

RESPIRATOR ARTICLE ABSTRACTS

We review the articles published in the American Industrial Hygiene Association Journal and the Applied Occupational and Environmental Hygiene Journal/or information that is applicable to the field of respiratory protection; we then publish abstracts of these articles. We appreciate the cooperation of the American Industrial Hygiene Association and the American Conference of Governmental Hygienists in allowing us to do this.—Ed.

"Respirator Fit Factor Performance while Sweating," by David M. Caretti and Paul D. Gardner, *AIHA Journal* 60:84-88 (1999)

The extent to which sweat accumulation inside respirators affects respirator fit has not been quantified. This study represents an attempt to measure facial sweating and to quantify its effects on fit factors of negative pressure, full-facepiece respirators. Respirator fit factor (FF) data were obtained while 14 subjects completed 30 minutes of treadmill walking at an intensity of 75% of age-predicted maximal heart rate in an aerosol test chamber under ambient environmental conditions. Subject facial and whole body sweat production were also measured. Statistical analysis of the treadmill FF results showed that respirator fit was significantly ($p < 0.05$) degraded after 14 minutes of exercise. Sweat accumulation inside the respirator facepiece averaged 30.9 ± 15.5 g. However, no significant correlation of subject facial sweat production with overall FF values measured during exercise was found. The results of this study indicate that respirator FFs degrade significantly over time under moderate exercise and environmental conditions and suggest that facial sweat accumulation alone does not account for the reduced FF levels.

"An Evaluation of an Air-Supplied Blouse and an Air Hood," by Louise Poirier, *AIHA Journal* 60:116-119 (1999)

Fit factor studies for an air-supplied blouse (blouse) and an air hood respirator (air hood) were conducted by Lawrence Livermore National Laboratory. Nine test subjects were used to test the blouse. Three subjects were used to test the air hood. Exercises conducted in the test chamber included touching toes, raising both arms overhead, squatting, twisting at the torso while holding a rod, and running in place. Both the air hood and blouse were tested with $8\text{ft}^3/\text{min}$ air supply. Both respirators were worn in a test chamber. The blouse provided a fit factor of greater than 40,000. The air hood, for nearly all tests, also provided a fit factor greater than 40,000 when worn correctly. Fit factors were also measured for improperly worn air hoods.

"Compliance with OSHA's Respiratory Protection Standard in Hospitals," by Usha Krishnan and Christopher A. Janicak, *AIHA Journal* 60:228-234 (1999)

This study examined the incidence of violations of occupational safety and health standards for respiratory protection in hospitals. Data from Occupational Safety and Health Administration inspections that occurred in hospitals and resulted in violations of the respiratory protection standards were examined. From July 1, 1990, to June 30, 1995, the complaint rates for hazards in the workplace significantly increased. During 1990-1991, tuberculosis hazard complaint inspection rates were approximately 5 complaints per 1000 complaint inspections conducted. During 1994-1995, tuberculosis hazard complaint inspection rates were approximately 76 complaints per 1000 complaint inspections conducted, representing an increase of over 15 times. During this same period, the percentage of respiratory protection violations in relation to all violations

doubled. Increased employee awareness of the hazards and current safety laws could have contributed to the increased frequency of employee complaints, leading to increases in inspections, violations, and fines. Employers must adhere to the current safety and health requirements specifically as they pertain to respiratory hazards and tuberculosis.

"Cognitive Performance and Mood During Respirator Wear and Exercise," by David M. Caretti, *AIHA Journal* 60:213-218 (1999)

The combined effects of respirator wear and low-intensity work on decision making and mood were assessed in eight subjects during 60 min of low-intensity treadmill walking with and without a respirator to determine whether the stresses of respirator wear negatively impact decision making. Subjects completed walks during no mask wear, wear of a respirator with high inspiratory resistance, and wear of a respirator with low resistance. Cognitive tasks included choice reaction (CHO), serial addition/subtraction (ADD), logical reasoning (LOG), and serial reaction (SER). Mood was measured using a questionnaire with 36 adjectives representing the factors of activity, anger, depression, fear, happiness, and fatigue. Data were obtained preexercise, after 20 and 40 min of walking, and postexercise. Combined respirator wear and low-intensity exercise did not affect accuracy, speed, or throughput in any of the cognitive tasks. Likewise, no significant effects of condition on the six mood factor scores were observed. These results show that the combination of respirator wear and low-level activity does not adversely alter cognitive performance or mood.

"Comparison of Six Respirator Fit-Test Methods with an Actual Measurement of Exposure in a Simulated Health Care Environment: Part III—Validation," by Christopher C. Coffey, Donald L. Campbell, and Warren R. Myers, *AIHA Journal* 60:363-366 (1999)

This article, the last in a series of three, describes the validation phase of a study conducted to test the correlation of respiratory fit factors to the subject's actual exposure using biological sampling. The study consisted of three phases: protocol development, method comparison testing, and validation. Six quantitative fit-test methods were evaluated in the method comparison testing phase. The two fit methods with the highest correlation with the wearers' measured exposure were a corn oil method ($R^2 = 0.81$) and an ambient aerosol method ($R^2 = 0.78$). Because the ambient aerosol method is more commonly used in the workplace, it was selected for further analysis. In this validation phase, the fit factors measured during the ambient aerosol fit-test were used to calculate the exposures to Freon®-113 by using the model determined in the method comparison testing phase of the study. The actual Freon®-113 exposures were then measured and compared with the predicted exposures. The results verified that the ambient aerosol method fit factors are highly correlated to the total Freon®-113 exposure dose and thus that the model had a predictive ability.

"Prediction of Respiratory Distress During Maximal Physical Exercise: The Role of Trait Anxiety," by Judy R. Wilson, Peter B. Raven, William P. Morgan, *AIHA Journal* 60:512-517 (1999)

Industrial respirators offer protection for men and women who are required to work in toxic and oxygen-deficient environments. Major advances continue to be made with respect to improved face mask designs and modes of protection, yet only recently have efforts been directed toward the development of criteria for use in evaluating individuals' psychological fitness to wear respirators. The purpose of the present investigation was to confirm (i.e., replicate) an earlier finding, using a simplified protocol, that an individual's tendency to experience respiratory distress during exercise can be predicted. In the present experiment, an independent sample of 38 subjects underwent a maximal exercise test. It was predicted that subjects with elevated trait anxiety scores would experience respiratory distress when required to perform heavy physical exercise using a full-facepiece, air-line supplied, pressure-demand respirator. The prediction of respiratory

distress was accurate in 34 of 38 cases (89.5%). It was concluded that an objective measure of trait anxiety can be used to identify those individuals who are most likely to experience distress while performing maximal physical exercise and using a pressure-demand respirator.

"Effect of Respirator Inspiratory Resistance Level on Constant Load Treadmill Work Performance," by Arthur T. Johnson, William H. Scott, Christopher G. Lausted, M. Benhur Benjamin, Karen M. Coyne, Manjit S. Sahota, and Monique M. Johnson, *AIHA Journal* 60:474-479 (1999)

Respirator inspiratory resistance can affect performance times, especially when the experiment is optimized to elicit respiratory stress. Twelve subjects performed on a treadmill at constant speeds and grades chosen to result in performance times of 5-15 min. Six levels of inspiratory resistance were used, ranging from 0.78 to 7.64 cm H₂O·sec/L. The results showed that performance times decrease linearly with resistance level, and no threshold resistance value is apparent. Inspiratory resistance also induces hypoventilation, with lower minute volumes and lower oxygen consumption values at higher resistances. These trends are also linear. From these results, there is no value for inspiratory resistance that can be given as a design goal. Other parameters such as weight and space may dictate filter resistance values, and these, in turn, will lead to determined performance degradations.

"A Study on the Relative Breakthrough Time (RBT) of a Respirator Cartridge for Forty-Six Kinds of Organic Solvent Vapors," by Shigeru Tanaka, Yoko Nakano, Kazuo Tsunemori, Masahiro Shimada, and Yukio Seki, *Applied Occupational and Environmental Hygiene* 14:691-695 (1999)

The breakthrough time of a commercially available respirator cartridge was measured for 46 kinds of organic solvents. The condition of the test air flow was set according to the Japanese government standard for the National Approval Test: at 300 ppm of an organic solvent vapor concentration, a temperature of 20°C, a relative humidity of 50 percent, and a flow rate of 30 L/min. The interval between the start of passing the test flow through a cartridge and the time when the concentration of organic solvent vapors at the downstream of the cartridge reached 5 ppm was measured. The ratios of breakthrough times of organic solvents to that of cyclohexane, which is designated as the standard test vapor in Japan, were calculated to obtain the relative breakthrough times (RBTs). Nine of the 46 organic solvents had breakthrough times shorter than that of cyclohexane, and these organic solvents with shorter RBTs were characterized by low boiling points and small molecular weights. The RBTs of 34 organic solvents were compared with the breakthrough times reported by Nelson, *et al.* The relationship between the RBTs of this experiment and those reported by Nelson correlated well (correlation coefficient: 0.861).

"A Description of Factors Affecting Hazardous Waste Workers' Use of Respiratory Protective Equipment," by Mary K. Salazar, Timothy K. Takaro, Catherine Connon, Kathy Ertell, George Pappas, and Scott Barnhart, *Applied Occupational and Environmental Hygiene* 14:470-478 (1999)

This article describes the first phase of a study that was designed to gain an understanding of hazardous waste workers' attitudes and beliefs about the use of respiratory protective equipment. Exploratory, open-ended interviews were conducted among 28 respirator users at a US Department of Energy facility. Subjects were asked to describe their knowledge, attitudes, and beliefs about their risks to hazards at their worksites and to discuss their use of respiratory protective equipment. A detailed content analysis of the interviews resulted in the generation of a taxonomy of issues and concerns which fell into three general categories: 1) *Knowledge, Beliefs, and Attitudes*, 2) *Physical and Psychological Effects*, and 3) *External Influences, Knowledge*,

Beliefs, and Attitudes included Training, Fit Testing, Medical Clearance, Work Exposures, Respirator Use, and Vulnerability to Disease. *Physical and Psychological Effects* included Somatic/Health Effects, Personal Comfort, Visual Effects, Fatigue, Communication, and Anxiety. *External Influences* included Structural Environment, Quality and Availability of Equipment, Other PPEs, Co-Worker Influence, Supervisor Influence, and Organizational Culture. The findings from this study have important implications to training and education programs. Effective respiratory protection programs depend on a knowledge of the factors that affect workers' use of equipment. This study suggests that efforts to assure equipment comfort and fit, to assist workers who see and hear less well as a result of their equipment, and to develop strategies to allay worker anxiety when wearing the equipment should all be components of a program. An organizational culture that supports and abets the appropriate use of equipment is also a critical element in a successful program.