

Respiratory Health Services Reported by U.S. Mining Facilities in the National Occupational Health Survey of Mining (1984-1989)

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This report describes the involvement of mine management personnel at U.S. mines in providing environmental and medical services related to respiratory health. The data were obtained by means of a questionnaire that was administered to mine management personnel at 491 mines and mills during May 1984 to August 1989. The data indicate that 62% of U.S. miners worked at facilities that provided at least a portion of workers with chest X-rays, and 41% worked at facilities that provided at least a portion of workers with pulmonary function tests. Eighty-five percent of miners worked at facilities in which the company required a medical examination of all new employees; the majority were required by company policy to have a medical examination before returning to work after an illness. However, only 2% of miners were required by company policy to have an exit medical examination when their employment ended. This report underscores the need for respiratory health to remain a primary concern of all persons who provide occupational health services to miners.

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INTRODUCTION

This report provides practicing occupational health physicians and others in the occupational health community with an overview of certain industrial hygiene and respiratory medical services provided by mine management personnel in the United States. These health services involve monitoring the respiratory health risk and status of miners resulting from employment in the mining industry. This report summarizes selected data collected from mine management personnel responses to a face-to-face health ques-

tionnaire at 491 mines and mills from May 1984 to August 1989. The National Institute for Occupational Safety and Health (NIOSH) of the Centers for Disease Control and Prevention, U.S. Public Health Service, developed the questionnaire as a part of an occupational health study of the mining industry in response to the U.S. Federal Mine Safety and Health Amendments Act of 1977, Public Law 91-173: Sec.101(a)(6)(B), entitled the National Occupational Health Survey of Mining (NOHSM).

During 1986 in the publication, *Proposed National Strategies for the Prevention of Leading Work-Related Diseases and Injuries*, NIOSH and the Association of Schools of Public Health stated that occupational lung disease is the leading form of work-related illness and injury [ASPH, 1986]. This statement is based on the prevalence of occupational lung diseases, the severity of the disease in affected individuals, and the amenability of the problem to prevention. This document pointed out that occupational lung disease is preventable and that personal habits such as cigarette smoking contribute to and even potentiate the problem [ASPH, 1986].

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A first step in prevention is surveillance. One of the purposes of the NOHSM surveillance project was to develop information on the policies of U.S. mine management personnel toward prevention of disease. Occupational lung disease in the mining industry has been well documented [NIOSH, 1986; Rom, 1994, Attfield et al., 1984]; however, surveillance is needed to identify specific occupations that have an elevated risk of developing lung disease. Therefore, the provision of health services for prevention of lung disease by mine management is of interest to NIOSH and other occupational health professionals.

METHODS

Statistical Sampling Procedure

The NOHSM was a health survey of miners. Since miners working in different mineral commodities may have different environmental exposures, the NOHSM selected workers, and therefore mines and mills, across all commodities per Standard Industrial Classification (SIC) codes used by MSHA. The mines surveyed were chosen by a statistic based systematic selection procedure designed by government contract [Katt et al., 1982]. The sampling procedure was designed so that information obtained from the survey on a portion of each mineral commodity (sample) could be projected to the entire mineral commodity. The sample included 59,536 workers employed at 491 mines and mills out of an estimated total of 272,000 workers employed at 2,131 mines and mills.

The mines and mills selected for the NOHSM were selected from a listing obtained from the Mine Safety and Health Administration (MSHA). Each year several commodities, such as lead/zinc, asbestos, uranium, and bituminous coal, were selected to be surveyed based on the employment records for each commodity supplied by MSHA. A base employment year of 1980 was used to determine operating rates for each commodity. Commodities with the highest employment rates were selected to be surveyed first, with the hope that commodities with a depressed business climate would have an opportunity to rebound before being selected to participate in this survey. Only mines whose MSHA records indicated their being active operating units were chosen. The annual average number of employees (disregarding contractor or office personnel) at each facility was used as the measure of employment. Mines that made up a large portion of the workers involved in a commodity were selected automatically. These mines were not used to project the results of the survey to the entire commodity or the mineral industry. Other mines that were not selected automatically, named non-self-representing units (NSRU's) or the probability sample, were weighted to represent a portion of the entire stratum. In this manner, the survey results were projected to the entire mineral commodity

based on worksite populations at the time of the surveys using a statistical algorithm. The survey site selection, along with the data projection strategy for this study, have been reported previously [Katt et al., 1982; Groce et al., 1986].

Personnel

The questionnaire was administered by 10 college-educated and NIOSH-trained personnel in a face-to-face interview with a knowledgeable representative of mine management at each of 491 mines and mills visited during May 1984 through August 1989. Care was taken during in-house training to ensure that each NIOSH surveyor completely understood each question and the method of recording answers to ensure that the questionnaire data were collected in a uniform manner. During the interview, NIOSH interviewers administered the questionnaire, clarifying each question as they proceeded, thereby ensuring that every question was understood and answered. The surveyors did not leave the facility until all of the data were collected. After each site survey was completed, NIOSH processed the questionnaire responses, and a copy of the coded results was sent to each firm with a request that management review the answers and check for errors.

National Occupational Exposure Survey

Results obtained from the National Occupational Exposure Survey (NOES), which was a similar survey of general industry conducted by the Division of Surveillance, Hazard Evaluations and Field Studies of NIOSH from 1981 to 1983, were used for comparison where available [Pederson and Sieber, 1988]. When comparing NOHSM and NOES results, one must keep in mind that there are some fundamental differences between the two, such as the average number of employees at each site. Also, the number of workers in any given mining commodity is much lower than the number of workers in general industry.

RESULTS

The selected NOHSM questionnaire results are presented as the percentage of estimated workers who worked at a facility with the given attribute. First, questionnaire responses concerning general medical services provided by mines will be examined. Second, responses concerning the provision of periodic chest X-rays and pulmonary function examinations will be discussed. Finally, the data regarding industrial hygiene services (such as workplace monitoring and personal protective health devices) will be examined. Where a federal regulation required companies in certain commodities to provide specific services, such as chest

X-rays at underground coal mines, NIOSH automatically indicated that the service was provided without asking the question of mine management personnel. These federal requirements are noted in the text for appropriate questions. Other than these exceptions, the term *requirement* relates only to company requirements.

Based on the questionnaire data provided by mine management personnel, the NOHSM estimated, during the period of the surveys, that the mining industry employed approximately 272,000 workers. Of these, the bituminous coal industry employed approximately 133,000. The remainder were divided among several other categories of mines: anthracite coal (2,300), sand and gravel (17,000), stone (58,000), metallic (30,000), and nonmetallic (32,000). These estimates include all production, maintenance, and administrative employees and exclude contractor and office personnel.

General Medical Services

Question 1: *Do you have on your payroll one or more on-site physicians to give your employees medical care?*

The results of this question show that an estimated 97% of miners in the United States worked at mines that did not have an on-site physician. One percent of the miners worked at mines that had a full-time on-site physician, and 2% worked at a mine that had a part-time on-site physician. The NIOSH general industry study, NOES [Pederson and Sieber, 1988], found that 14% of workers in general industry worked at a facility that had a full-time on-site physician and another 11% worked at a facility that had a part-time on-site physician.

Question 2: *Does this facility have one or more nurses on the payroll to provide care for employees?*

The data revealed that 10% of miners worked at a facility that had a nurse on the payroll to provide care for employees. NOES [Pederson and Sieber, 1988] found that 37% of workers in general industry worked at a facility that employed one or more nurses.

Question 3: *Do you require medical examinations of your employees who return to work after an illness?*

The data showed that 50% of U.S. miners, as compared with 45.5% of workers in general industry [Pederson and Sieber, 1988], worked at facilities requiring *all* employees to have a medical examination to return to work after an illness. An additional 31% of miners, as compared with

18.4% of workers in general industry (Pederson and Sieber, 1988), worked at facilities that required *some* of their employees to have a medical examination before returning to work after an illness.

Respiratory Medical Examinations

Question 4: *Do you provide chest X-rays or pulmonary function tests to all or to selected groups of employees on a periodic basis?*

The NOHSM survey sample selection procedure did not distinguish between underground and surface bituminous coal mines and mills. Since underground coal mines are required by law to provide chest X-rays [Code of Federal Regulations, 1989], NIOSH recorded a positive answer for all *underground* coal mines without asking if chest X-rays were provided. Table I includes both underground and *surface* bituminous coal mines. Surface bituminous coal mines are not required by law to provide chest X-rays. Interestingly, 52% and 40% of workers in the metallic minerals and nonmetallic minerals industries, respectively, were at a facility that provided chest X-rays for *all* employees as compared with the bituminous coal industry, in which only 10% of miners were at a facility that provided chest X-rays for *all* employees.

Approximately 42% of workers in the mining industry were employed at mines that provided pulmonary function tests to at least *some* of their employees. The metallic minerals industry provided a greater percentage of workers with periodic pulmonary function tests than other mineral industries. Forty-eight percent (48%) of workers in the metallic minerals industry were at a facility that provided pulmonary function tests to *all* employees; another 27% worked at a facility that provided at least *some* of their employees with pulmonary function tests. In contrast, only 9% of workers in the sand and gravel industry were estimated to be at a facility that provided *all* employees with periodic pulmonary function tests. Table I summarizes the results of X-ray provision, and Table II summarizes the results of pulmonary function testing availability.

Industrial Hygiene Services

Question 5: *Do you employ full-time individuals at this facility whose major responsibilities are in the area of prevention of illnesses?*

For the purposes of this question, a full-time individual in the area of illness prevention must have been spending at least 50% of their time at the facility performing applicable duties to be counted. Physicians and nurses were not included in this question. The intent of this question was to

identify employment of persons who are trained in identifying and evaluating environmental conditions and not those involved in direct medical care. This includes such occupational titles as industrial hygienist, industrial health engineer, environmental health engineer, and occupational safety and health engineer, to name a few possibilities. These were classified by the surveyor as either certified or not certified industrial hygienists. A certified industrial hygienist is an individual who has passed the certification examination of the American Board of Industrial Hygiene. The *certified industrial hygienist* designation does not include those certified by MSHA as certified dust samplers.

As shown in Table III, NOHSM estimated that 14% (38,000 workers) of the mining industry were employed at facilities with full-time individuals responsible for the prevention of illness, but who were not certified industrial hygienists. Only 1% of workers in the mining industry worked at facilities in which a full-time certified industrial hygienist was employed. Therefore, approximately 15% of workers in the mining industry were employed at a mine that had a full-time individual responsible for the prevention of illness. The mineral industry with the greatest percentage of workers (37%) at facilities employing individuals responsible for the prevention of illness was the metallic minerals industry. The NOES data indicate that 17% of workers in general industry work at a facility that employs a full-time individual who spends 50% or more of his or her time in the area of illness prevention.

Question 6: *Has your facility received industrial hygiene services on a consulting basis during the past 12 months?*

If a facility had received industrial hygiene services from the company corporate office, then the appropriate answer was "yes, from non-government sources." Inspections carried out routinely by MSHA or other government agencies did *not* qualify as "yes, from government sources." The only time a yes answer from government sources was appropriate was when the firm had made a special request to a government source for industrial hygiene support. Table IV summarizes the results of this question. Twenty-nine percent of the workers in the mining industry were at facilities that had requested industrial hygiene support from a consultant during the previous 12 months. Approximately 106,000 workers (80%) of the largest commodity, bituminous coal, worked at facilities that had not received industrial hygiene services on a consulting basis during the previous 12 months. The metallic minerals industry had the greatest percentage (63%) of workers at a facility that used consultants for industrial hygiene services. Twelve percent of those in the sand-and-gravel industry were at a facility that used the government for industrial

hygiene services, while this was true for only 3% of the entire mining industry.

Environmental Monitoring Programs

Question 7: *Do you have a program under which you regularly or periodically monitor the health-related presence of fumes, gases, mists, dusts, or vapors?*

The answers were recorded as either "yes" or "no" for each type of agent. The results are reported here as the percentage of workers who worked at a facility that had a program for that particular agent. This study excluded from consideration monitoring done by a government entity such as MSHA. Only monitoring done by the mine was recorded as a "yes." Monitoring done for reasons other than health, such as comparison with the explosive limits of methane, was excluded. Table V shows that dust monitoring received more attention than fumes, gases, mists, and vapors. For the mining industry as a whole, 65% of workers were at a mine that monitored periodically or regularly for dust. Coal mine operators are required by law to monitor for dust [Code of Federal Regulations, 1989]. Approximately 49% of non-coal mine workers were at a facility that monitored periodically or regularly for dust.

The percentage of miners who worked at facilities that did not monitor the health-related presence of any of the agents—fumes, gases, mists, dusts, or vapors—was estimated to be 23%. The data indicated that less than 1% of miners were at facilities that did not monitor for any of these agents but had an on-site physician to give care to their employees. Similarly, less than 1% of the miners worked at facilities that did not monitor for any of these agents but had a nurse on site to give care to their employees. Approximately 0.4% worked at facilities that did not monitor for any of these agents but did employ an industrial hygienist. Also, 2.5% of miners were employed at facilities that did not monitor for any of these agents but did use industrial hygiene services on a consulting basis during the previous 12 months.

Personal Protective Health Devices

Question 8: *Are there areas in this facility in which personal protective health devices or equipment are required or recommended?*

It is important to realize that this question asked specifically about personal protective *health* devices, such as respiratory and hearing protection. Safety equipment, such as hard hats, safety glasses, and steel-tip boots, were not considered. As shown in Table VI, an estimated 95% of

U.S. miners worked either at a facility that required or recommended, or both required and recommended, the use of personal protective health devices.

The data also showed that 1.6% of U.S. miners worked at facilities that did not either require or recommend the use of personal protective health devices and did not monitor the health-related presence of any of the following: fumes, gases, mists, dusts, or vapors. Also 4.3% of miners were at facilities that neither required nor recommended the use of personal protective health devices and did not employ an industrial hygienist.

Availability Of Respirators

Data on the types of respirators available for use were collected during the work-site walk-through and were projected to the entire mining industry. In order to be counted, the respirator had to be available in the immediate working area. This was determined by observation and through questioning the workers. These data show that approximately 2% of *all* miners had a chemical cartridge full-face respirator available, 19% had a particulate filter half-face respirator available, and 31% had a particulate filter quarter-face respirator available. These percentages are not mutually exclusive; a miner may have used a half-face particulate filter part of the time and used a quarter-face particulate filter part of the time. For all other types of respirators, less than 1% of *all* miners are estimated as having access to any particular type. This means that quarter-face particulate filters and half-face particulate filters were the most commonly available respirators in the mining industry. A half-face respirator covers the wearer's nose and mouth and fits under the chin, while a quarter-face respirator covers only the nose and mouth and rests against the chin. The quarter-face particulate respirator designation includes single-use paper dust masks.

DISCUSSION

The NOHSM data show that during 1984–1989, only 3% of U.S. miners were at facilities that employed an on-site physician at least part time, and only 10% were at facilities that employed a nurse to provide care for employees. However, the data show that 50% of U.S. miners were at facilities requiring *all* employees to have medical examinations when returning to work after an illness. In addition, another 31% were at facilities requiring *some* employees to have medical examinations when returning to work after an illness. This study also found that 85% of miners, as compared with 49.9% of workers in general industry [Pederson and Sieber, 1988], worked at facilities that required a medical examination of all new employees. Therefore, these preplacement and post-illness examinations may be one of the few opportunities for some miners to be informed about

respiratory health concerns or other health hazards specific to the mining process. Physicians have a valuable opportunity during these examinations to encourage workers to be cognizant of health hazards associated with mining. The NOHSM also found that 98% of miners worked at facilities that did not require a medical examination when their employment ended.

Some of the data indicate the extremes of health programs within the mining industry. Approximately 75% of the workers within the metallic mining industry are estimated as working at facilities that provide pulmonary function tests to *some* employees; only an estimated 9% of the employees within the sand and gravel industry have such an employer. Within the metallic minerals industry, an estimated 37% of the miners have an employer who employs an industrial hygienist; only an estimated 3% of the stone miners, and none of the sand and gravel workers, worked for someone who employed an industrial hygienist.

Similar extremes are apparent when the air monitoring data of Table V are examined. Within the metallic mining industry, an estimated 84% of the workers have an employer who regularly or periodically monitors dust levels; within the stone mining industry, that estimated percentage is reduced to 29%; the estimated percentage for sand and gravel operations is lower, 21%. On the other hand, a relatively small percentage of coal miners is estimated as being covered by a periodic vapor sampling program: 0% was estimated for anthracite coal, and 5% was estimated for bituminous coal. Even if one takes gas sampling (for health purposes) into account, the percentages are substantially lower than for dust: an estimated 4% of the anthracite miners are covered by a health-related gas sampling program, and an estimated 36% of the bituminous coal miners are similarly covered.

NIOSH recently bolstered its efforts to inform those associated with the mining industry of its concern regarding one of the greatest threats to respiratory health—silicosis—in a NIOSH Alert titled, “Request for Assistance in Preventing Silicosis and Deaths in Rock Drillers” [NIOSH, 1992]. Since 1974 NIOSH has urged the use of medical surveillance for workers exposed to crystalline silica [NIOSH, 1974]. NIOSH recommends that all workers who may be exposed to crystalline silica have medical and occupational histories recorded accompanied by pulmonary function testing (spirometry) and chest X-rays classified according to the 1980 International Labour Office (ILO) Classification of Radiographs of Pneumoconioses [NIOSH, 1992; International Labour Office, 1980]. Also, an annual evaluation for tuberculosis is recommended [NIOSH, 1974; American Thoracic Society, 1986]. All diagnosed or suspected cases of occupational lung disease are to be reported to the appropriate state health department.

In a recent survey [Burstein and Levy 1994], to which 115 of the 127 medical schools in the United States re-

sponded, it was found that 68% of the responding schools specifically taught occupational health. Of these, 78% taught about occupational respiratory disorders. Therefore, approximately only 53% of the medical schools that responded to the survey specifically teach about occupational respiratory disease. This survey also found that only four of the responding schools taught occupational health during a physical diagnosis course. Therefore, the importance of those who provide occupational respiratory health services cannot be overstated. Respiratory health should remain a primary concern of all persons who provide health services to miners.

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APPENDIX

TABLE I. Percent of Workers at Mining Facilities Providing Chest X-Rays (1984-1989)

Worker group	Estimated number of workers ^a	None	Yes, all	Yes, all executive/management only	Yes, all production workers only	Yes, selected workers only
Anthracite	2,300	67%	0%	0%	20%	13%
Bituminous	133,000	18%	10%	9%	54%	9%
Metallic	30,000	24%	52%	2%	0%	22%
Nonmetallic	32,000	33%	40%	7%	2%	18%
Sand & gravel	17,000	93%	4%	0%	0%	3%
Stone	58,000	76%	11%	0%	2%	11%
All mining	272,000	38%	18%	5%	27%	12%
NOES	33,275,000	66%	12%	1%	<1%	21%

^aSee Methods.

TABLE II. Percent of Workers at Mining Facilities Providing Pulmonary Function Tests (1984–1989)

Worker group	Estimated number of workers ^a	None	Yes, all	Yes, all executive/management only	Yes, all production workers only	Yes, selected workers only
Anthracite	2,300	83%	0%	0%	4%	13%
Bituminous	133,000	59%	7%	16%	0%	18%
Metallic	30,000	25%	48%	2%	0%	25%
Nonmetallic	32,000	43%	34%	2%	1%	20%
Sand & gravel	17,000	91%	9%	0%	0%	0%
Stone	58,000	78%	15%	0%	0%	7%
All mining	272,000	58%	16%	9%	1%	16%
NOES	33,275,000	66%	12%	1%	1%	20%

^aSee Methods.**TABLE III.** Percent of Workers at Mining Facilities Employing Industrial Hygienists (1984–1989)

Worker group	Estimated number of workers	Yes, but no CIH ^a	Yes, a CIH ^a	Yes, both a CIH ^a and non-CIH	No industrial hygienist
Anthracite	2,300	0%	0%	0%	100%
Bituminous	133,000	16%	0%	0%	84%
Metallic	30,000	31%	3%	3%	63%
Nonmetallic	32,000	17%	1%	0%	82%
Sand & gravel	17,000	0%	0%	0%	100%
Stone	58,000	3%	0%	0%	97%
All mining	272,000	14%	<.5%	<.5%	85%

^aCertified Industrial Hygienist.**TABLE IV.** Percent of Workers at Mining Facilities Receiving Industrial Hygiene Services by Consultant (1984–1989)

Worker group	Estimated number of workers	Yes, by govt. source	Yes, by non-govt. source	Yes, by govt. and non-govt. source	No industrial hygiene consulting
Anthracite	2,300	4%	21%	0%	75%
Bituminous	133,000	0%	14%	6%	80%
Metallic	30,000	5%	50%	8%	37%
Nonmetallic	32,000	4%	35%	11%	50%
Sand & gravel	17,000	12%	10%	0%	78%
Stone	58,000	5%	17%	3%	75%
All mining	272,000	3%	21%	5%	71%
NOES	33,275,000	3%	14%	0%	83%

TABLE V. Air Monitoring—Percent of Workers at Mining Facilities Answering Yes for a Particular Agent (1984–1989)

Worker group	Estimated number of workers	Fumes	Gases	Mists	Dust	Vapors
Anthracite	2,300	0%	4%	0%	70%	0%
Bituminous	133,000	0%	36%	4%	82%	5%
Metallic	30,000	79%	84%	53%	84%	71%
Nonmetallic	32,000	34%	54%	15%	68%	29%
Sand & gravel	17,000	4%	4%	4%	21%	4%
Stone	58,000	7%	11%	2%	29%	2%
All mining	272,000	14%	36%	10%	65%	15%

TABLE VI. Percent of Workers at Mining Facilities that Either Required and/or Recommended Personal Protective Health Devices* (1984–1989)

Worker group	Estimated number of workers	Yes, required	Yes, recommended	Yes, both required and recommended	No
Anthracite	2,300	20%	27%	50%	3%
Bituminous	133,000	5%	15%	75%	5%
Metallic	30,000	17%	<.5%	82%	<.5%
Nonmetallic	32,000	25%	13%	60%	2%
Sand & gravel	17,000	29%	12%	40%	19%
Stone	58,000	19%	11%	69%	1%
All mining	272,000	13%	12%	70%	5%

*Includes respiratory and hearing protection. Excludes safety devices, for example goggles, shoes, hats.