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RESPIRATOR USE AMONG WESTERN PENNSYLVANIA SURFACE MINERS. S. Franco, J. Cocalis, NIOSH, Morgantown, WV; E. Mauger, Hershey Medical Center, Hershey, PA; K. Stricklin, MSHA, Hunker, PA

Respirator use among western Pennsylvania surface miners was evaluated as part of a silicosis screening survey. This survey was sponsored by a partnership between the Pennsylvania Chronic Respiratory Disease Program, the Mine Safety and Health Administration (MSHA), the National Institute for Occupational Safety and Health (NIOSH), and the Penn State College of Medicine. This report summarizes the results of that screening regarding the use of respirators.

Questionnaires were administered and completed by 664 surface miners that addressed work habits and respirator usage patterns. The majority of the workers were male, white of non-Hispanic origin, and employed. The mean age was 47 years (range of 22 to 87). A large percentage of workers were found to have radiographic evidence consistent with silicosis. Analysis of questionnaires suggested that improper use of respirators was common. A total of 507 (76.4%) of surface miners reported their companies provided dust respirators. More than half (55.1%) of all miners reported not using a respirator at all. Of the 294 workers who reported using a respirator, 40.8% (120) reported using it all or most of the time, and only 27.6% (81) reported being fit-tested and trained in using a respirator. Interfering facial hair was reported by 31% (91) of the minors.

As a result NIOSH and MSHA administered a silicosis prevention special emphasis program that targeted surface miners. The objective included respirator usage training, and healthy work habits education. Fitting, training, availability and proper usage are all necessary to effectively prevent silicosis among at-risk populations.

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PREDICTION OF RESPIRATOR CARTRIDGE SERVICE LIFE AGAINST ORGANIC VAPORS AT WORKPLACE CONCENTRATIONS. E.W. Johnson, L.A. Brey, 3M, St. Paul, MN

Prediction of respirator cartridge service lives against organic vapors is a subject of increasing interest to industrial hygienists. Considerable work has been reported in which parameters derived from breakthrough curve measurements are used in mathematical models for prediction of respirator cartridge service lives. Agreement between theory and experiment has been fairly good over the range of challenge concentrations for which data are available. Most of the available data on service lives of respirator cartridges against organic vapors has been obtained at challenge concentrations from about 500 to 1000 ppm. Very little service life data are available at the low concentrations commonly encountered in workplace air due to the very long times required for these experiments.

To check these predictions at low concentrations, breakthrough curves were determined for commercially available respirator cartridges at three organic vapor challenge concentrations — typically at 1× and 10× the TLV (to 50% breakthrough) and at 1000 ppm (to 100% breakthrough). MEK were among the compounds tested. Testing was done at a volumetric flow of 32 L/min per cartridge (equivalent to 64 L/min for a pair of cartridges) at 50% RH. A Bruel and Kjaer photoacoustic IR gas monitor was used to detect breakthrough.

The two highest concentration breakthrough curves for each compound were used to derive the parameters in the reaction kinetic (RK) equation necessary to generate the theoretical breakthrough curve for the lowest concentration breakthrough curve. Attention is drawn to situations where the model breaks down; in particular, highly volatile organics such as acetone that can migrate through the sorbent bed during storage.

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SURVIVAL AND GROWTH OF BACTERIA ON RESPIRATOR FILTERS. Z. Wang, T. Reponen, K. Willeke, S. Grinshpun, University of Cincinnati, Cincinnati, OH

All nine types of respirators certified under the 1995 National Institute for Occupational Safety and Health regulations for respirators can be used by health care workers for the prevention of *Mycobacterium tuberculosis* (MTB) transmission. The N95 half-mask particulate respirator is the most frequently used for this purpose. Questions have been raised regarding the possibility of MTB growth on respirators due to handling, storage, and reuse. This study was conducted to determine whether MTB may grow, and how long it may survive on a respirator filter.

Bacillus subtilis (BS), *Pseudomonas fluorescens* (PF), and *M. smegmatis* (MS) were selected as MTB simulant bacteria. Bacteria were aerosolized with a Collison nebulizer from three different suspensions: deionized water, human saliva, nutrient broth (tryptic soy broth for BS and PF, Middlebrook 7×10 for MS). Deionized water represented loading with bacteria only, human saliva represented loading during respirator wear, and nutrient broth represented the extreme situation with optimal nutrients. A preconditioned 37-mm filter was cut from a N95 respirator and was challenged 10 minutes with the aerosolized bacteria and nutrients in an aerosol exposure chamber. The airflow rate through the filter was 5 L/min during the loading cycle. This corresponds to a breathing rate of 85 L/min under heavy work load. Loaded filters were incubated at 85% relative humidity. The incubation temperature was 371C for BS and MS and 281C for PF. Analyses were conducted after 0, 1, 3, 6, 9, and 13 days of incubation. Before studying the survival, several elution methods were evaluated: vortexing, ultrasonicing, and mechanical shaking after submerging the exposed filter in a buffer solution. The total bacteria were counted with a hemocytometer while the viable count was analyzed by cultivating diluted bacterial suspensions on agar.

The data indicate that vortexing is the best elution method, with the highest total and culturable bacteria. It was, therefore, used in this study. None of these three test bacteria were able to grow on the N95 respirator material. However, BS could survive on filters over 13 days while MS survived for 1-3 days depending on the nutritional conditions. This indicates that used respirators may be a potential MTB transmission source if improperly stored and [illegible]

MATERIALS HANDLING DEVICES & OTHER BACK ERGONOMICS ISSUES

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SOME ERGONOMIC PRINCIPLES FOR MATERIALS HANDLING DEVICES. D.B. Chaffin, C. Woolley, J. Foulke, R. Rabourn, University of Michigan, Ann Arbor, MI; M. Nussbaum, Virginia Tech, Blacksburg, VA; C. Jimmerson, Ford Motor Co., Redford, MI

It is often the case in industry that moving materials requires a complex, ergonomics system perspective both to assure that workers are accommodated and protected, and that productivity and quality goals are achieved. This presentation attempts to use such a systems perspective to provide guidance on how different materials handling aids can be specified and used to reduce conflict inherent in these missions.

As an attempt to reduce manual lifting and carrying requirements inherent in different jo today, many companies have embarked on th purchase and use of a variety of material handling assist devices. These range from simple carts to sophisticated articulated balance arms. Ergonomic studies on the use of such devices have been conducted at the University of Michigan's Center for Ergonomics and elsewhere for the past few years. From these studies it is clear that these devices can reduce low back stress when careful attention is given to basic ergonomic principles. Under some circumstances, however, a particular device may increase the metabolic energy expenditure and time required to perform a materials handling task, and may have little or no beneficial biomechanical effect.

The presentation reviews several different published studies by the authors and others on this issue. It attempts to synthesize some of the major findings in a manner that provides a scientific basis for principles meant to assure ergonomic benefits result from the specification and use of different devices. The resulting principals are proposed to guide decisions about whether a materials handling device is needed (2) what type of device to use under specific conditions (e.g., container lifts, carts, hoists, or articulated balance arms, etc.), (3) what changes in the workplace may be needed to use a device effectively, and (4) what type of special worker training may be needed to use a specific device.

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ERGONOMIC AND SAFETY ASPECTS OF EQUIPMENT USED IN TRUCKING DELIVERY OPERATIONS: AN EVALUATION OF RAMPS AND HAND TRUCKS. W.M. Keyserling, K.A. Monroe, C.B. Wooiley, S. S. Ulin, University of Michigan, Ann Arbor, MI

Ramps and two-wheeled hand trucks are routinely used by truck drivers to unload product from trailers. Because loads in the hand truck can be quite heavy (sometimes more than 250 kg), drivers may be required to exert high hand forces when maneuvering the truck down the ramp. In addition to high biomechanical loads on the musculoskeletal system, there is an elevated risk of slips and falls due to increased [illegible] gonal requirements at the shoe-ramp interface