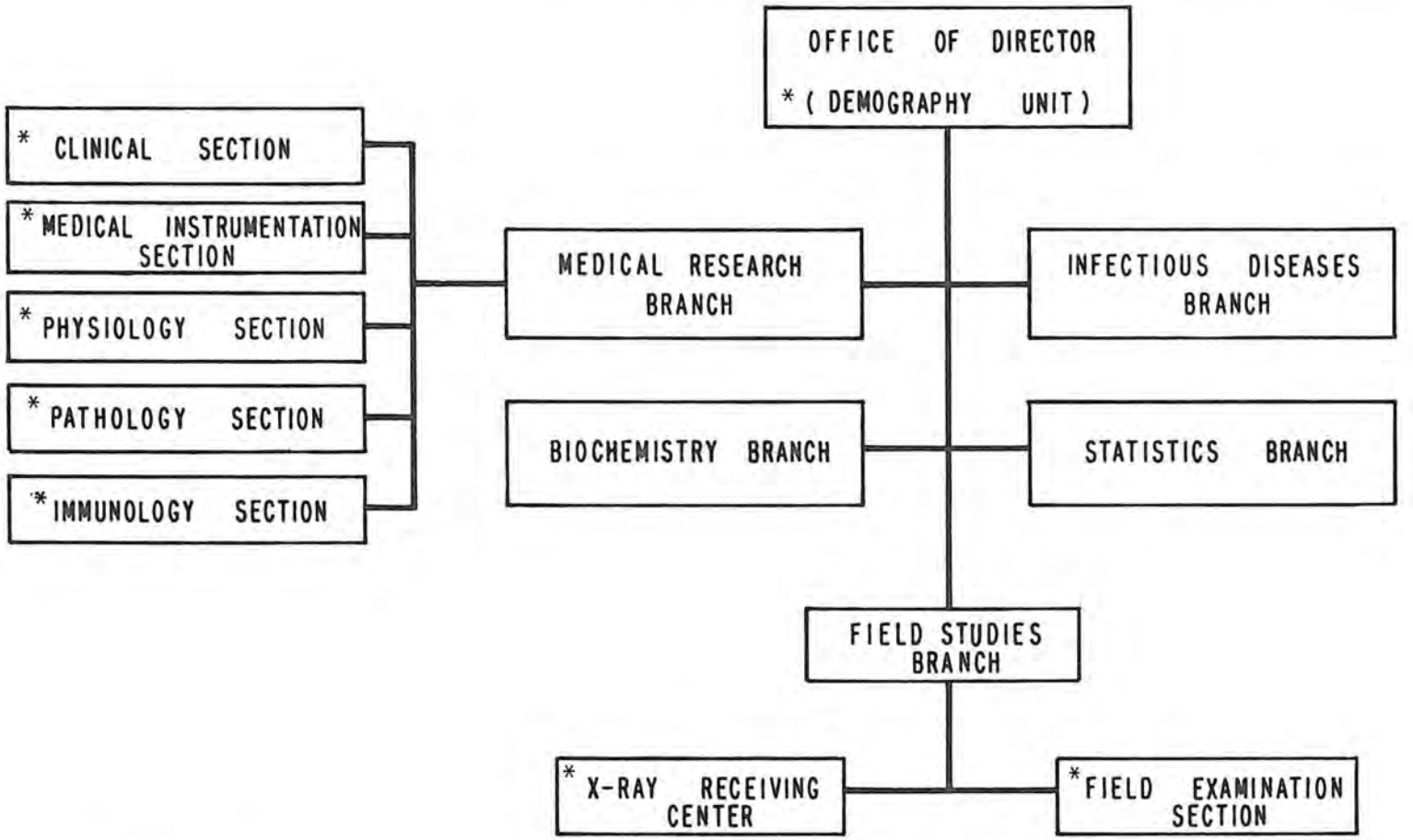
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health
Appalachian Laboratory for Occupational Respiratory Diseases



* Informally organized functional units

January 1 , 1974

Figure 2. Organization chart for the Appalachian Laboratory for Occupational Respiratory Diseases.

CONTENTS

GLOSSARY

"A" Reader--An X-ray reader who has demonstrated proficiency in using the ILO-U/C system of classification of chest X-rays for pneumoconiosis by successfully completing a course sponsored by the American College of Radiology or by successfully classifying and submitting to a panel of radiologists assembled by ALFORD, 6 sample chest X-rays. Chest X-rays classified by an "A" Reader are then submitted to a "B" Reader for final reading.

ACOSH--The Appalachian Center for Occupational Safety and Health, located in Morgantown, West Virginia. The facility houses the Appalachian Laboratory for Occupational Respiratory Diseases and the Testing and Certification Laboratory.

ALFORD--The Appalachian Laboratory for Occupational Respiratory Diseases, located in Morgantown, West Virginia. It is the focal point of NIOSH coal mine health and safety research and examination facilities.

"B" Reader--An X-ray reader whose proficiency in the use of the ILO-U/C system of classification of chest X-rays has been demonstrated by his passing a specially designed proficiency examination given on behalf of or by ALFORD. The first interpretation of an X-ray by a "B" Reader is considered a final reading.

Category--As used with X-ray reading, means the classification denoting the extent and profusion of the opacities according to the ILO/UC Classification System.

Closing Volume--The volume of air in the lungs when the small airways of the lungs cease participation during exhalation. It is a useful measure of abnormalities in the lungs.

Coal Mine Health Research Advisory Committee--A group established by the Federal Coal Mine Health and Safety Act of 1969 to consult with, and make recommendations to, the Secretary, Department of Health, Education, and Welfare regarding coal mine health research. A list of Advisory Committee members is given in Appendix D.

CWP--Coal Workers' Pneumoconiosis.

Federal Coal Mine Health and Safety Act of 1969--Public Law 91-173 (as amended by PL 92-303). Under this law, the Secretary of Health, Education, and Welfare is directed to conduct several programs related to the health and safety of coal miners. Operational authority for all health programs, except Title IV ("Black Lung" Benefits) and the enforcement of coal mine health standards, is delegated to NIOSH.

FEV1.0--The measure of the volume of air exhaled in one second, a useful test of lung function.

Flow-Volume Curve--The mathematical curve showing the relationship between the ratio at which air is expelled (flow) and the volume of air in the lungs. ALFORD researchers are currently exploring the Flow-Volume relationship as a possible way of detecting disease in the small airways of the lungs.

Gough Section--A thin, paper-mounted cross-section of a whole lung, useful in pneumoconiosis research.

ILO-U/C Classification System--The classification of the pneumoconioses devised in 1971 by an international committee of the International Labour Office and described in "Medical Radiography and Photography," volume 48, No. 3, December 1972.

Interferon--A virus-fighting protein normally produced in human cells. ALFORD researchers are currently studying the effect of coal dust and other foreign substances on the ability of the cells to produce interferon.

Interim Compliance Panel--A group whose function, as authorized by the Federal Coal Mine Health and Safety Act of 1969, is to review applications from coal operators for temporary exemption from the Federal standards.

MESA--Mining Enforcement and Safety Administration. Under the Department of the Interior, MESA conducts safety research and enforces coal mine health and safety standards established by and under the Federal Coal Mine Health and Safety Act of 1969 and by NIOSH.

National Study of Coal Workers' Pneumoconiosis (CWP)--A broad-based study of CWP which involves medical examinations of miners performed by ALFORD field teams. The Study began prior to the enactment of the Federal Coal Mine Health and Safety Act of 1969. However, medical examinations performed in the Study satisfy the examination requirements established by the Act.

NCWAS--National Coal Workers' Autopsy Study established by the Federal Coal Mine Health and Safety Act of 1969. The Study authorizes autopsies of miners and former miners to determine cause of death, the relationship of CWP to the cause of death, and the degree of CWP suffered by the miner at the time of death. Many autopsies, compensated for by ALFORD under the Study, help miners' dependents establish eligibility for "Black Lung" benefits.

Perfusion--The distribution of blood within the lungs.

PMF--Progressive Massive Fibrosis, also called "complicated CWP" in recent years.

Profusion--The number of opacities (either small rounded or small irregular) per unit area of lung tissue appearing in a chest X-ray.

Pulmonary Ventilation--The distribution of air within the lungs.

Second Round--The second administrative division, currently underway, of medical examinations taken under ALFORD's miner examination service program authorized by the Act or under the National Study of Coal Workers' Pneumoconiosis. The Second Round of examinations established by the Act began July 27, 1973, and is expected to be completed in the early months of 1975. The second round of examinations under the National Study began July 18, 1972, and is expected to end also in early 1975. Both examination programs are continuing projects, and the administrative periods, rounds, are used only as a convenient method of assessing, at prescribed intervals, the results of the examinations.

SEM--Scanning electron microscope, a highly sophisticated research tool used by ALFORD scientists in numerous applications including pulmonary tissue study.

Small Airways--The airways smaller than 2.0 mm in diameter in the gas exchanging portion of the lungs.

Small Irregular Opacity--An opaque area of irregular shape observable on lung X-rays when certain pulmonary disorders, including pneumoconiosis, are present.

Small Rounded Opacity--An opaque area approximately round and varying in diameter appearing on lung X-rays when numerous pulmonary disorders, including CWP, are present.

Step-Wedge--A plastic test object developed by Oregon State University which, when X-rayed, reveals a number of vital characteristics about the X-ray equipment and the manner in which it is used. The radiographic characteristics of the step-wedge are similar to those of human tissue. Radiographs of the step-wedge, which is available on loan from NIOSH, are submitted by X-ray facilities in order to gain NIOSH approval to perform and be compensated for X-rays under the medical examination program.

TCL--Testing and Certification Laboratory, a NIOSH facility located in the Appalachian Center for Occupational Safety and Health in Morgantown, West Virginia. Here mining safety equipment is tested and approved for use.

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CHAPTER 1

ADMINISTRATION

Introduction

Under Public Law 91-173, the Federal Coal Mine Health and Safety Act of 1969 (as amended by P.L. 92-303), the Secretary of Health, Education, and Welfare conducts programs dedicated to improving the health and protecting the lives of coal miners and others whose work requires proximity to the products of coal mines. The law authorizes the operation of clinical facilities for analyzing and treating respiratory and pulmonary impairments in miners. The law also provides for major investigative and research efforts devoted to the prevention and early detection of respiratory diseases in coal miners. Operational authority for meeting these responsibilities has been delegated to the National Institute for Occupational Safety and Health (NIOSH), whose mission, with regard to the Federal Coal Mine Health and Safety Act of 1969, is to ensure that the coal miner carries out his work under conditions that are as uninjurious as possible to his health.

The responsibility for coal mine safety research and for enforcement of both health and safety standards for coal mines has been delegated to the Department of the Interior. The administration of Black Lung Benefits, originally one responsibility of the Social Security Administration, has been transferred to the Department of Labor. All claims filed after July 1, 1973, have been reviewed by the Department of Labor while the Social Security Administration continues to administer payments for claims made before that date.

Under the Federal Coal Mine Health and Safety Act of 1969, underground coal mine operators are required to maintain average respirable dust levels at no greater than 2.0 mg./m3 in all areas where miners are exposed. The Act provides, however, that an operator who cannot meet the standard may apply to the Interim Compliance Panel for a temporary noncompliance permit. NIOSH provides personnel and administers salaries and related costs for Interim Compliance Panel operations.

In 1974, NIOSH continued its progress in fulfilling the responsibilities of the Department of Health, Education, and Welfare under the Act. NIOSH also continued to maintain a close working relationship with the Mining Enforcement and Safety Administration of the Department of the Interior and the Interim Compliance Panel and aided them in carrying out their duties. NIOSH activities under the Act were undertaken primarily at the Appalachian Laboratory for Occupational Respiratory Diseases (ALFORD) at Morgantown, West Virginia; however, significant work was also carried out in the NIOSH laboratories at Cincinnati, Ohio.

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Program Costs

NIOSH appropriations for activities directly related to the Federal Coal Mine Health and Safety Act of 1969 totaled $9,100,000 in fiscal year 1974 and $4,900,000 in fiscal year 1975. Of the FY 1974 appropriations, $3,582,000 was a one-time expenditure for the development of clinical facilities for the analysis, examination, and treatment of respiratory and pulmonary impairments in active and inactive coal miners as authorized by section 427(a) of Public Law 92-303, the Black Lung Benefits Act of 1972.

Of the total amount appropriated for these clinical facilities, $2,382,000 was awarded in grants to states which either (1) contained 3 percent of the nation's active and inactive coal miner population and which had been designated by their respective governors as agencies to receive funds to carry out a miners' respiratory clinic program, or (2) received grant support under the Appalachian Regional Commission Black Lung Clinic Program. Such grants were awarded to Pennsylvania, West Virginia, Virginia, eastern Kentucky, Alabama, Tennessee, Illinois, and Ohio. These grants are administered by the Department of Health, Education, and Welfare Regional Offices.

The remaining $1.2 million of the clinical facilities appropriation was awarded to an independent contractor to provide all the necessary labor, facilities, and equipment, either directly or through subcontract, 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 concentrations of more than 500 of the nation's active and inactive coal miner population. Regions scheduled for development under the contract include Indiana, western Kentucky, Arkansas-Oklahoma, Colorado-New Mexico, Utah-Wyoming, and Missouri-Kansas.

Program Areas funded in fiscal years 1974 and 1975 were as follows:

	1974		1975	
	Dollars	Percent	Dollars	Percent
Support of Interim Compliance Panel and Advisory Council	270,000	3	170,000	3
Medical Examinations and Autopsy Program	2,050,000	23	1,530,000	31
Clinical and Rehabilitation Research	1,567,000	17	1,360,000	28
Engineering Research	600,000	7	780,000	16
Laboratory Research (e.g., Biochemistry, toxicology, etc.)	1,031,000	11	1,060,000	22
Development of Clinical Facilities	3,582,000	39	0	0
Total	9,100,000	100	4,900,000	100

CHAPTER 2

MEDICAL SERVICE PROGRAMS

NIOSH has been assigned the responsibility for two important medical service programs which provide considerable direct benefit to miners and their families. The medical examination program monitors the health of active underground coal miners. The autopsy service program assists the widow and family of the deceased miner in determining the cause of the miner's death and the degree of pneumoconiosis suffered by the miner at the time of his death.

Examinations for Underground Coal Miners

To protect the health of the nation's underground coal miners and to evaluate the effectiveness of current coal mine health standards (in particular the air-borne dust standard), section 203 of the Coal Mine Health and Safety Act of 1969 specifies that coal mine operators will provide the opportunity for all miners to receive periodic medical examinations. Regulations implementing the Act provide that every new miner be given a chest X-ray within 6 months of the commencement of his employment in an underground coal mine and at established intervals thereafter. NIOSH is responsible for assuring each coal miner the opportunity to be examined and for providing the results of these periodic medical examinations to the miner and his physician.

The first round of examinations of active underground miners was completed in December 30, 1971. New miners, however, continued to be examined upon employment in accordance with the Act. The NIOSH X-ray Receiving Center at the Appalachian Laboratory for Occupational Respiratory Diseases (ALFORD) in Morgantown, West Virginia, received and processed over 71,000 X-rays under the first round of examinations and assessed each one for evidence of coal workers' pneumoconiosis. The results of this analysis were summarized in the 1973 Annual Report of the Coal Mine Health and Safety Program. Immediately after the completion of the first round, NIOSH began preparing for the second round of medical examinations as required by the 1969 Act.

Second Round of Medical Examinations

To improve the quality of both the chest X-rays and interpretations during the second round of examinations, NIOSH undertook an extensive certification program of both X-ray facilities and physicians who make the

final X-ray interpretations. To be eligible to participate in the second round, an X-ray facility must demonstrate its ability to take high quality diagnostic chest X-rays for pneumoconiosis. To meet this requirement, each facility must submit an X-ray of a plastic test-object (step-wedge) developed at Oregon State University and available on loan from ALFORD. In addition, six examples of X-rays of human subjects must be submitted. The radiograph of the plastic step-wedge readily and reliably reveals several specific and vital characteristics of the X-ray equipment and the manner in which it was used, characteristics which immediately affect the quality of the X-ray made. In addition to the 125 X-ray facilities approved during the latter months of 1973, 61 facilities were approved in 1974, thereby establishing a total of 186 X-ray facilities approved to participate in the second round of examinations.

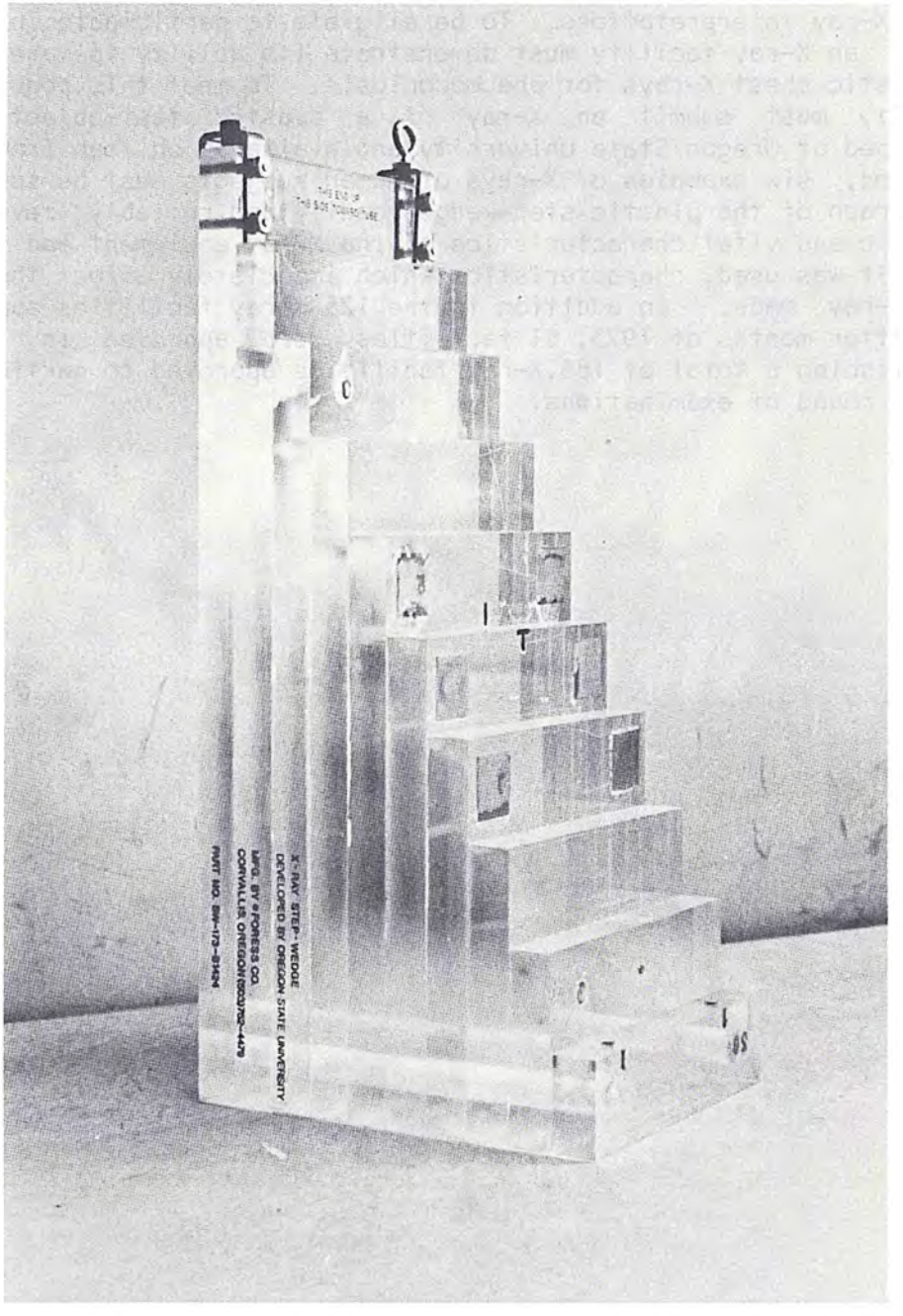

Figure 3. Step-wedge. This plastic test object was developed to help standardize X-ray quality.

X-Ray Interpretation Procedures. NIOSH has taken steps to standardize the methods for interpreting X-rays in the second round. Because the variability of interpretation of X-rays was considerable during the first round, a third reading to resolve conflicts in interpretation was necessary in about 26 percent of the X-rays. In round two, however, no X-ray will receive more than two readings. Under the revised regulations, interpretations are made by two types of readers. The first or "A" reader must have demonstrated his proficiency in the use of the UICC/Cincinnati or ILO-U/C systems for X-rays of pneumoconiosis. He may do so either by completing a course of instruction approved by ALFORD on the ILO-U/C Classification System or by submitting to ALFORD six sample X-rays classified by him which are considered properly classified by a panel of expert radiologists assembled by ALFORD. The last or "B" reader must pass a specially designed proficiency examination developed at Johns Hopkins University and given by ALFORD. In the second round, all X-rays interpreted at an X-ray facility by "A" readers are then sent to "B" readers whose interpretations are final. If the X-ray is interpreted at the facility by a "B" reader, it need not be reinterpreted. The first reading by a "B" reader is final.

Figure 4. Here at ALFORD's Receiving Center a computer letter is generated to inform each miner of the results of his chest X-ray examination.

By the end of 1974, 1,059 physicians had taken the necessary steps to become "A" readers and 80 physicians had passed a specially designed proficiency examination and were approved as "B" readers.

NIOSH also modified the procedures for processing examination data. The modifications resulted in a significant reduction in the amount of time a miner must wait before receiving notification of the results of the examination. During the first round, miners waited an average of 4 months; during the second round, an average of only 45 days.

Preliminary Results of Second Round Examinations Conducted Through 1974

Between July 27, 1973, and December 31, 1974, NIOSH received and processed X-rays from 41,024 examinations authorized under the Act. The results of these second round X-rays showed that 4,129 miners had category 1 coal workers' pneumoconiosis (CWP), 1,066 miners had category 2 CWP, 125 miners had category 3 CWP, and 235 miners had complicated CWP. Categories 1, 2, and 3 CWP refer to the extent and profusion of the opacities noted in X-rays of simple coalworkers' pneumoconiosis according to the ILO/UC Classification System. Table 1 shows the geographic distribution of the various categories of CWP according to the examinations completed between July 27, 1973, and December 31, 1974, in the second round.

After the completion of the second round in 1975, ALFORD will begin a thorough statistical analysis to compare the data from the first and second rounds. The value of the medical examination data will be enhanced by data received from the Occupational History Questionnaire administered to miners who participate in the second round of examinations.

TABLE 1. COAL WORKERS' PNEUMOCONIOSIS BY STATE AS OF DECEMBER 31, 1974, AS DETERMINED IN THE SECOND ROUND OF EXAMINATIONS UNDER THE ACT

STATE	X-RAY READINGS					
	CAT 0	CAT 1	CAT 2	CAT 3	PMF	TOTAL
ALA	761	136	17	3	7	924
COLO	538	12	11	1	1	563
ILL	3550	462	75	3	19	4109
IOWA	17	5	1	0	0	23
KEN	6562	629	114	9	19	7333
OHIO	1441	67	10	1	4	1523
PA-BI	6705	1001	289	50	87	8132
PA-AN	47	26	16	4	4	97
TENN	103	16	4	2	0	125
UTAH	416	27	6	0	1	450
VIRG	3109	287	42	1	5	3444
WASH	11	1	0	0	0	12
W VA	12202	1860	480	51	88	14281
WYO	7	0	1	0	0	8
TOTAL	35469	4529	1066	125	235	41024

Computer Classification of X-Rays. Because of the wide geographic distribution of coal miners examined under the 1969 Act, most X-rays have been taken by independent medical contractors operating near the work sites. Most X-rays are then interpreted by physicians who are also contractors. Because of the large number of X-ray facilities and physicians involved in the program, total consistency in X-ray quality and interpretation has been difficult to obtain. The development of the step-wedge and its use in certifying X-ray facilities has greatly improved the quality of X-rays. The improvement of regulations regarding both "A" and "B" readers for proficiency in interpreting X-rays for pneumoconiosis has resulted in greater consistency of X-ray readings. However, the goal of total consistency is still to be achieved.

For this reason NIOSH is presently studying the feasibility of using image analysis (texture and pattern) by computer to assist in X-ray interpretation. In a prototype system being developed under contract for NIOSH, X-rays are optically scanned with a laser beam, or image dissector. The data compiled in the scanning are then analyzed in a digital computing system. The system is designed also to provide an index of the quality of the X-ray as well as an evaluation of the degree of CWP suffered by the examinee. In another method under investigation, an X-ray can be mathematically "warped" to fit closely over an earlier X-ray. The scanning and computing procedures should then determine the degree of progression of disease during the elapsed time between X-rays.

X-ray image analysis by computer is presently undergoing extensive study. Much additional research will be necessary before the technique can be widely implemented in examinations of underground coal miners; however, initial indications are that the method is potentially an invaluable aid to X-ray interpretation.

Autopsy Service

The Federal Coal Mine Health and Safety Act of 1969 authorized the creation of the National Coal Workers' Autopsy Study (NCWAS) primarily to assist the widows and families of deceased coal workers in determining the cause of death and the degree of pneumoconiosis suffered at the time of death. In many cases the autopsies paid for by this program have enabled miners' dependents to establish eligibility for "Black Lung" benefits.

Participation in 1974

During 1974, the NCWAS accepted 628 cases. Over 1,300 cases have been accepted since the program's inception, and a detailed review of these first 1,300 cases is currently in progress.

National Coal Workers' Autopsy Study Research

Although the major function of the NCWAS is to provide service to widows and families of deceased miners, research is also an important part of the program's responsibilities. In some countries, the law has required for many years that deaths of coal miners receiving compensation be reportable and that an autopsy be performed. In several of these countries the cardio-respiratory organs are forwarded to a central laboratory where experienced pathologists, specializing in CWP, study the material in detail. In the United States, however, the relatively new autopsy service is voluntary rather than mandatory, and the procedures for performing autopsies are much less stringent than those in other countries. But the data available from the service have proved to be very useful in the research effort to understand the causes of death in coal miners. Prior to the establishment of the NCWAS, such data were very difficult for U.S. researchers to obtain.

Characteristics of the NCWAS Sample

The wide geographic distribution of the NCWAS autopsy cases has enhanced the usefulness of the data obtained. Over 150 pathologists from 26 States have submitted cases to the program. Table 2 shows the geographic distribution of those cases.

The NCWAS has expanded dramatically since 1971. However, as might be expected because of the voluntary nature of the program, the number of deceased miners who actually undergo autopsy and whose cases are made available to the NCWAS is relatively small. It is estimated that the population of working and retired coal miners in the United States is 300,000. Using standard mortality tables it can be calculated that approximately 5,000 to 6,000 deaths will occur annually in this population. Based on these figures, it is apparent that less than 15 percent of the estimated deceased miners have been included in the National Coal Workers' Autopsy Study. It is not known which of the autopsied miners were awarded "Black Lung" benefits while they were still alive. It is quite possible that many miner autopsies are authorized by next-of-kin in an attempt to establish eligibility for benefits denied to the miner during his lifetime. It is known, however, that not all of the autopsies are being performed for compensation purposes.

TABLE 2. NATIONAL COAL WORKERS' AUTOPSY

STUDY CASES BY STATE OF DEATH
AS OF DECEMBER 1974

STATE OF DEATH	AUTOPSIES		STATE OF DEATH	AUTOPSIES	
	TOTAL	PERCENT		TOTAL	PERCENT
Pennsylvania	594	46.81	Oklahoma	4	0.32
West Virginia	350	27.58	Missouri	4	0.32
Illinois	71	5.60	Indiana	3	0.24
Ohio	50	3.94	New Jersey	3	0.24
Kentucky	49	3.86	New York	2	0.16
Virginia	41	3.23	Washington	2	0.16
Wyoming	26	2.05	Washington, D.C.	2	0.16
Colorado	23	1.81	Arizona	1	0.08
Utah	9	0.71	Connecticut	1	0.08
New Mexico	7	0.55	Florida	1	0.08
Kansas	6	0.47	Georgia	1	0.08
Michigan	6	0.47	Oregon	1	0.08
Tennessee	5	0.39	Texas	1	0.08

It is possible, of course, that a number of autopsies are performed on deceased coal miners and not submitted to the NCWAS. In some instances, survivors are unwilling to provide the consent and the brief historical information required by the autopsy service. Occasionally, a pathologist may be unwilling or unable to submit the required data and materials. In some cases, ignorance of the existence and purpose of the autopsy service may prevent cases from reaching the NCWAS.

The sampling problems encountered by the autopsy service are the same as those reported for similar studies in the United States and abroad. The major problem is the inability to know the biases of the autopsy population. In the NCWAS autopsies are accepted regardless of cause of death.

Correlation of X-Ray and Pathological CWP Information

Although established procedures for classifying the severity of pneumoconiosis from X-rays have existed for some years, an analogous classification system for pathological use is presently being developed by NIOSH. The urgent need for such a system is made apparent by the fact that in the first 500 NCWAS cases, submitting pathologists used 165 different terms for CWP diagnosis.

The first step in developing standards of classification for the type and severity of CWP involved a detailed investigation of the correlation between patterns appearing on clinical chest X-rays and the underlying structural and chemical changes in the lung tissues. Previous studies had correlated the total dust content of the whole lung with the category of pneumoconiosis judged by X-ray, but the correlation of individual X-ray shadows with specific tissue structures and chemical changes had not previously been accomplished.

During 1974, new methods and equipment were developed for freezing the whole lung at full inspiration and then freeze-drying the entire organ in a vacuum chamber. Using this technique, no chemicals are added to the tissue, and nothing except water is removed. All chemicals and particulates are available for analysis. By careful serial deconstruction procedures it is possible to correlate the findings of chest X-rays with pathological findings for the whole lung as well as parts, even those of ultramicroscopic size. The development of these methods promises to be of great use not only in the study of coal workers' pneumoconiosis but in other pulmonary disease research as well.

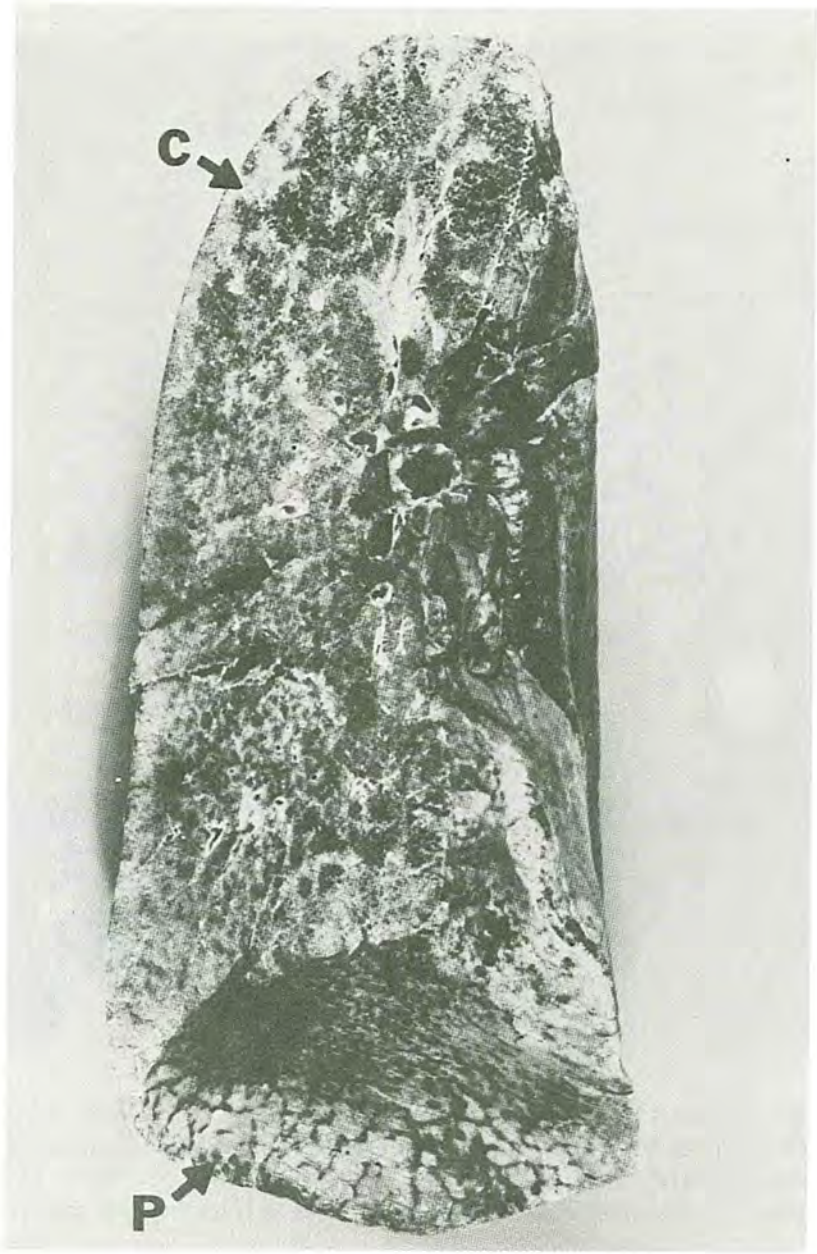

Figure 5. Freeze-dried whole lung from deceased coal miner. Pleural (outer) surface (P) shows mottling by retained coal dust. The cut surface (C) of the lung shows the major airways and the intense deposition of dust throughout the pulmonary tissue.

Figure 6. Gough section (paper-mounted section of whole lung, 0.3 mm thick) of coal miner's lung, showing characteristic changes of simple CWP, i.e., dust deposition around dilated small airways. This is called focal dust emphysema. The dusty areas around the airways are called coal macules.

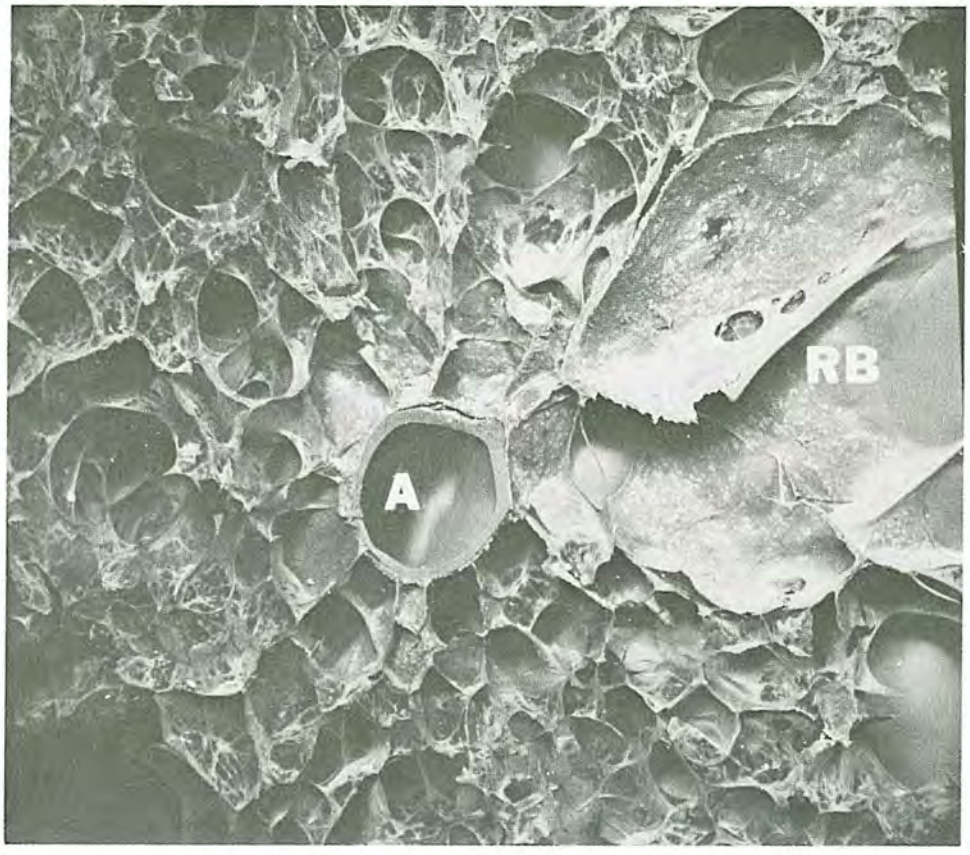

Figure 7. Scanning electron microscope image of area of coal miner's lung magnified 35 times, showing an artery (A), a dilated respiratory bronchiole (airway) (RB) and the surrounding nearly normal lung tissue composed of a multitude of thin-walled sacs called alveoli. The tiny whiter spots on the surface of the airway are inhaled dust particles which have been deposited on this surface and engulfed by white blood cells (macrophages).

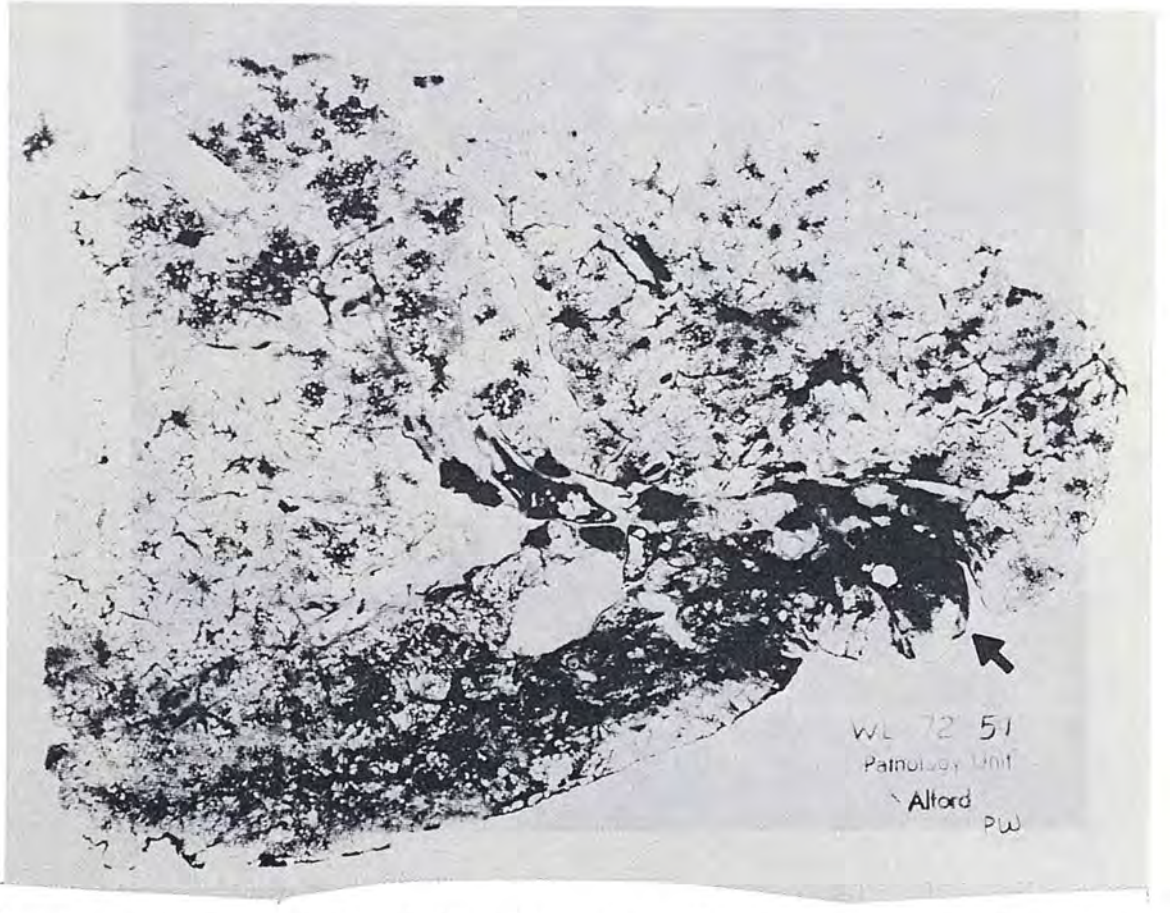

Figure 8. Gough section of lung from coal miners with complicated coal workers' pneumoconiosis (progressive massive fibrosis). In the upper lobe a large portion of the lung tissue has been replaced by a contracted, scarred, deeply pigmented area (arrow). Other areas of this section show simple CWP.

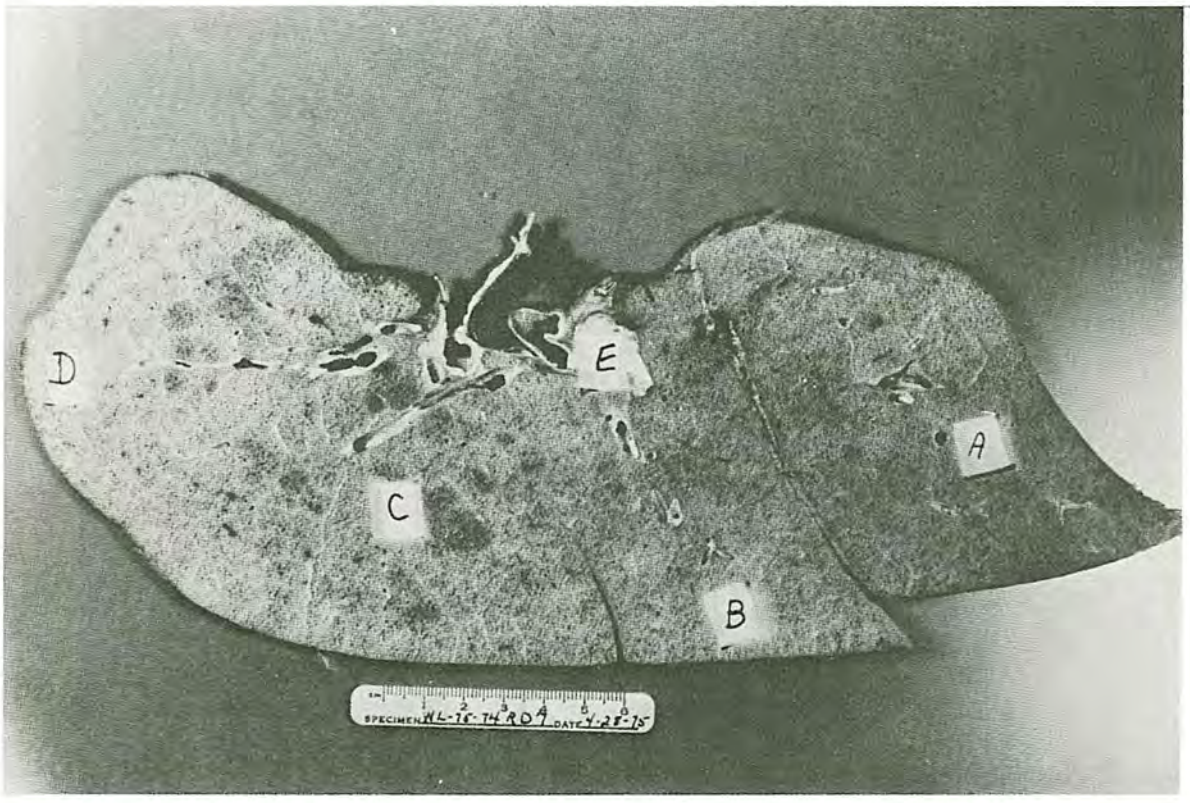

Figure 9. Three-millimeter slice of freeze-dried control (non-miner) lung showing excellent preservation of the tissue. The letters (A-E) indicate regions which were removed for chemical and microscopic examination.

Figure 10. Scanning electron microscope being used to study CWP. Its high resolution and ability to analyze respirable dust particles make the instrument ideally suited for this type of research.

CHAPTER 3

COAL MINE HEALTH RESEARCH

During 1974, the NIOSH Appalachian Laboratory for Occupational Respiratory Diseases (ALFORD) in Morgantown, West Virginia, continued to be a major center for coal mine health research in the United States. NIOSH has assembled, at ALFORD, extensive laboratory facilities and scientific expertise capable of supporting a wide spectrum of research devoted to improving the health of the coal miner. In addition to the research carried on at ALFORD, limited coal mine health research is also conducted at NIOSH laboratories in Cincinnati, Ohio. These activities are in the fields of toxicology, physical and analytical chemistry, ergonomics, noise research, and environmental control and personal protection.

The NIOSH coal mine health research effort is augmented by grants awarded to non-profit institutions, contracts with various commercial enterprises, agreements with other Federal agencies, and special foreign currency agreements with foreign countries. All 1974 NIOSH grants, contracts, interagency agreements, and special foreign currency agreements in the area of coal mine health research are tabulated in Appendices A through C.

During 1974, ALFORD's coal workers' pneumonoconiosis research continued its broad investigation of the disease and its impact on the coal mining community. The various phases of the investigation can be characterized as follows:

- Surveys to determine the prevalence and progression of CWP and to evaluate its impact on life expectancy of today's coal miners.

- Development of early diagnostic tools--both clinical and biochemical--which will detect respiratory impairment before clinically significant irreversible changes occur.

- Investigations of the mechanism by which lung function is altered in CWP.

- Investigations of the possible role of genetic predisposition or biologic sensi-

tivity in the development of CWP and other occupational respiratory diseases.

- Investigations of the relationship of infectious diseases, such as viral infections, to disability as it occurs in coal miners.

- Investigations of coal mine dust itself and the reactions of individual cells and tissues to the dust.

Community Surveys

ALFORD is evaluating the effect of CWP on the coal mining community through two different types of studies in which samples of the coal miner population are surveyed: (1) The National Study of Coal Workers' Pneumoconiosis, a long-term epidemiological, medical study of working underground coal miners designed to determine the prevalence and progression of CWP, and (2) demographic studies designed to determine the effect of CWP on the death rates of bituminous and anthracite miners. Each of these studies produced significant findings in 1974.

National Study of Coal Workers' Pneumoconiosis

The National Study of Coal Workers' Pneumoconiosis began in August 1969, prior to the enactment of the Federal Coal Mine Health and Safety Act of 1969. The purposes of the Study are (1) to relate CWP progression to levels of respirable dust exposure, (2) to provide a scientific basis for determining the progression of the disease by use of serial X-rays, and (3) to estimate the industry-wide prevalence of CWP.

The miners are examined at each participating mine by medical teams from ALFORD. Each examination includes an occupational history, two standard chest X-rays, a simple test of lung function, and a short questionnaire on chronic bronchitis developed by the Medical Research Council of Great Britain. The examinations provided through the Study completely satisfy the periodic medical examination requirements of the Federal Coal Mine Health and Safety Act of 1969. Operators who offer their miners the opportunity to be examined through the Study are considered to have satisfied the regulations.

The miners were chosen for the Study to represent varying geographic regions, coal seams, and mining methods. Because the Study involves

monitoring miners' health at 3 to 5 year intervals, mines with an expected working life of at least 10 years and which employed at least 100 miners were chosen. An effort was also made to choose mines for which prior dust exposure information is available.

The first round of the Study, comprised of examinations of 9,076 miners at 31 mines, was completed in 1971. The second round began in July 1972.

The Second Round of the National Study of Coal Workers' Pneumoconiosis

The second round of the National Study of Coal Workers' Pneumoconiosis continued through 1974 and is expected to be completed in early 1975. In 1974, 4,072 miners were examined at 15 underground coal mines. Table 3 shows the data collected from examinations conducted in 1974 as well as a comparison of data obtained from the first round and all second round examinations performed to date. Although the prevalence figures for complicated pneumoconiosis and all three categories of simple pneumoconiosis are significantly lower in the second round, it should not be assumed that the health of coal miners has improved. Approximately one-half of the men examined in the first round were not examined in the second. Many older men retired and some left the mining industry because of disability or other reasons. Often they have been replaced by young men who have not been exposed to coal mine dust. Thus the prevalence figures for the second round probably reflect the change in the miner sample rather than a general improvement in total miner health.

TABLE 3. COMPARISON OF FIRST AND SECOND ROUND NSCWP

Round	Men Examined	Percent Participation	Classification 0	1	2	3	Complicated
Second Round (1974)	4072	64	89.6	6.5	1.5	0.1	0.2
Total Second Round (1972 through 1974)	8282	76	87.3	8.1	1.7	0.2	1.3
Total First Round	9076	90.5	70.1	21.2	5.6	0.6	2.5

Participation in the Second Round. Participation in the second round has been considerably lower than in the first. The reasons for this development are not clear, but may include the relative lack of health concern in younger miners and the loss of interest in the examinations resulting from the short time between the first and second rounds. A

thorough investigation of the causes of the change in participation and the effect of the change on the results of the National Study of Coal Workers' Pneumoconiosis is currently underway.

Ventilatory Capacity. The study of ventilatory capacity of miners was especially productive during 1974. It was again concluded that there is no relationship between ventilatory capacity and X-ray category of simple pneumoconiosis. However, those miners whose X-rays showed evidence of complicated pneumoconiosis suffered definite ventilatory impairment. Such findings are consistent with similar studies conducted in the United States and abroad.

Demographic Studies

In continuing studies, ALFORD demographers are investigating the death rates of coal miners and the causes of their deaths in an effort to determine to what extent such factors as occupational history, severity of coal workers' pneumoconiosis, airway obstruction, and chronic bronchitis might lead to excess mortality. Such studies involve the comparison of death rates of coal miners with the expected death rates of average populations of employed males. The usefulness of the standard mortality ratio (SMR), defined as the ratio of the number of observed deaths to the number of expected deaths, depends on the degree to which the biases affecting the death rates are understood. During 1974, ALFORD conducted extensive analyses to determine how factors such as race, standard of living, and smoking habits may affect mortality rates to help determine how the mortality rates of coal miners differ from those of the general population of employed males.

Mortality Study of West Virginia Miners. ALFORD is presently studying the mortality of a cohort of about 3,500 West Virginia bituminous coal miners who applied at least once from 1965 to 1970 for compensation for respiratory disability allegedly arising from coal mine dust. During 1974, all data were collected for the analysis, except that from death certificates requested but not yet received. The objective of the study is to determine the degree to which various lung disorders including CWP may have contributed to any excess mortality in the group of miners studied.

The ALFORD study is similar to a study of 4,000 Pennsylvania coal miners compensated in 1967 by the State of Pennsylvania for dust related respiratory disability. When the ALFORD study is completed, the data will be compared with that from the Pennsylvania study. The degree to which the earlier findings are confirmed is critical in reaching conclusions about the relationship of mining-related lung disorders and excess mortality.

Early Diagnosis of Altered Lung Function

A major goal of coal mine health research is to detect changes in lung function before irreversible disease occurs. In many cases, the individual miner may have developed serious irreversible lung disorders by the time he begins to notice respiratory symptoms. NIOSH researchers hope, therefore, to develop methods by which such disorders can be detected before they become apparent through respiratory symptoms. Research directed toward early detection of coal mining related respiratory disease involves studies of lung function and studies of biochemical indicators.

Lung Mechanics

ALFORD researchers have developed computer programs and systems to measure and record mechanical properties of the human lung in an effort to link early alteration in lung pressure, flow, and volume with airway disease. One very useful measure of lung function is the flow-versus-volume curve. Researchers have observed a significant reduction in flow when the lung volume is half its full capacity or less. Such an abnormality may be present even though the results of standard tests of lung function, such as the measure of the volume exhaled in one second (FEV1.0) or the test of resistance to air flow within the large airways, are within normal limits.

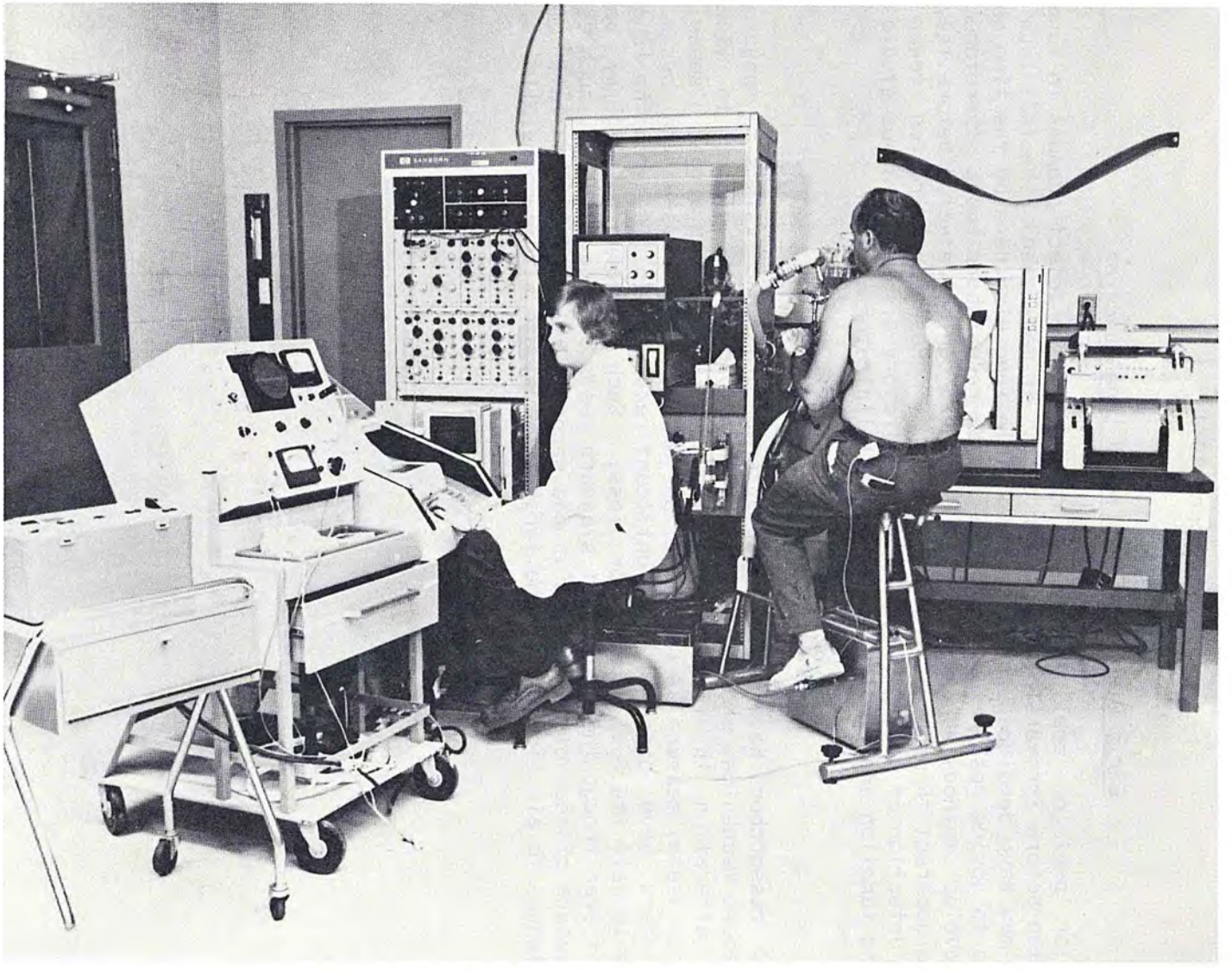

Figure 11. A coal miner is tested on pulmonary function equipment at ALFORD laboratories in Morgantown, West Virginia.

Study of Flow-Volume Curves. During 1974, ALFORD scientists conducted a large-scale study to determine whether flow-volume curves could be used as a means of detecting disease in the small airways of the lung. Approximately 8,000 coal miners were examined in ALFORD laboratories on specialized equipment developed by NIOSH engineers.

Each subject's peak flow and flow rate at 25, 50, 75, and 90 percent of his vital capacity were recorded. Preliminary results indicate that underground exposure to coal mine dust does have a significant effect on flow rates. Other factors affecting reduction in flow rates among these subjects appear to have been caused by aging and cigarette smoking.

Careful analysis of the results of this study is underway to determine whether flow reduction is due to premature loss of elastic recoil in lung tissue or to an abnormal increase in the resistance to air flow in the small airways (less than 2 millimeters in diameter) within the gas exchanging portion of the lungs. Preliminary analysis reveals that reduced flow is the result of loss of elastic recoil in some individuals and increased airway resistance in others. The study is expected to be completed in 1975. When the results have been fully evaluated, scientists hope to be able to determine more accurately the relative importance of loss of elastic recoil and airway resistance in reducing air flow and to determine whether these changes in lung function are reversible.

CWP and Ventilatory Capacity. During 1974, ALFORD researchers continued to measure ventilatory capacity of coal miners in an effort to determine whether this capacity declines as the severity of CWP increases according to X-ray category for simple coal workers' pneumoconiosis. No such correlation was found. However, miners with complicated pneumoconiosis suffered definite ventilatory impairment.

It has been concluded that while underground coal mining may lead to very minor reductions of ventilatory capacity, such reductions are usually minimal in the absence of complicated pneumoconiosis.

Closing Volume and Early Detection of Lung Disease. It has been demonstrated that abnormalities in the small airways of the lungs may be present when results of standard tests of pulmonary function are normal. ALFORD researchers, therefore, are seeking improved tests which will detect small airway impairment while the disease is still in very early stages of development. One such test is the measure of "closing volume," defined as the amount of air in the lungs when the small airways cease participation during exhalation. In 1974, ALFORD developed and tested a computer method to measure closing volume. Use of the computer increased the

reproducibility of the test by eliminating the variations in measurement which arise when human observers are utilized to make the evaluations. Extensive use of computerized closing volume measurements will be made in 1975.

Single-Breath Tests. ALFORD researchers are also investigating the usefulness of single-breath tests in detecting small airway impairment. It has been demonstrated that measurements of pressure, flow, and volume taken during the exhalation of a single breath of 80 percent nitrogen and 20 percent oxygen can provide valuable information about the operation of the small airways of the lung. This single-breath nitrogen-oxygen test has also been proved an easily reproducible technique in field testing situations.

During 1974, ALFORD researchers experimented with a modified single-breath test in which the nitrogen was replaced with helium, which can be exhaled more quickly and more easily than nitrogen. The flow of the mixture of 80 percent helium and 20 percent oxygen can be more easily controlled than that of the nitrogen-oxygen mixture, and the same information can be obtained.

Specialized equipment and computer programs used to calculate and record the data have been installed in ALFORD laboratories and the apparatus has been thoroughly tested on 25 normal volunteers. The procedure will be used to study a group of 100 active coal miners in 1975 in an attempt to detect signs of early lung disease.

Cigarette Smoking and Lung Mechanics. Data collection was completed during 1974 for a non-occupationally exposed group of 60 young subjects, between the ages of 20 and 30, to determine the effects of cigarette smoking on closing volume and flow-volume curves. Tests were made at regular intervals on all subjects, and a preliminary analysis of the results indicates that more than 10 years of smoking is necessary before effects are apparent in closing volume tests. The results of this study will be compared with data from the National Study of Coal Workers' Pneumoconiosis in order to separate the effects of occupational exposure from those of environmental exposure.

Air and Blood Distribution

ALFORD physiologists have been studying, since 1972, changes in the distribution of air (ventilation) and the distribution of blood (perfusion) within animal lungs caused by changes in airway resistance. The knowledge

gained through these investigations is applicable to any lung disease in which airway resistance is increased, including CWP, asthma, bronchitis and emphysema.

Studies in 1974 were designed to probe the relationship between lung airway obstruction and the patterns of air and blood flow within the lung. Results indicate that reasonably severe obstruction does not give rise to the proportionally high disturbances in blood flow that were expected. However, significant alterations in the air flow patterns were noted in the affected lung. The studies indicate that, as a whole, the cardiopulmonary system is reasonably tolerant of airway obstruction in experimental animals at rest. Experiments linking the effects of alterations of carbon dioxide and oxygen levels in combination with obstruction will continue into 1975.

Air-Liquid Boundary Bubbles. Measurement of the lungs' closing volume has been shown to be very sensitive to changes in small airway resistance. Thus, a systematic study was undertaken by ALFORD physiologists in order to understand the relationship between the two. These experiments, carried out on excised rat lungs, were part of a larger investigation of respiratory mechanics carried out to develop new approaches to the early detection and measurement of small airway disease, such as CWP. The lungs were cycled--inflated and deflated--from a minimum transpulmonary pressure to a maximum transpulmonary pressure and back again. The pressures and rate of ventilation were varied between cycles. The ratio of the amount of air trapped within the lung at a minimum pressure to the maximum lung volume for the same cycle increased during successive inflation-deflation cycles. This indicates an increased amount of trapped gas and, thus, an increased closing volume.

The results of these experiments are consistent with the hypothesis that bubbles are formed within the air spaces of the lungs and that the bubbles are mainly responsible for the increased amount of trapped gas. Closing volume measurement has been explained, heretofore, in terms of the collapse of the small airways, but these results indicate that bubbles formed in the air spaces produce the same physical effect. Thus, bubble formation might explain the mechanism responsible for closing volume.

During 1974, ALFORD physiologists demonstrated for the first time that bubbles form and continue to be present around the air-liquid boundary of the intact isolated rat lungs. Studies will continue in 1975 to attempt to demonstrate that this bubble formation is a normal occurrence in in vivo lungs and that some of the occupational respiratory diseases begin or are enhanced due to the disturbances in ventilation and perfusion of the lungs caused by these bubbles.

Particle Deposition Studies

It has long been known that the amount and the patterns of particle deposition in the lungs depend to a considerable degree on the size, shape, and density of the particles. Researchers have investigated various methods of introducing test particles into animal lungs and then recording their deposition characteristics, but such efforts have traditionally been hampered by the difficulty of obtaining consistently uniform particles of known size, shape, and density.

Radioactively Tagged Uniform Particles. During 1974, ALFORD physiologists demonstrated for the first time that it is possible to obtain such particles in several sizes within the 0.5 to 2 micron range. These particles, made of polymer material and tagged with radioactive iodine, can be introduced into the lungs of laboratory animals and then electronically traced to determine where they are deposited. This new process has the potential to provide researchers with valuable information about the deposition of coal dust in the lungs. Previous studies have indicated that the percentage of particles deposited in the human lung varies widely from individual to individual. Through the use of these newly-developed techniques, physiologists hope to learn the causes for this variation.

Airway Smooth Muscle Studies

In an effort to learn more about the operation of lung airways and, therefore, to more readily understand airway disease, ALFORD physiologists are studying the operation of the smooth muscle tissue which controls the expansion and contraction of the airways.

During 1974, researchers continued to study the response of normal airway smooth muscle in dogs, to application of the drug, acetylcholine (Ach). It is well known to scientists that Ach, which is normally produced in animals and humans, causes airway smooth muscle to contract, but the mechanism by which this phenomenon occurs is not fully understood. ALFORD researchers hope to learn more about the operation of smooth muscle tissue in the airways by controlling the levels of Ach in the laboratory animal tissue and recording the responses. When the normal operation of smooth muscle tissue is known, researchers will then have a set of criteria against which to study the smooth muscle operation of animals exposed to aerosolized coal dust.

During 1974, ALFORD physiologists amassed much new information about the response of smooth muscle tissue to Ach. It was learned that Ach causes a

slow, sustained contraction of the muscle which persists for as long as the drug is present. Microelectrodes used to measure the electrical properties of the cell membrane during the muscle contractions have revealed no appreciable membrane depolarization during this mechanical process. The contraction is initially caused by the release of calcium ions from within the muscle cells. The later, sustained portion of the contraction results from the movement of calcium ions across the cell membrane from outside the cell to inside, as well as by the release of calcium ions from within the cell. These experiments will continue into 1975 until the mechanism by which the small muscle tissue functions can be more fully ascertained.

Genetic Factors and Disease Predisposition

Inheritable disorders in man have long been linked with physical defects and disease susceptibility. More recently, however, scientists have begun to investigate the possibility that genetic deficiencies may contribute to an individual's susceptibility to the effects of occupational hazards. If the markers which identify those genetic deficiencies can be known, it is possible to identify workers who may have a greater than normal risk factor in particular occupational environments. Thus, biochemical research directed toward isolating and identifying certain genetic deficiencies is potentially a valuable aid in early detection and diagnosis of occupational diseases.

Pulmonary Disease and Alpha-1-Antitrypsin Inhibitors. NIOSH scientists are currently engaged in research to determine whether there exists a correlation between the presence of chronic obstructive pulmonary diseases and genetic deficiency. In one such effort, researchers are studying the association of lung disorders with the quantities of certain substances in blood serum which normally inhibit the hydrolization of body proteins. It has been demonstrated that uninhibited hydrolization of proteins can be associated with pulmonary disease.

Research is currently underway to study and quantify the levels of inhibitors of the group alpha-1-antitrypsin present in a group of coal miners in the area who suffer from pneumoconiosis of varying degrees of severity. Results indicate that for the worker whose serum contains intermediate levels of these genetically determined inhibitors, no definitive correlation can be made between the inhibitor levels and the presence of broncho-pulmonary disease. However, those individuals whose serum contains extremely low levels of inhibitors exhibit a significantly higher incidence of lung pathologies than would be expected from the general population. The possibility that the work place may be an

exacerbating influence in these individuals may be an important consideration in "screening" these workers in preemployment examinations.

IgE, Protein Complement Levels, and CWP. During 1974, biochemists at ALFORD have also investigated the possibility of associating levels of various protein fractions and immunoglobulins with simple and complicated coal workers' pneumoconiosis. Much of this research involved measuring the levels of protein complement fractions and the immunoglobulin, IgE, in coal workers with CWP and progressive massive fibrosis (PMF). Preliminary findings indicate that the levels of the complement fractions in the miners do not differ significantly from levels expected in non-miners. It is not clear at this stage of the research whether the levels of the complements may vary significantly from normal when other debilitating disease is present in conjunction with CWP or PMF.

Abnormally high levels of the immunoglobulin reagin factor, IgE, were occasionally observed in this study. However, it is possible that these IgE levels resulted from worker sensitization. That is, trace-metal binding in the lung tissues may produce, as an immunological response, elevated IgE levels.

Antigen Presence and CWP. In other investigations of possible genetic predisposition to coal workers' pneumoconiosis, ALFORD scientists are studying the relationship between CWP and the presence of substances in the blood, called antigens, which stimulate production of antibodies. ALFORD researchers examined 277 coal miners, some of whom had no pneumoconiosis and some of whom exhibited X-ray evidence of varying degrees of the disease. In each subject the presence or absence of each of 23 recognized type HL-A antigens was tabulated. The results were then compared with data describing the expected occurrence of these antigens in the general population. Figure 12 shows the results of this analysis in regard to 2 of the 23 antigens, A012 and W18. For those miners who had no CWP, antigens A01 and W18 were present with a significantly greater frequency than would be expected in a normal population. In addition, the frequency of A01 in miners with both simple and complicated disease falls short of the expected frequency. The frequency of W18 in miners with simple disease is virtually equal to the expected frequency while the W18 frequency in complicated CWP cases is only about one-half the frequency expected in the general population. These results suggest that the presence of A01 and W18 antigens may increase the relative ability to resist development of complicated pneumoconiosis. This continuing research promises to be valuable in early detection of CWP and in the prevention of disease progression.

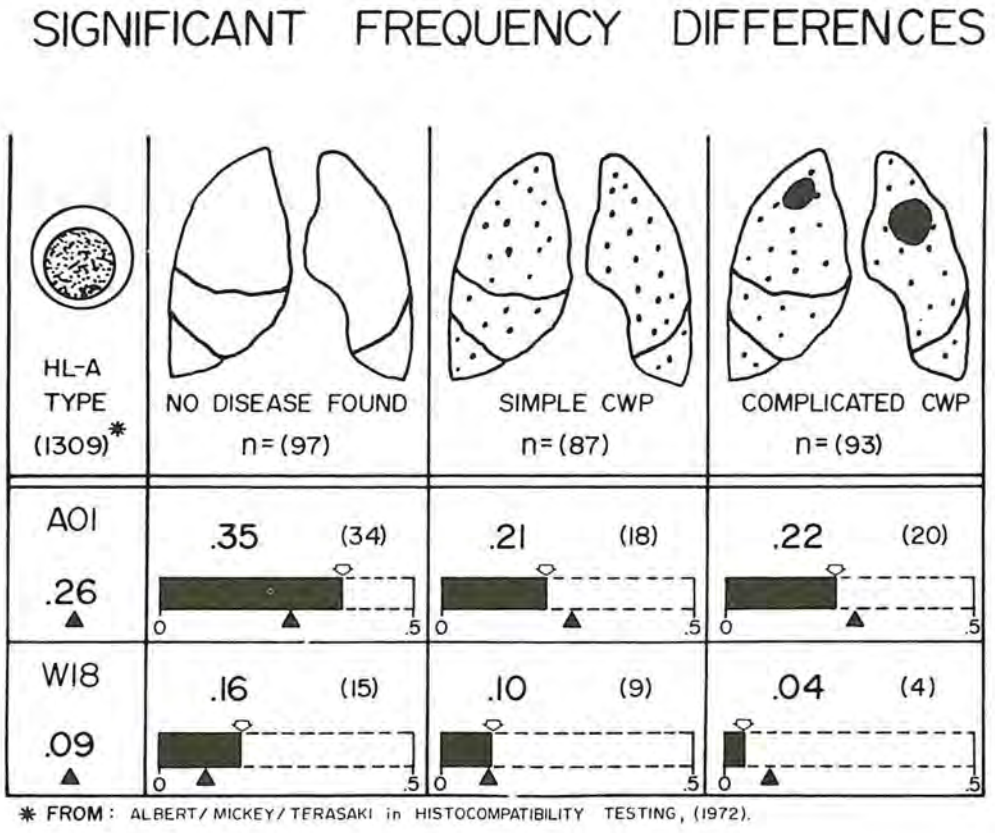

Figure 12. The observed (▽) and expected (▲) HL-A antigenic frequencies for three numerically balanced groups of coal workers matched for age and years in mining.

Connective Tissue Constituents in the Lung

NIOSH biochemists have been studying the formation and the metabolism of connective tissue constituents in the lung. It has been shown that in the progression from simple to complicated coal workers' pneumoconiosis, large conglomerate masses develop. These masses, which eventually break down and leave cavitations, are primarily collagenous fibers synthesized by fibroblast cells found in the lung. While the normal metabolic activity of lung connective tissue is relatively low, the activity increases with the deposition of coal dust in the organ. Thus the internal "scarring" of the tissues may be reflected in the metabolic processes of these cells. The physiological integrity of the lung is dependent on the proper alteration and syntheses of these tissue constituents which make up the organ.

During 1974, it was discovered that human embryonic lung fibroblast cells can survive in the presence of small quantities of coal dust and the metabolism of these cells remains relatively unchanged. Studies are continuing, however, to determine the mechanism by which the organization of the collagenous fibers produced by these cells may be lost, thereby impairing the function of the lung.

Studies of Variation of Chest X-Ray Interpretation

ALFORD epidemiologists studied, during 1974, the chest X-rays of coal miners taken under the National Study of Coal Workers' Pneumoconiosis in an effort to determine the degree and significance of variability in interpretations of these X-rays. While earlier studies have investigated the variability in interpretations of the profusion of CWP indicated by X-rays, no analysis of variability in interpreting the type of opacity present on X-ray films had been undertaken. During 1974, NIOSH statisticians found that in approximately two-thirds of the X-rays, readers disagreed about whether particular opacities should be classified as irregular or rounded. It was concluded, therefore, that epidemiological studies which depend on the differentiation of types of opacities should involve a majority opinion from several interpreters.

In another study of variability of X-ray reading, trials were conducted at the Los Angeles County Hospital to determine whether consistent decision rules were observed by interpreters in reading X-ray zones and in relating zone readings to overall diagnosis. Preliminary data indicate that no consistent decision rules exist; however, the analysis is not yet complete.

Lung Function and Types of Opacities. Another study, based on British information, was designed to determine what factors were associated with the occurrence of irregular small opacities in the chest X-rays of coal miners and whether the lung function of miners with irregular opacities differed from that of miners with rounded opacities. It was discovered that the prevalence of irregular small opacities was greater among smokers than non-smokers. Lung function capabilities were generally lower among smokers with irregular opacities than among smokers with rounded opacities. However, in non-smokers, no significant difference was found in lung function between miners with rounded and irregular opacities. It is concluded that while cigarette smoking is frequently associated with the presence of irregular opacities in the chest X-rays, other important factors, such as the presence of aerosolized asbestos and other fibers, may also be associated with this disorder.

Pulmonary Zonal Involvement. During 1974, ALFORD researchers also studied pulmonary zonal involvement in CWP. In this study, a series of chest X-rays from working coal miners were analyzed for the frequency in which the six standard zones were involved by CWP. Most subjects with categories 2 and 3 simple CWP had involvement of all six zones. However, in miners who were diagnosed as category 1, zonal involvement was much more varied. An attempt was also made to relate the X-ray zonal changes to ventilatory capacity. No such relationship was evident, a finding that is in accord with previous studies.

Exercise Studies

Severe lung disability interrupts the supply of oxygen to the rest of the body as well as the removal of carbon dioxide and other gases produced by the body. Thus, it affects the amount of work a person can do. ALFORD researchers are studying tests of exercise (work) capacity in an effort to develop a test which will measure the full exercise capacity before the heart must make its maximum effort. Such an indicator would make it possible to determine work capacity of coal miners and others with serious heart-lung disorders and might also serve as an early diagnostic indicator of developing heart-lung disease.

Equipment has been developed and installed in ALFORD laboratories to perform non-invasive exercise studies to correlate volume of air exhaled, heart rate, breathing rate, and oxygen consumption with the amount of work performed. A computer program has been developed to calculate results accurately and efficiently. During 1974, these procedures have been tested on 25 normal volunteers. An exercise study of coal miners, using these

newly-developed procedures, will be initiated in 1975 in an effort to establish objective measures of disability.

Infectious Disease Research

Complicated colds, viral pneumonia, and other influenza infections which cause fluid to collect in the lungs damage the structure of the lungs and may cause scars. They are among the leading causes of respiratory disability, and present a serious danger to persons with other lung diseases, such as CWP. Moreover, there is a possible synergistic relationship between infectious lung diseases and other lung diseases, such as CWP. It is possible that one disease weakens the lungs for the other while the damage of one compounds that of the other. Thus, it is one goal of NIOSH coal mine health research to assess the interactions of coal dust, infectious agents, and immune mechanisms in the lungs; to assess the susceptibility of the coal miner, his family, and his community to repeated infectious diseases (relapses); and to develop techniques for finding and treating those in the community who are or might become subject to repeated infections.

Coal Dust and Cellular Virus-Fighting Ability. ALFORD scientists are currently studying the processes by which the immune mechanisms of human cells operate in the presence of infectious agents. It has been observed that the production of interferon, a substance normally present as a cellular defense mechanism, is reduced in tissue cultures treated with various dusts. During 1974, researchers studied the effect of coal dust on the ability of tissue to resist virus present in a dormant state in the cells. Upsetting the normally dormant cell viruses, it was thought, might lead to cancerous changes in the cells. However, while very little virus-fighting interferon was produced in the chronically infected cells, no cancerous changes were observed in these cells after dust exposure. Further study will attempt to determine whether dust can enhance or inhibit cancer formation when virus is added to a cell and a stimulus such as ultraviolet light is applied.

It has been found that the interferon production of dust exposed cells does not decline when the cells are first treated with the compound, poly-4-vinyl pryridine-N-oxide. Thus, a means to protect the cells from the adverse effects of dust on interferon production has been demonstrated. Further research will investigate the interactions of dust particulates and infectious agents in experimental animals whose biological protective processes have been altered by the application of poly-4-vinyl pryridine-N-oxide.

Chronic Bronchitis Research. It has been found that subjects with severe chronic bronchitis maintain a constant production of sputum which is heavily infected with the bacterium Haemophilus influenzae. The subjects, however, have consistently failed to benefit from prophylactic doses of antibiotics. The serum consistently contains an antibody to the infecting bacterium. Subjects whose sputa is productive but non-infected generally have no detectable antibody in their sera and could reasonably benefit from antibiotics.

In the study of chronic bronchitis, therefore, there is a need for a simplified quantitative test for antibody of the bacterium. In this way, it would be possible to determine whether a patient is acutely infected, intermittently infected, or non-infected. Thus, those who might benefit from prophylactic therapy might be identified. During 1974, a wet mass of 50 grams of Haemophilus influenzae was collected for test processing. It is estimated that 200 grams will be needed in the research.

Respiratory Infections Survey in a Mining Community

It is generally believed that viruses are responsible for respiratory complications which accompany many other diseases, especially in those individuals with underlying lung disease such as coal workers' pneumoconiosis. The identification of these viruses, however, has remained obscure.

During the winter of 1973-74, ALFORD researchers undertook to study the prevalence and effects of respiratory viruses in a typical coal mining community. Blood samples from a group of miners and non-miners and their respective wives from the Central Guyan Valley of Wyoming County, West Virginia, were taken both before and after the winter. Each of the 322 subjects was also asked to answer a questionnaire about respiratory symptoms. The pre-winter serum for each subject showed a base line of infectious experience for that individual. The post-winter serum sample was then compared with the earlier sample and all increases in antibodies were tabulated.

An analysis of these data has shown that, as expected, miners had higher crude rates of respiratory symptoms than non-miners. However, contrary to expectations, miners' wives reported no more respiratory symptoms than non-miners' wives. The sera from the study were examined for antibodies to four strains of influenza virus. It was determined that no more than 7

percent of the subjects suffered wintertime infections to any one influenza virus strain. It was also found that as many infections were found among the asymptomatic subjects as among those who had reported influenza symptoms. In general, the survey indicates that influenza infections were too infrequent and sporadic to create adverse health consequences in the community studied.

Physical and Analytical Chemistry

During 1974, researchers at the NIOSH physical and analytical chemistry laboratories in Cincinnati, Ohio, continued to study the lung tissue of coal miners and non-miner control subjects. Through a comprehensive examination of the chemical composition of lung tissues, NIOSH hopes to be able to understand the relationship between chemical changes in the lungs and observed pneumoconiotic changes.

A NIOSH study completed in 1973 involved the examination of tissue from the lungs of deceased West Virginia coal miners and a control group of non-miners who had been residents of West Virginia coal-mining communities. Using X-ray analysis and thin sections of the lungs, called "Gough sections," researchers found that significant damage to the lungs increased as the concentrations of beryllium, magnesium, vanadium, total dust, coal dust, and free silica increased in the tissues. The study demonstrated the need for a more comprehensive study using similar analytical procedures.

Study of Pennsylvania Coal-miners' Lungs

NIOSH subsequently contracted for the acquisitions of 100 lungs of non-miners to be used as a control group and compared to a group of coal-miner lungs. The non-miner lungs were delivered to NIOSH laboratories within a few hours after autopsy, examined by pathologists, sectioned for microscopic study, and then carefully minced, homogenized, frozen, freeze-dried, and finally reduced to ash. All operations were carried out under contamination-free conditions in order to eliminate the possibility of introducing additional dust and metal deposits to the tissue. Quantitative measurements of the concentrations of dust, free silica, hydroxyproline, and 21 trace metals were then compiled.

In 1974, the chemical analyses of the control-group lungs were completed. The results of a rigorous statistical analysis, involving the chemical analysis data and extensive personal and occupational history data available for each deceased control subject, are expected in 1975. This study will attempt to correlate concentrations of foreign matter in the

lungs with the age and sex, as well as the smoking habits and occupational histories, of the subjects.

A group of Pennsylvania coal miners' lungs is currently being prepared for chemical analysis using the same procedures followed in the preparation of the control-group lungs. The miners' lungs are minced, homogenized, frozen, freeze-dried, and ashed. Again all operations are performed in a contamination-free environment.

The remaining work on the Pennsylvania miner lungs promises to be the most significant phase of the study, for it will involve a direct correlation between the degree of coal worker's pneumoconiosis and the presence of foreign chemical substances as well as a regression analysis correlating these findings with the detailed occupational histories for each miner. During 1975, the processing and analysis of these lung samples will be completed and the study brought to a close.

NIOSH chemists have developed, during the years of their involvement in lung research, tissue-processing methods which are currently being reviewed by the Intersociety Committee, a group comprised of representatives of various professional and scientific societies. The Intersociety Committee has given special recognition to two recently developed processing procedures and plans to publish them during 1975. The NIOSH tissue-processing method is one of the two.

Toxicology Research

Coal Dust Inhalation Studies

During 1974, NIOSH toxicologists continued laboratory studies of experimental animals. In one study, Cynomolgus monkeys were exposed to chronic inhalation of two types of bituminous coal dust--a Pennsylvania coal dust found in an area where workers suffer a high incidence of coal workers' pneumoconiosis, and a Utah coal dust from an area in which a low incidence of CWP has been recorded. The monkeys were exposed to controlled concentrations of the coal dust samples in specially-designed chambers for 7 hours per day, 5 days per week. In these studies, now in their fifth year, toxicologists maintain detailed records of any changes in the monkeys' pulmonary functioning. This information is then correlated with pathological data gathered from lung tissue of monkeys exposed to the same coal dust concentrations and then sacrificed. The animals are exposed to coal dust in concentrations of two milligrams of respirable dust per cubic meter of air (2mg/m3), the current Federal maximum allowable standard for

underground coal mines. The ultimate objective of this research is to determine whether the current dust exposure standard is adequate or in need of revision.

In 1974, data from the study of dust-exposed and non-exposed control group monkeys continued to indicate that, as a group, the exposed monkeys suffered greater obstruction in the small airways of the lungs. The same can be said for most individual monkeys exposed to the coal dust, although some monkeys showed no small airway obstructions. Similar observations have been noted, however, in coal miners: while most miners who were exposed to coal dust over long periods demonstrated small airway obstruction, some miners exposed to the same dust did not.

Of two animals selected and sacrificed from each exposure group (one with demonstrated obstructive impairment, one without), pathological evaluation of lung tissues indicated no significant differences in the amount of coal dust deposited in the lungs. However, a significant increase in bronchiolar smooth muscle was discovered in the animals with pulmonary obstructions. NIOSH research is continuing to determine whether similar bronchiolar smooth-muscle tissue can also be found in miners.

A recently-developed test of airway function has been applied in the study of the Cynomolgus monkeys. By determining the "closing volume"--the lung volume at which airways begin to collapse in the volume dependent zones, presumably as a result of small airway closure--NIOSH scientists are more readily and accurately able to judge the degree of small airway impairment. Initial studies have shown an increase in mean values of closing volumes for the monkeys exposed to coal dust.

Germfree Inhalation Studies

In another NIOSH research effort, toxicologists are studying the effects of coal dust inhalation, at concentrations of 10 mg/m3 for 6 months, on small animals in contamination free conditions. Germfree laboratory rats are maintained in an uncontaminated environment where they breathe sterile airborne coal dust. A control group of non-exposed rats is being maintained in similar germfree conditions. Researchers hope, in this way, to shield the rats from microbial flora which could affect their respiratory systems and, thereby, render the experimental data unreliable.

The pulmonary function data from these germfree animals have been evaluated along with data from animals subjected to identical concentrations of coal dust under non-germfree conditions. Results show that the animals

dust inhalation under both germfree and non-germfree conditions demonstrated significantly reduced ventilatory capacities when compared with their non-exposed counterparts. However, the variances for data collected from the germfree specimens were much smaller than those for animals tested under conventional conditions. Such results indicate that animal response to coal dust exposures can be defined better in the absence of microbial flora. These experiments are especially significant in coal mine health research because they are the first to demonstrate ventilatory reduction as a result of coal dust exposure alone. The absence of microbial flora in the experiments precludes the possibility that observed responses to the coal dust are caused in part from bronchitis or other such respiratory disorders.

Sanitation

The maintenance of good sanitary procedures within coal mines is required by the Act and considered by NIOSH and the Mining Enforcement and Safety Administration (MESA) to be essential in safeguarding the health of the miner. During 1974, NIOSH and MESA completed a study of coal mine sanitation. The study surveyed the attitudes of both miners and mine operators as a preliminary step to the development of a manual of good practice which will be completed in 1975. Present systems of providing potable water and disposing of wastes were also studied. NIOSH engineers are currently drafting proposed regulations for submission to the Department of Interior.

Behavioral and Motivational Research

NIOSH psychologists have initiated a survey of attitudinal and motivational factors affecting coal miner utilization of safety and health practices. The study involves the health and safety consciousness of the underground coal miner in 15 high-accident and 15 matched low-accident mines. Plans call for interviewing 1500 underground miners, foremen, management personnel, union stewards, and miners' wives to identify psychological variables which enhance or impede coal miner safety motivation. An additional 2,000 miners at the same mine sites will be administered a generalized job stress questionnaire for the purpose of looking at the relationship between job stress and coal miner health. During 1974, the test protocol was developed and mine sites were chosen. The project is to be completed during 1975.

Grants

NIOSH plans, directs, and coordinates a program of grants for support of research at universities, State and local agencies, and other public and non-profit institutions on problems related to the health of the coal miner and the maintenance of a safe work environment. Applications are solicited under guidelines similar to those of the National Institutes of Health and are reviewed three times a year by a panel of distinguished scientists who assess the merit of each application. Close interagency liaison is maintained with the Department of the Interior to prevent project duplication.

In 1974, NIOSH grants supported both fundamental and applied research in occupational respiratory disease; head and body protection; and coal miner stress from heat, noise, and vibration. Twenty projects were active during the year and a total of $926,176 were allocated. A listing of these grants is given in Appendix C.

Special Foreign Currency Program

The Special Foreign Currency Program operates under authority of the President in Section 104(b)(3) of the Agricultural Trade Development and Assistance Act as amended (P.L. 83-480). The program is supported by U.S. owned foreign currencies which have been determined by the Treasury Department to be in excess of normal U.S. needs in certain designated countries. These excess currencies were obtained through the sale of agricultural products and must be used in foreign countries involved; there is no appropriated dollar outflow from the United States in connection with this program. During 1974, the Special Foreign Currency Program supported one project in connection with coal mine health research.

Chest Diseases in Coal Miners

The Institute of Occupational Medicine in Mining and Metallurgical Industries in Sosnowiec, Poland, is determining the role of all factors in the coal miner's work environment which relate to the rate and pattern of morbidity, mortality, and absenteeism with special reference to respiratory tract disorders. Sickness and accident absence data have been collected for about 95 percent of the 7,000 coal mine employees under consideration. A medical examination--including laboratory analysis, chest X-ray, electrocardiogram, and spirometric lung-function tests--has been administered to over 4,000 underground miners. Microclimate measurements as well as analysis of the air for chemical and physical agents have been

continued at the underground work sites and above ground community areas. Data collection should be completed by mid-1976. Extensive analysis of the information will then begin.

CHAPTER 4

AIR SAMPLING AND PERSONAL PROTECTIVE EQUIPMENT

The NIOSH Testing and Certification Laboratory, housed along with ALFORD in the Appalachian Center for Occupational Safety and Health (ACOSH) at Morgantown, West Virginia, has the responsibility for testing and certifying devices and instruments used to protect workers from occupational hazards. The coal mine health research activities of this NIOSH laboratory, in cooperation with the NIOSH Division of Laboratories and Criteria Development at Cincinnati, Ohio, include the development, testing, and certification of air sampling instruments and personal protective equipment for coal mine use.

Air 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 the coal mine environment to insure compliance with established standards.

During 1974, NIOSH installed a large dynamic coal dust chamber capable of producing 2,800 liters of aerosol per minute. This chamber, developed under an interagency agreement with the Atomic Energy Commission's Los Alamos Scientific Laboratory (AEC-LASL), allows for the simultaneous testing of 12 respirable coal mine air samples.

An intermediate volume personal air sampler with a capacity of 25 liters per minute, developed under contract with NIOSH, was also received and evaluated during 1974. NIOSH engineers developed several electronic motor control circuits to be incorporated into the intermediate volume sampler for the purpose of insuring uniform flow through the instrument.

A laboratory evaluation of an instantaneous aerosol mass monitor was also completed during the year. This device provides for direct and continuous readings of coal dust concentrations. Use of the instantaneous aerosol mass monitor eliminates the need to remove a filter and compare the pre-exposure and post-exposure weights to determine coal dust levels. The instantaneous monitor also allows for measurement of peak dust conditions such as those which occur at the moment when the mining equipment first strikes the mine face.

Respirator Research Activities. The Coal Mine Health and Safety Act of 1969 requires that mine operators provide respirators for miners exposed to coal mine dust whenever the concentration of respirable dust exceeds the established standard. The Act also requires miners to be provided respirators when they are exposed for short periods to inhalation hazards from gas, dust, fumes, or mist.

During 1974, an applied research and development program was initiated to establish new performance criteria for respirators and to improve equipment designs in order to minimize wearer discomfort.

Under an interagency agreement with the Atomic Energy Commission's Los Alamos Scientific Laboratory, NIOSH engineers are developing improved methods and equipment for testing dust, fume, and mist respirators. These tests emphasize the importance of comfortable facepiece fitting and reduction of breathing resistance as well as the filtration capabilities of the device. Under the new procedures, respirators will be scrutinized for comfort and efficiency by a test panel of males and females having anthropometric specifications representative of approximately 95 percent of the U.S. working population. The objective of this program is to increase miner acceptance of respirators. It has been found that miners are frequently reluctant to accept many respirators currently available and often negligent in using the devices even when dust levels may be hazardous. NIOSH researchers are seeking to insure that coal miners are provided respirators which are as comfortable and efficient as possible.

NIOSH has developed a respirator design guide to assist manufacturers in meeting new performance requirements. The guide provides anthropometric data tabulated for U.S. workers and gives the variability of facial measurements which must be accommodated by respirators. NIOSH engineers are also developing a manual which will apprise coal mine operators of their responsibilities to establish acceptable respirator programs and will assist them in meeting current requirements under the Act.

CHAPTER 5

COOPERATIVE AND RELATED COAL MINE HEALTH ACTIVITIES

Coal Mine Health Research Advisory Committee

Among the provisions of the Federal Coal Mine Health and Safety Act of 1969 is the establishment of the Coal Mine Health Research Advisory Committee. The Committee, initiated in 1970, consults with and recommends to the Secretary of the Department of Health, Education, and Welfare on matters related to coal mine health research.

The Committee membership includes the Director of the Bureau of Mines or his delegate, the Director of the National Science Foundation or his delegate, the Director of the National Institutes of Health or his delegate, and 14 additional members appointed by the Secretary of HEW. A list of current members appears in Appendix D.

During 1974, the Committee met twice--March 28-29 in Cincinnati, Ohio, and June 3 in Rockville, Maryland--to review coal mine health research activities conducted by NIOSH and to offer recommendations concerning future research and cooperative activities. During 1974, the Committee directed specific attention to the following:

(1) The progress in the second round of the National Coal Study.
(2) Research on the treatment of coal workers' pneumoconiosis.
(3) The use of computer techniques in the interpretation of chest roentgenograms.
(4) How the budget affects research and service activities of NIOSH in relation to the health of coal miners.
(5) Dust characterization of mines included in the National Coal Study.
(6) The autopsy program as mandated by the Federal Coal Mine Health and Safety Act of 1969 and its research possibilities.
(7) The toxicity of coal mine dust in primates.
(8) The NIOSH planning cycle in relation to coal mine health research.

(9) Criteria for the diagnosis of disability and death from coal workers' pneumoconiosis.
(10) Studies of coal particle deposition in the lungs.

In addition the committee recommended that three coal research grants be approved and one coal research grant be disapproved.

Interim Compliance Panel

Under the provisions of the Federal Coal Mine Health and Safety Act of 1969, each underground coal mine operator is required, effective December 30, 1972, to continuously maintain the mine atmosphere to which each miner is exposed at an average respirable dust level of 2.0 mg/m3 or less. The Act provides, however, that an operator may apply for relief if he cannot meet the standard. The Interim Compliance Panel (ICP) can issue a temporary noncompliance permit allowing respirable dust levels not to exceed 3.0 mg/m3, for a period not to exceed 12 months.

Continuing support was provided to the Interim Compliance Panel by NIOSH during 1974 under the terms of an agreement negotiated between the Office of the Secretary, HEW, and the Interim Compliance Panel in September 1970. That agreement provided for the provision of personnel, payment of salaries and related costs, and payment of 40 percent of all other costs incident to ICP operations.

On January 1, 1974, only 17 permits for noncompliance with 2.0 mg/m3 dust standard were still in force. During the year, no new applications for noncompliance permits were received. However, all 17 mine operators holding previously issued noncompliance permits applied for renewal. The Panel issued renewal permits for 11 mines and denied permits for 6 mines. The 11 permits granted renewal covered 58 working sections. The 6 mines denied renewal involved 54 working sections. The renewal permits were for relatively short periods of time, ranging from 3 to 6 months.

By December 31, 1974, only 1 permit was still in force. As indicated in the Act, the Panel is to have completed all of its functions and to cease to exist not later than June 30, 1976.

NIOSH, The Mining Enforcement and Safety Administration (MESA) and the Bureau of Mines

During 1974, MESA and the Bureau of Mines continued to coordinate their coal mine health activities with NIOSH. These activities can be categorized as follows:

(1) Joint Projects:
- National Study of Coal Workers' Pneumoconiosis
  (NIOSH--medical examinations; MESA--dust sampling)
- Noise and Hearing Survey
  (NIOSH--audiograms; MESA--environmental noise)

(2) Complementary Projects (benefiting both agencies):
- Development of Instrumentation to Measure Dust, Gases, etc.
- Sanitation
  (NIOSH will develop good practices manual for use in coal mines)
- Diesel Engine Research
  (NIOSH--proposed literature search of particulates, criteria documents on nitrogen dioxide, etc.; MESA--research on engine performance features)

(3) Cooperative Implementation of Coal Act:
- NIOSH develops standards for health, MESA enforces standards

(4) Informal Contacts Between Program Staffs of Two Agencies

(5) Joint Staff Seminars:
- (Example: Conference on Progress of Coal Act Implementation)

(6) Reciprocal Representation on Advisory Committees:
- NIOSH representative on Interior's Advisory Committee on Coal Safety Research

Bureau of Mines representative on the Secretary's Coal Mine Health Research Advisory Committee and on training grant study group

(7) Joint Discussions of Proposed Hearings and Regulations Regarding Coal Miners' Health

Social Security Administration

During 1974, the Social Security Administration (SSA) provided a liaison officer to the Secretary's Coal Mine Health Research Advisory Committee. This representative, while not a member of the Committee, participated as a privileged observer and contributed to the proceedings informally. In addition, the SSA took part in conferences on X-ray quality control during the year.

Bureau of Radiological Health

NIOSH and the Bureau of Radiological Health maintain an interagency agreement dealing with the problems of quality control as related to X-rays taken under the Federal Coal Mine Health and Safety Act.

Department of Labor

On July 1, 1973, the U.S. Department of Labor assumed the responsibilities previously held by the Social Security Administration with regard to adjudicating claims for compensation for coal workers' pneumoconiosis. Claims filed on July 1, 1973, and after are investigated by the Department of Labor. Compensation is awarded by the Department if it is determined that no coal mine operator can be held responsible for payment. In addition, the Department of Labor appoints a liaison representative to participate informally at meetings of the Secretary's Coal Mine Health Research Advisory Committee.

APPENDIX A

COAL MINE HEALTH CONTRACTS

CONTRACT	HSM-99-71-022
CONTRACT PERIOD	06/30/71 - 12/31/74
FUNDS TO DATE	$623,281
FY 74 FUNDING	$0
PROJECT OFFICER	Earle P. Shoub
TITLE	Follow-up Study of Three Coal Mining Communities in West Virginia
ABSTRACT	Follow-up the people who were studied approximately 6 years ago in Mullens and Richwood, West Virginia, by the USPHS and in Marion County, West Virginia, 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, Michigan
CONTRACT DIRECTOR	I.T.T. Higgins

CONTRACT	HSM-99-72-057
CONTRACT PERIOD	06/15/72 - 05/31/75
FUNDS TO DATE	$127,800
FY 74 FUNDING	$0
PROJECT OFFICER	Earle P. Shoub
TITLE	Provision of Ancillary Services and Domiciliary Care
ABSTRACT	Reimburse the West Virginia University Medical Center Hospital for ancillary services, laboratory tests, and the use of facilities not available in NIOSH where special clinical studies will be carried out on coal miners with respiratory impairment.
CONTRACTOR	West Virginia Medical Center Hospital Morgantown, West Virginia
CONTRACT DIRECTOR	Eugene L. Staples

CONTRACT	HSM-99-72-133
CONTRACT PERIOD	06/30/72 - 06/30/75
FUNDS TO DATE	$409,025
FY 74 FUNDING	$0
PROJECT OFFICER	N. LeRoy Lapp

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 better understand the determinants of the maximal expiration flow-volume curve.
CONTRACTOR	Mayo Foundation Rochester, Minnesota
CONTRACT DIRECTOR	R.E. Hyatt
CONTRACT	HSM-99-72-151
CONTRACT PERIOD	06/30/72 - 12/31/74
FUNDS TO DATE	$165,156
FY 74 FUNDING	$13,854
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 which influence coal miners' acceptance and participation in established safety and health practices.
CONTRACTOR	Westinghouse Electric Corporation Columbia, Maryland
CONTRACT DIRECTOR	C. Grether
CONTRACT	HSM-99-73-004
CONTRACT PERIOD	10/02/72 - 12/30/74
FUNDS TO DATE	$709,946
FY 74 FUNDING	$375,410
FY 75 FUNDING	$30,676
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, West Virginia
CONTRACT DIRECTOR	Wayne A. Muth
CONTRACT	HSM-99-73-6
CONTRACT PERIOD	06/01/72 - 05/31/75
FUNDS TO DATE	$12,940
FY 74 FUNDING	$7,454

PROJECT OFFICER	Earle P. Shoub
TITLE	X-ray Interpretation: Second Round National Study of Coal Workers' Pneumoconiosis
ABSTRACT	Interpret and classify by the ILO-U/C system, X-ray films from the second round of the National Study of Coal Workers' Pneumoconiosis and, in addition, examine side-by-side pairs of films from the same miners taken approximately 3 years apart and determine progression, if any, of the disease over that time interval in those subjects.
CONTRACTOR	Professional Staff Association Los Angeles, California
CONTRACT DIRECTOR	George Jacobson
CONTRACT	HSM-99-73-7
CONTRACT PERIOD	01/01/73 - 05/31/75
FUNDS TO DATE	$9,475
FY 74 FUNDING	$6,566
PROJECT OFFICER	Earle P. Shoub
TITLE	X-ray Interpretation: Second Round National Study of Coal Workers' Pneumoconiosis
ABSTRACT	Interpret and classify by the ILO-U/C system, X-ray films from the second round of the National Study of Coal Workers' Pneumoconiosis and, in addition, examine side-by-side pairs of films from the same miners taken approximately 3 years apart and determine progression, if any, of the disease over that time interval in those subjects.
CONTRACTOR	Johns Hopkins University Baltimore, Maryland
CONTRACT DIRECTOR	Martin W. Donner and Paul Wheeler
CONTRACT	HSM-99-73-008
CONTRACT PERIOD	12/01/72 - 05/31/75
FUNDS TO DATE	$10,367
FY 74 FUNDING	$5,968
PROJECT OFFICER	Earle P. Shoub
TITLE	X-ray Interpretation: Second Round National Study of Coal Workers' Pneumoconiosis
ABSTRACT	Interpret and classify by the ILO-U/C system X-ray films from the second round of the National Study of Coal Workers' Pneumoconiosis and, in addition, examine side-by-side pairs of films from the same miners taken

	approximately 3 years apart and determine progression, if any, of the disease over that time interval in those subjects.
CONTRACTOR	John M. Dennis Baltimore, Maryland
CONTRACT DIRECTOR	John M. Dennis
CONTRACT	HSM-99-73-009
CONTRACT PERIOD	12/01/72 - 05/31/75
FUNDS TO DATE	$8,420
FY 74 FUNDING	$6,539
PROJECT OFFICER	Earle P. Shoub
TITLE	X-ray Interpretation: Second Round National Study of Coal Workers' Pneumoconiosis
ABSTRACT	Interpret and classify by the ILO-U/C system, X-ray films from the second round of the National Study of Coal Workers' Pneumoconiosis and, in addition, examine side-by-side pairs of films from the same miners taken approximately 3 years apart and determine progression, if any, of the disease over that time interval in those subjects.
CONTRACTOR	Orlando F. Gabriele Morgantown, West Virginia
CONTRACT DIRECTOR	Orlando F. Gabriele
CONTRACT	HSM-99-73-011
CONTRACT PERIOD	12/01/72 - 05/31/75
FUNDS TO DATE	$3,939
FY 74 FUNDING	$3,581
PROJECT OFFICER	Earle P. Shoub
TITLE	X-ray Interpretation: Second Round National Study of Coal Workers' Pneumoconiosis
ABSTRACT	Interpret and classify by the ILO-U/C system, X-ray films from the second round of the National Study of Coal Workers' Pneumoconiosis and, in addition, examine side-by-side pairs of films from the same miners taken approximately 3 years apart and determine progression, if any, of the disease over that time interval in those subjects.
CONTRACTOR	Eugene P. Pendergrass Philadelphia, Pennsylvania
CONTRACT DIRECTOR	Eugene P. Pendergrass

CONTRACT	HSM-99-73-14
CONTRACT PERIOD	02/12/73 - 02/11/75
FUNDS TO DATE	$45,367
FY 74 FUNDING	$0
PROJECT OFFICER	Robert B. Reger
TITLE	Roentgenographic Interpreter Proficiency Evaluation System
ABSTRACT	Provide for the selection and validation of a series of films which could be used with the proper analytical techniques to evaluate the proficiency of roentgenographic interpreters.
CONTRACTOR	Johns Hopkins University Baltimore, Maryland
CONTRACT DIRECTOR	Alvin Lazen

CONTRACT	HSM-99-73-40
CONTRACT PERIOD	06/01/73 - 05/31/75
FUNDS TO DATE	$8,767
FY 74 FUNDING	$3,932
PROJECT OFFICER	Earle P. Shoub
TITLE	X-ray Interpretation: Second Round Study of Coal Workers' Pneumoconiosis
ABSTRACT	Interpret and classify by the ILO-U/C system, X-ray films from the second round of the National Study of Coal Workers' Pneumoconiosis and, in addition, examine side-by-side pairs of films from the same miners taken approximately 3 years apart and determine progression, if any, of the disease over that time interval in those subjects.
CONTRACTOR	Benjamin Felson, Cincinnati General Hospital
CONTRACT DIRECTOR	Benjamin Felson

CONTRACT	HSM-99-73-57
CONTRACT PERIOD	06/30/73 - 12/31/74
FUNDS TO DATE	$72,486
FY 74 FUNDING	$0
PROJECT OFFICER	Robert B. Reger
TITLE	Digitalized Image Processing of Chest X-rays to Assess Progression and Categorize CWP
ABSTRACT	Investigate the feasibility of the use of digital image change detection techniques for improving the

	readability and diagnosis of progression of Coal Workers' Pneumoconiosis from chest roentgenograms.
CONTRACTOR	Control Data Corporation Minneapolis, Minnesota
CONTRACT DIRECTOR	R.L. Lillestrand
CONTRACT	HSM-99-73-59
CONTRACT PERIOD	06/30/73 - 05/31/75
FUNDS TO DATE	$4,719
FY 74 FUNDING	$2,797
PROJECT OFFICER	Earle P. Shoub
TITLE	X-ray Interpretation: Second Round National Study of Coal Workers' Pneumoconiosis
ABSTRACT	Interpret and classify by the ILO-U/C system, X-ray films from the second round of the National Study of Coal Workers' Pneumoconiosis and, in addition, examine side-by-side pairs of films from the same miners taken approximately 3 years apart and determine progression, if any, of the disease over that time interval in those subjects.
CONTRACTOR	Leonard J. Bristol Saranac Lake, New York
CONTRACT DIRECTOR	Leonard J. Bristol
CONTRACT	HSM-99-73-80
CONTRACT PERIOD	06/30/73 - 06/29/75
FUNDS TO DATE	$160,912
FY 74 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, Pennsylvania
CONTRACT DIRECTOR	Howard Rockette
CONTRACT	HSM-99-73-81
CONTRACT PERIOD	06/30/73 - 11/30/74
FUNDS TO DATE	$164,693
FY 74 FUNDING	$0

PROJECT OFFICER	Marilyn Hutchison
TITLE	Investigation of the Sanitation Practices Associated with Coal Mine Operations
ABSTRACT	Collect and evaluate basic data through a literature review and a field survey of 200 mines concerning the sanitation practices in coal mines. This is done to appraise the effectiveness of current regulations for adequately protecting the health of miners.
CONTRACTOR	University Science Center, Inc. Pittsburgh, Pennsylvania
CONTRACT DIRECTOR	Alvan W. Leavitt
CONTRACT	HSM-99-73-92
CONTRACT PERIOD	06/30/73 - 12/29/74
FUNDS TO DATE	$238,870
FY 74 FUNDING	$72,374
FY 75 FUNDING	$27,760
PROJECT OFFICER	Alan H. Purdy and Robert B. Reger
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 in chest X-rays.
CONTRACTOR	University of Southern California Los Angeles, California
CONTRACT DIRECTOR	Richard P. Kruger and Ernest L. Hall
CONTRACT	CDC-99-74-04
CONTRACT PERIOD	12/14/73 - 06/01/74
FUNDS TO DATE	$2,400
FY 74 FUNDING	$2,400
PROJECT OFFICER	Robert B. Reger
TITLE	Fast Internal Sorting of X-ray Film
ABSTRACT	Determine whether, as picture processing and X-ray photo technology is increasing the input-output image data rate, there is now an increasing need for a fast internal computer sort (or set of fast internal sorts) of X-ray photo data.
CONTRACTOR	West Virginia University Morgantown, West Virginia
CONTRACT DIRECTOR	David C. Rine

CONTRACT	CDC-99-74-25
CONTRACT PERIOD	06/27/74 - 06/26/76
FUNDS TO DATE	$20,736
FY 74 FUNDING	$20,736
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 and one program development or editing job to execute simultaneously on a PDP-12 central processor with minimal modification to existing programs.
CONTRACTOR	West Virginia University Morgantown, West Virginia
CONTRACT DIRECTOR	Thomas McIntyre

CONTRACT	CDC-99-74-37
CONTRACT PERIOD	06/26/74 - 06/25/77
FUNDS TO DATE	$1,200,000
FY 74 FUNDING	$1,200,000
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 concentrations 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 DIRECTOR	Bedford W. Bird

CONTRACT	CDC-99-74-49
CONTRACT PERIOD	06/26/74 - 06/25/75
FUNDS TO DATE	$38,462
FY 74 FUNDING	$38,462
PROJECT OFFICER	John L. Hankinson
TITLE	Construction of a Flow-Volume Calibrator
ABSTRACT	Develop, construct, evaluate, and furnish a portable flow-volume calibrator suitable for calibrating and

	evaluating various models and types of spirometers and flow measuring devices generally used in clinical studies.
CONTRACTOR	University of Utah Research Institute Salt Lake City, Utah
CONTRACT DIRECTOR	C.D. Baker
CONTRACT	CDC-99-74-112
CONTRACT PERIOD	06/26/74 - 06/30/75
FUNDS TO DATE	$9,760
FY 74 FUNDING	$9,760
PROJECT OFFICER	Robert B. Reger
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, Maryland
CONTRACT DIRECTOR	Alvin G. Lazen
CONTRACT	CDC-99-74-115
CONTRACT PERIOD	06/27/74 - 06/26/75
FUNDS TO DATE	$24,000
FY 74 FUNDING	$24,000
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Periodic Medical Examinations for Coal Miners in Pennsylvania
ABSTRACT	Provide for the making and definite interpretation of medical examinations, including chest X-rays required under Section 203 of the Federal Coal Mine Health and Safety Act of 1969 at underground coal mines and related operations in the State of Pennsylvania where the operator has failed to provide an acceptable Coal Mine Operator's Plan.
CONTRACTOR	Commonwealth of Pennsylvania Harrisburg, Pennsylvania
CONTRACT DIRECTOR	John W. Krauber
CONTRACT	210-75-0009
CONTRACT PERIOD	12/05/74 - 06/30/75
FUNDS TO DATE	$10,350

FY 75 FUNDING	$10,350
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definite Interpretation of Chest Roentgenograms
ABSTRACT	Provides for definite interpretations on a per unit basis up to 9,000 X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 by an approved "B" Reader when the first interpretation is made by an approved "A" Reader.
CONTRACTOR	West Virginia University Morgantown, West Virginia
CONTRACT DIRECTOR	David M. Murphy
CONTRACT	210-75-0010
CONTRACT PERIOD	11/14/74 - 06/30/75
FUNDS TO DATE	$13,050
FY 75 FUNDING	$13,050
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definite Interpretation of Chest Roentgenograms
ABSTRACT	Provides for definitive interpretations on a per unit basis up to 9,000 X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 by an approved "B" Reader when the first interpretation is made by an approved "A" Reader.
CONTRACTOR	R. Brent Harrison Charlottesville, Virginia
CONTRACT DIRECTOR	R. Brent Harrison
CONTRACT	210-75-0011
CONTRACT PERIOD	11/18/74 - 06/30/75
FUNDS TO DATE	$13,500
FY 75 FUNDING	$13,500
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretations of Chest Roentgenograms
ABSTRACT	Provides for definitive interpretations on a per unit basis up to 9,000 X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 by an approved "B" Reader when the first interpretation is made by an approved "A" Reader.
CONTRACTOR	Joseph C. Furnary Baltimore, Maryland
CONTRACT DIRECTOR	Joseph C. Furnary

CONTRACT	210-75-0012
CONTRACT PERIOD	11/15/74 - 06/30/75
FUNDS TO DATE	$15,750
FY 75 FUNDING	$15,750
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretations of Chest Roentgenograms
ABSTRACT	Provides for definitive interpretations on a per unit basis up to 9,000 X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 by an approved "B' reader when the first interpretation is made by an approved "A" Reader.
CONTRACTOR	Clinton W. Stallard Newport News, Virginia
CONTRACT DIRECTOR	Clinton W. Stallard

CONTRACT	210-75-0013
CONTRACT PERIOD	11/18/74 - 06/30/75
FUNDS TO DATE	$17,100
FY 75 FUNDING	$17,100
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretation of Chest Roentgenograms
ABSTRACT	Provides for definitive Interpretation on a per unit basis up to 9,000 X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 by an approved "B" Reader when the first interpretation is made by an approved "A" Reader.
CONTRACTOR	Jospeh Rosenstein Saranac Lake, New York
CONTRACT DIRECTOR	Joseph Rosenstein

CONTRACT	210-75-0014
CONTRACT PERIOD	11/29/74 - 06/30/75
FUNDS TO DATE	$17,550
FY 75 FUNDING	$17,550
PROJECT OFFICER	Phyllis J. Popovich
TITLE	Provide Definitive Interpretation of Chest Roentgenograms
ABSTRACT	Provides for definitive interpretations on a per unit basis up 9,000 X-rays taken under the Federal Coal Mine Health and Safety Act of 1969 by an approved "B" Reader

	when the first interpretation is made by an approved "A" Reader.
CONTRACTOR	Leonard Bristol Saranac Lake, New York
CONTRACT DIRECTOR	Leonard Bristol
CONTRACT	210-75-0015
CONTRACT PERIOD	12/01/74 - 12/01/75
FUNDS TO DATE	$53,040
FY 75 FUNDING	$53,040
PROJECT OFFICER	Earle P. Shoub
TITLE	Task Force on Pneumoconioses
ABSTRACT	Develop a task force on Pneumoconioses to improve the quality of radiographs entering the system, conduct a conference of "B" X-ray Readers, and conduct a three-day conference at the completion of the second round of X-rays taken under the Federal Coal Mine Health and Safety Act of 1969.
CONTRACTOR	American College of Radiology Chevy Chase, Maryland
CONTRACT DIRECTOR	Edgar Dessen

APPENDIX B

COAL MINE HEALTH INTERAGENCY AGREEMENTS

AGREEMENT	NIOSH-I-71-10
FUNDS TO DATE	$317,080
FY 74 FUNDING	$75,000
PROJECT OFFICER	Alan H. Purdy
TITLE	X-ray Technician Training
ABSTRACT	A continuing project at the Science and Engineering Laboratory of Oregon State University to provide support in the certification of X-ray facilities, the evaluation of X-ray equipment, and the development of advanced methods of quality control designed to reduce the variabilty of "B" readings.
AGENCY	Bureau of Radiological Health Food and Drug Administration
PROJECT DIRECTOR	William J. Felton

AGREEMENT	NIOSH-I-72-12
FUNDS TO DATE	$0
FY 74 FUNDING	$0
PROJECT OFFICER	Robert H. Schutz
TITLE	Respirator Testing
ABSTRACT	Defines NIOSH - Bureau of Mines roles and relationships in the testing and certification of respirators for use in coal mines.
AGENCY	Bureau of Mines Washington, D.C.
PROJECT OFFICER	William R. Wayment

AGREEMENT	NIOSH-IA-74-31
FUNDS TO DATE	$5,000
FY 74 FUNDING	$5,000
PROJECT OFFICER	Alan H. Purdy
TITLE	Radiation and Radioisotope Imaging: Present Status and Future Trends
ABSTRACT	Provides support of an interagency study to assess radiological imaging.
AGENCY	National Science Foundation
PROJECT DIRECTOR	Gilbert B. Devey

AGREEMENT	NIOSH-IA-75-3
FUNDS TO DATE	$2,000
FY 75 FUNDING	$2,000
PROJECT OFFICER	Pierre Decoufle
TITLE	Retrospective Mortality Survey of Coal Miners
ABSTRACT	Provides the following information on 3,800 names and social security numbers: (1) last quarter for which earnings have been reported, or (2) date of and location of death claim, (3) last residence of deceased, and (4) date of and state of last employment if last residence cannot be provided.
AGENCY	Social Security Administration
PROJECT DIRECTOR	Vincent A. Serio

AGREEMENT	NIOSH-IA-75-12
FUNDS TO DATE	$1,500
FY 75 FUNDING	$1,500
PROJECT OFFICER	Carl E. Ortmeyer
TITLE	Mortality data in Connection with Health Research Study of Coal Miners
ABSTRACT	Provides the following information on 3,500 names and social security numbers: (1) last quarter for which earnings have been reported, or (2) date of and location of death claim, (3) last residence of deceased, and (4) date of and state of last employment if last residence cannot be provided.
AGENCY	Social Security Administration
PROJECT DIRECTOR	Vincent A. Serio

APPENDIX C

GRANTS ACTIVE IN CALENDAR YEAR 1974

PROJECT NUMBER	NAME INSTITUTION PROJECT TITLE	CALENDAR YR. 74 SUPPORT FY 74 SUPPORT	 FY 75 SUPPORT
OCCUPATIONAL RESPIRATORY DISEASE			
	TOXICOLOGIC		
OH 00322-07	John M. Peters Harvard University Boston, Massachusetts "Health Hazards of Di-Isocyanates"		42,614
OH 00342-04	Morris Polard University of Notre Dame Notre Dame, Indiana "Effects of Environmental Pollutants in Germfree Rodents"		18,743
OH 00355-03	Harold G. Petering University of Cincinnati Cincinnati, Ohio "Interaction of Coal Dust with Essential Metals"	47,608	
OH 00356-04	Robert Christian University of Cincinnati Cincinnati, Ohio "Cellular Response to Coal Dust in Vitro"		47,350

MORPHOLOGIC

OH 00334-05	Juraj Ferin University of Rochester Rochester, New York "Air Pollutants and Lung Clearance of Particles"	77,843	
OH 00352-05	Eugene D. Robin Stanford University Palo Alto, California "Lung Cell Function in Health and Disease"	90,945	
OH 00357-04	E. Bingham Mattheis University of Cincinnati Cincinnati, Ohio "Fate of Inhaled Coal Dust"		32,880
OH 00396-02	Edward D. Palmes New York University New York, New York "Aerosol Deposition in Human Subjects"	38,225	

DIAGNOSTIC

OH 00360-04	Robert Burrell West Virginia University Morgantown, West Virginia "Immune Injury in Occupational Respiratory Diseases"	33,312	

PHYSICAL AGENTS

OH 00308-18	Paul Magee University of Pittsburgh Pittsburgh, Pennsylvania "Evaluation of Stresses of Exposure to Heat"	18,176	
OH 00350-04	Wallace D. Ward University of Minnesota Minneapolis, Minnesota "Damage-Risk Criteria for Intermittent Noise Exposures"	55,583	

OH 00364-03	Donald Henderson State of New York Upstate Medical Center Syracuse, New York "The Effects of Impulse Noise on Auditory System"	90,905	
OH 00470-02	Douglas D. Reynolds University of Texas Austin, Texas "Vibration Characteristics of the Hand and Arm"		26,194
OH 00479-01	John C. Guignard University of Dayton Dayton, Ohio "Effects of Vibration on Human Comfort and Performance"	74,918	
OH 00556-01	Donald Henderson State of New York Upstate Medical Center Syracuse, New York "The Effect of Noise on Hearing"		28,396
OH 00583-01	E. E. Kamon Pennsylvania State University University Park, Pennsylvania "Evaluation of Stresses of Exposure to Heat"		42,232

HEAD AND BODY PROTECTION

OH 00301-03	George G. Snively Snell Memorial Foundation, Inc. N. Tarrytown, New York "Head Protection of Industrial Workers"	
OH 00404-02	Alan M. Nahum University of California La Jolla, California "Prevention of Accidental Head Injury"	26,207

MATERIALS HANDLING

OH 00514-01	Albert B. Schultz University of Illinois Chicago, Illinois "Back Injuries: Mechanical Stresses in the Human Spine"	62,308	

SHIFTWORK

OH 00331-03	Elliot D. Weitzman Montefiore Hospital and Medical Center Bronx, New York "The Sleep-Waking Cycle and its Neuro Endocrine Correlates"		71,737

APPENDIX D

COAL MINE HEALTH RESEARCH ADVISORY COMMITTEE

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APPENDIX E

SELECTED PUBLICATIONS

Abraham, J.L., P.B. DeNee: Biomedical Applications of Backscattered Electron Imaging--One Year's Experience with SEM Histochemistry. Scanning Electron Microscopy/ 1974 (Part I): Proceedings of the Seventh Annual Scanning Electron Microscope Symposium, pp. 251-258, April 1974.

Amandus, H.E., N.L. Lapp, W.K.C. Morgan and R.B. Reger: Pulmonary Zonal Involvement in Coal Workers' Pneumoconiosis. Journal of Occupational Medicine, 16:245-247, 1974.

Amandus, H.E., E.P. Pendergrass, J.M. Dennis and W.K.C. Morgan: Pneumoconiosis: Inter-Reader Variability in the Classification of the Type of Small Opacities in the Chest Roentgenogram. American Journal of Roentgenology, 122 (4):740-743, 1974.

Burrell, R., D.K. Flaherty, P.B. DeNee, J.L.Abraham and A.H. Gelderman: The Effect of Lung Antibody on Normal Lung Structure and Function. American Review of Respiratory Diseases, 109:106, 1974.

Costello, J., C.E. Ortmeyer and W.K.C. Morgan: Mortality from Lung Cancer in U.S. Coal Miners. American Journal of Public Health, 64:222, 1974.

DeNee, P.B. and J.L. Abraham: SEM Backscattered Electron Imaging--An Aid to Dust and Particulate Characterization. Proceedings of the Microbeam Analysis Society, July 1974.

DeNee, P.B., J.L. Abraham, A.H. Gelderman and G. Boyd Shaw: SEM Identification of Biogenic Silica in Jute: Silica in Human Lung Following Exposure to Burning Jute. Proceedings of the Microbeam Analysis Society, July 1974.

DeNee, P.B., J.L. Abraham and P.A. Willard: Histochemical Stains for the Scanning Electron Microscope--Qualitative and Semi-Quantitative Aspects of Specific Silver Stains. Scanning Electron Microscopy/1974 (Part I): Proceedings of the Seventh Annual Scanning Electron Microscope Symposium, pp. 259-266, April 1974.

Hahon, N.: Depression of Viral Interferon Induction in Cell Monolayers by Coal Dust. British Journal of Industrial Medicine , 31:201-208, July 1974.

Hahon, N. and J.A. Booth: Hemadsorption Cell-Counting Assay of Interferon. Archiv fur die gesamte Virusforschung, 44:160-163, 1974.

Hankinson, J.L. and William D. Rose: Automated Spirometry System. Proceedings of the San Diego Biomedical Symposium, 13:1-3 to 3-3, 1974.

Lapp, N.L.: Volume de Fermeture. Proceedings Enseignement Post Universitaire, Physio-Pathologie Respiratoire, Nancy, France, October 1974.

Morgan, W.K.C.: Lung Volumes and Flow Rates in Black and White Subjects. Thorax, 29:185, 1974.

Morgan, W.K.C., L. Handelsman, J. Kiblestis, N.L. Lapp and R.B. Reger: Ventilatory Capacity and Lung Volumes of U.S. Coal Miners. Archives of Environmental Health, 28:182, 1974.

Morgan, W.K.C, N.L. Lapp and E.J. Morgan: The Early Detection of Occupational Lung Disease. British Journal of Dis. Chest, 68:75, 1974.

Morgan, W.K.C., M.R. Petersen and R.B. Reger: The "Middling" Tendency: A Possible Source of Bias in the Interpretation of Chest Films for Pneumoconiosis. Archives of Environmental Health, 29:334-337, 1974.

Ortmeyer, C.E., J. Costello, W.K.C. Morgan, S. Swecker and M. Peterson: The Mortality of Appalachian Coal Mines, 1963-1971. Archives of Environmental Health, 29:67, 1974.

Reger, R.B., M.R. Petersen and W.K.C. Morgan: Variation in the Interpretation of Radiographic Change in Pulmonary Disease. Lancet, 1:111, 1974.

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