

Survey of respirator use in the U.S. mining industry

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Abstract

The need for improved respirator programs and a lack of information about respirator use led the National Institute for Occupational Safety and Health (NIOSH) and the Bureau of Labor Statistics (BLS) to conduct a survey of the respirator use and practices of U.S. industrial employers in 2001-2002. The survey revealed that the "mining" industry (including the "oil and gas extraction" industry) had the second highest percentage of establishments (12%) and the highest percentage of employees (10%) that were required to use respirators (required either by the employers or by federal regulation). The respirator use and practices reported by mining establishments often fall short of American National Standards Institute Inc. (ANSI) and NIOSH recommendations for respiratory protection (ANSI, 1969; NIOSH, 1987, 2005). Mining respirator-using establishments generally had a lower percent of occurrence of indicators of potentially inadequate respiratory protection programs than all private-sector respirator-using establishments. The notable exception is the relatively higher percentage (40.0%) of mining establishments using airline respirators that have couplings that are compatible with other air or gas supply lines or didn't know if the couplings were compatible with other air or gas supply lines, as compared to all private-sector establishments (23.7%); this should prompt all mining establishments using airline respirators to carefully examine their airline respiratory protection because even one misuse of this equipment can result in a fatality. The most common indicators of potentially inadequate respiratory protection programs within the mining industry, based on this data, are those reflecting a lack of written respirator program elements.

Background and methods

Respirators are an important element in many occupational health and safety programs. The National Institute for Occupational Safety and Health (NIOSH) recommends that respirators be used while other controls are being implemented or when other controls are not feasible (NIOSH, 2005). Until adequate engineering controls are available and widely implemented, the rate and effectiveness of respirator use and respirator programs need to be improved to help prevent death and disease.

In 1999 NIOSH reviewed existing data regarding respirator use in private sector U.S. business establishments. NIOSH found that previous surveys of respirator use within the private sector of U.S. business establishments (NIOSH, 1978, 1988, 1996; NCHS, 1994; Eastern Research Group, 1999) were either outdated or limited in scope. For this reason, many fundamental questions about respirator use in the United States remained unanswered. A number of issues, such as how many employers use each of the respirator fit-test methods and the characteristics of respiratory protection programs provided by employers, had not been systematically investigated. This type

of information is critical to ensuring that respirator programs adequately protect U.S. workers (Doney et al., 2005).

The need for improved respirator programs and the lack of information about respirator use led NIOSH and the Bureau of Labor Statistics (BLS) to conduct a survey of respirator use and practices of U.S. industrial employers in 2001-2002. NIOSH investigators provided BLS with direction on technical subjects such as regulations associated with respirator use and respirator types and uses. In addition, NIOSH investigators provided BLS with an initial set of questions for the survey (BLS/NIOSH, 2003a).

BLS pretested the draft questionnaire to gauge its content as well as semantic and linguistic features and obtain respondent reaction. Twelve cognitive interviews were conducted at eleven establishments during two rounds of pretesting (Fisher et al., 2001). After modification, the questionnaire was field-tested at 120 establishments to obtain additional data on the cognitive, linguistic and measurement issues regarding the collection of respirator use data (DeMaio and Rothgeb, 1996). The results of the field-testing were discussed

with the BLS Business Research Advisory Committee and the Labor Research Advisory Committee to produce a final survey questionnaire, which is included in the BLS/NIOSH report (BLS/NIOSH, 2003a).

In August 2001 a questionnaire and cover letter were mailed to 40,002 establishments (including between 2,250 and 2,500 mining establishments) selected from a sampling frame of 174,305 private-sector establishments that were used in the 1999 BLS Survey of Occupational Injuries and Illnesses (BLS, 1999). For the purposes of this paper, "all private industries" includes the "mining" industry and the term "all mining" includes the "oil and gas extraction" industry. "Coal mining," "metal mining" and "mining and quarrying of nonmetallic minerals, except fuels" "establishments" as used in the survey are analogous to "mine operators" as used by the Mine Safety and Health Administration (MSHA).

The cover letter and questionnaire both directed the person best informed about respirator use at the establishment to complete the questionnaire. Another copy of the cover letter and survey questionnaire were sent in October 2001 to establishments that had not responded to the initial mailing. Telephone callbacks to remaining nonrespondents were conducted from December 2001 through February 2002. The survey response rate was 75.5% overall and 61% for "metal mining," 44% for "coal mining," 84% for "oil and gas extraction," 64% for "mining and quarrying of nonmetallic minerals, except fuels" and 61.0% for the entire "mining" industry.

The results of the survey are national estimates based on the survey weighting and a selected probability sample, rather than a census of all establishments. Most of the questions asked the establishment's respirator program director/overseer about the types of respirators used and the manner in which they were required to be used (required either by the employers or by federal regulation) in the 12 months prior to completing the survey questionnaire. NIOSH and BLS analyzed the survey data by industry division, two-digit Standard Industrial Classification (SIC) level within each industry division (Office of Management and Budget, 1987) and establishment employment size group (BLS/NIOSH, 2003a). The survey did not distinguish underground from surface mine establishments; nor did it distinguish various mining occupations. Thus, findings are not analyzed by those factors.

The findings reflect efforts by the BLS to adjust for non-response bias, anomalous responses and data that reflect respondent error and inconsistency; those efforts are described in the BLS/NIOSH report (BLS/NIOSH, 2003b). In addition, standard errors have been calculated for each estimated result published in the BLS/NIOSH report. The complete survey description and survey results were published in printed and electronic formats and may be obtained in electronic form at <http://www.cdc.gov/niosh/docs/respsurv/> or in hard copy or compact disc by calling 1-800-35NIOSH.

Respirator use — as required by MSHA

MSHA regulations at 30 CFR 70.100(a) and 71.100 require, among other things, that operators at coal mines maintain the average concentration of respirable dust in the active workings of each coal mine at or below the applicable limit. Regulations at 30 CFR 70.300 provide that approved respiratory protection must be made available to all affected underground miners (though it is not required to be worn).

According to MSHA regulations at 30 CFR 56/57.5001(a), a metal/nonmetal miner's exposure shall not exceed the threshold limit values (TLVs[®]) adopted by the American Conference of Governmental Industrial Hygienists (ACGIH[®], 1973). When a

TLV[®] is exceeded, MSHA's regulations at 30 CFR 56/57.5005 require that metal/nonmetal mine operators install all feasible engineering and administrative controls to reduce the miner's exposure level to the respective TLV[®]. Respiratory protection must be used to supplement controls when controls are not feasible, when establishing controls, and during occasional entry into hazardous atmospheres to perform maintenance or investigations. When respirators are required, mine operators must establish a respiratory protection program consistent with the requirements of the American National Standards Institute, Inc. — ANSI Z88.2-1969. Some of these requirements are that mine operators must:

- provide a respiratory protection program with standard operating procedures governing the selection, fit testing and use of respirators;
- select respirators based on the hazards to which the worker is exposed;
- provide procedures for cleaning and maintaining respirators;
- provide effective training to employees who are required to use respirators so they understand the need, use, limitations, and capabilities of the respirators they wear; and
- provide fit testing for each tight-fitting negative-pressure respirator wearer.

Respirator use — as required by OSHA

The Occupational Safety and Health Administration (OSHA) enforces respirator use within the "oil and gas extraction" industry, with the exceptions of oil sand and oil shale mining, which are covered by MSHA. The "oil and gas extraction" industry is classified under the mining industry by the BLS (Table 1). OSHA respiratory protection regulations at 29 CFR 1910.134 require that each establishment:

- develop and implement a written respiratory protection program with worksite specific procedures and elements for required respirator use;
- designate a single program administrator who is qualified by appropriate training or experience to administer the respiratory protection program;
- evaluate the respiratory protection program's effectiveness;
- use a method of respirator selection that includes identification and evaluation of airborne hazards in the workplace;
- provide a written procedure for maintaining respirators;
- provide a written procedure for evaluating the effectiveness of respirator use;
- provide effective training to employees who are required to use respirators so they understand the need, use, limitations and capabilities of the respirators they wear;
- provide a medical evaluation to determine the employee's fitness to use a respirator in the conditions for which they are required, before the employee is fit tested or required to use the respirator in the workplace.
- provide for fit testing of tight-fitting positive- and negative-pressure respirator wearers;
- ensure that airline respirator hose couplings are incompatible with other gas line couplings in their workplace; and
- implement a change schedule that will ensure that cartridges and canisters are changed before the end of their service life (if there is no end-of-service-life indicator appropriate for conditions in their workplace).

Table 1 — National estimates of the number and percent of mining establishments requiring respirator use in the past 12 months.

Industry	Establishments ² requiring respirators		Employees required ³ to use respirators	
	Number	Percent	Number	Percent
Metal mining (SIC 10)	127	39.2	9,584	24.6
Mining and quarrying of nonmetallic minerals, except fuels (SIC 14)	2,170	20.0	19,506	15.1
Coal mining (SIC 12)	186	8.1	6,107	7.4
Oil and gas extraction (SIC 13) ¹	1,009	6.1	18,787	6.4
All mining (includes oil and gas extraction)	3,493	11.7	53,984	9.9
All private industries (includes mining)	281,776	4.5	3,303,414	3.1

¹In the "oil and gas extraction" industry, MSHA regulates respirator use and other health and safety issues pertaining only to the oil sand and oil shale mining industries (SIC 131). OSHA regulates respirator use for all other industries pertaining to the "oil and gas extraction" industry.

²For the mining industries "establishments" as used by BLS are analogous to "mine operators" as used by MSHA.

³Required respirator use means required either by the employers or by federal regulation.

Findings

The overall establishment estimate for required respirator use (3,493 mining establishments or 11.7% of all mining establishments) has a 95% confidence interval (CI) of ± 45 establishments (Table 1). The overall estimate of the number of mining employees required to use respirators (53,984 mining employees or 9.9% of all mining employees) has a 95% CI of $\pm 1,455$ employees. Among all major industry divisions classified by the BLS, the "mining" industry had the second highest percentage of establishments and highest percentage of employees with required respirator use (BLS/NIOSH, 2003a).

Among all two-digit SICs, the "metal mining" industry had the highest percentage (39.2%) of required respirator use by establishments (BLS/NIOSH, 2003a). The nonmetallic minerals industry (the BLS designation is "mining and quarrying of nonmetallic minerals, except fuels") had the highest number of mining establishments (2,170) and employees (19,506) with required respirator use (Table 1).

The "metal mining" industry had the highest percentage (16.7%) of air-supplied respirator use by establishments. "Oil and gas extraction" had 2.3%, "coal mining" had 1.5%, and "nonmetallic minerals, except fuels" had 1.1% of air-supplied respirator use by establishments. The "metal mining" industry also had the highest percentage (39.2%) of air-purifying respirator use by establishments. "Nonmetallic minerals, except fuels" had 19.7%, "coal mining" had 7.5%, and "oil and gas extraction" had 6.1% of air-supplied respirator use by establishments (BLS/NIOSH, 2003a).

As indicated in Table 2, respirator use and practices reported by mining establishments often fall short of ANSI and NIOSH recommendations for respiratory protection (ANSI, 1969; NIOSH, 1987, 2005). Mining respirator-using establishments usually had a lower percent of occurrence of indicators of potentially inadequate respiratory protection programs than all private-sector respirator-using establishments (Table 2). The notable exception is the relatively higher percentage (40.0%)

of mining establishments using airline respirators that have couplings that are compatible with other air or gas supply lines or didn't know if the couplings were compatible with other air or gas supply lines, as compared to all private-sector establishments (23.7%). The estimate for the number of mining establishments using airline respirators that have couplings that are compatible with other air or gas supply lines (219 mining establishments) has a 95% CI of ± 73 establishments (Table 1). The most common indicator of potentially inadequate respiratory protection programs within the mining industry, based on this data, is a lack of written respirator program elements.

Discussion

Written procedures and staff training are important for maintaining the quality of respirator programs. Properly written documentation helps assure continuity in decision making for all aspects of a respiratory protection program. Periodic evaluation of respirator use in the establishment helps ensure that the written respiratory protection program is being properly implemented and the employees properly use respirators.

Medical assessment of employees who may be required to use respirators is important because of the potential for added physiological and psychological burden on employees, which varies with the type of respirator worn, the job, the workplace conditions in which the respirator is used and the medical status of the employee (Harber, 1984; Hodous, 1986; Pappas et al., 1999).

It is important to select a respirator based on the hazards to which the worker is exposed. NIOSH recommends that the evaluation of hazards include air sampling either at the work site or at a similar work site (NIOSH, 1987; 2005).

From 1984 through 1995, 15 deaths related to airline coupling compatibility between respirators and nonbreathable air supplies were identified in nonmining industries (Suruda, 2003). These fatalities could have been prevented with proper training and compliance with existing recommendations and

Table 2 — Percent of respirator-using establishments with indicators of a potentially inadequate respiratory protection program by industry.

Indicator ³	Percent ¹ of occurrences among respirator-using establishments ² (lower is better)	
	All mining (includes oil and gas extraction)	All private industries (includes mining)
No written change-out schedule for establishments with the use of air-purifying gas/vapor filters	80.8	78.1
Improper method of setting air pressure to control airflow on airline respirators, or don't know which method is used	61.0	77.2
No written procedures to periodically evaluate the effectiveness of respirator use, or don't know if such procedures exist	54.3	64.3
No written program for deciding how respirators are used	51.3	65.5
Airline respirator hose couplings are compatible with couplings for other air or gas supply lines, or don't know about compatibility	40.0	23.7
No written procedures and schedule for maintaining respirators, or don't know if such procedures exist	38.8	49.0
No assessment of the medical fitness of respirator-wearing employees, or don't know if assessment is done	34.9	51.2
No fit testing for each tight-fitting respirator wearer, or don't know if fit testing is done	28.0	43.3
No training for employees regarding respirator use and limitations	18.6	41.4
No specific respirator training for program administrator	17.1	41.9
Use of dust masks (disposable) to protect against gases or vapors	9.9	25.3

¹ Percentages are calculated by dividing the number of establishments with the given indicator by the number of establishments estimated to use the applicable types of respirators. Some indicators do not apply to all types of respirators.

² For the mining industries "establishments" as used by BLS are analogous to "mine operators" as used by MSHA.

³ Indicators are based on ANSI and/or NIOSH recommendations.

regulations for coupling incompatibility for airline respirators (ANSI, 1969; 29 CFR 1910.134). The relatively high percentage of mining establishments that have air line respirator couplings that are compatible with other air or gas supply lines should prompt those mining establishments to carefully examine their airline respiratory protection, because even one misuse of this equipment can result in a fatality. If air line respirator couplings are found to be compatible with couplings for any nonrespirable worksite air or gas, prompt action should be taken to modify the equipment to preclude inadvertent and potential fatal connections (MSHA, 2004; OSHA, 2004).

In addition to publications that can be used as guides by mining establishments to improve their respirator programs (ANSI, 1969; NIOSH, 1989a, 1989b), other sources can be contacted for respiratory protection consultation. When a respiratory protection program is required, a representative from the MSHA district office is available to assist the mine operator. The NIOSH National Personal Protective Technology Laboratory investigates reported problems with NIOSH-certified respirators in mine establishments and other workplaces and responds to information requests made by telephone (412-386-4000) or by e-mail (pitnpptlinternet@cdc.gov). Private consultants can also provide suggestions for program improvement.

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

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