

RESPIRATOR ARTICLE ABSTRACTS

We review the articles published in the American Industrial Hygiene Association Journal (AIHJ) and the Applied Occupational and Environmental Hygiene Journal for 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.

"A Comparison of Controlled Negative Pressure and Aerosol Quantitative Respirator Fit Test Systems by Using Human Subjects," Clifton D. Crutchfield, Richard W. Murphy, and Mark D. Van Ert, *American Industrial Hygiene Association Journal*, January, 54(1):10–14, 1993.

A quantitative respirator fit test system based on controlled negative pressure was evaluated by comparison testing with a computerized aerosol fit test system. Experiments ranged from multiple sequential tests of a single subject wearing a respirator equipped with a series of fixed leaks to sequential fit tests of 125 U.S. Air Force personnel using both systems. Throughout each test phase, measured negative pressure fit factors were consistently more conservative and less variable than aerosol fit factors. Comparison of subject and fixed leak fit factors indicated significant loss of aerosol during subject fit tests. Negative pressure system results did not show any effect from subject-related losses.

"Deaths Involving Air-Line Respirators Connected to Inert Gas Sources," J. B. Hudnall, A. Suruda, and D. L. Campbell, *American Industrial Hygiene Association Journal*, January, 54(1):32–35, 1993.

During 1984 to 1988, the U.S. Occupational Safety and Health Administration (OSHA) investigated 10 incidents, with 11 fatalities, involving the inadvertent connection of air-line respirators to inert gas supplies. Seven deaths resulted from connecting an air-line respirator supply hose to a line which normally carried inert gas. Four deaths were caused by leakage or backfill of inert gas into a line which normally carried breathable air. Ten of the deaths were from nitrogen and one from argon. The circumstances of the 11 deaths indicated that coupling compatibility and supervisory oversight were major factors in the inappropriate supply of irrespirable gas to the respirators worn by these workers. Conscientiousness among safety personnel to the hazards of asphyxiation by inert gas, and compliance with current OSHA regulations, the ANSI Z88.2 standard, and NIOSH respirator certification approval regulations would have prevented these fatalities.

"Loading and Filtration Characteristics of Filtering Facepieces," C. C. Chen, M. Lehtimäki, and K. Willeke, *American Industrial Hygiene Association Journal*, February 54(2):51–60, 1993.

Most filtering facepieces used today are made of electret material (material with significant electrical charges on the filter fibers). Because of the addition of this electrical removal force, the filtration efficiency can be significantly increased without increasing the air pressure drop inside the respirator; pressure drop is closely related to physiological load. However, the removal by electrical forces is reduced in time, as aerosols deposit on the filter fibers. We have studied the contribution of this electrical removal and its change in time as a function of aerosol loading. To prove the change in aerosol penetration is due to the reduction of electrical force, the electrical charges were removed from new facepieces by the application of appropriate chemicals.

The dust-mist filtering facepieces tested have similar fiber diameters and packing densities, as determined by scanning electron microscopy and pressure drop data. At a face velocity of 10 cm/s (corresponding to 100 l/min. through a complete filtering facepiece) and an aerosol size of 0.16 μm , electrical force removal accounts for 69% of the total filtration for the respirator found to have the best filter quality but only 25% for the respirator (from a different manufacturer) found to have the worst filter quality. Our experimental data show that the removal-efficiency of these facepieces is reduced in time by as much as this amount. However, under normal wear conditions, the total aerosol particle load is not as high as shown and the filtering facepieces are likely to be discarded before the fiber charges (i.e., the electrostatic attractions) are significantly diminished.

"A Model for Correcting Workplace Protection Factors for Lung Deposition and Other Effects," Paul Hewett, Barry G. Pallay, and John F. Gamble, *American Industrial Hygiene Association Journal*, April, (4)142:149, 1993.

The Workplace Protection Factor (WPF) is a measure of the protection provided by an industrial respirator against a challenge agent. It is traditionally defined as the ratio of the ambient contaminant concentration (C_0) in a worker's breathing zone to the in-facepiece contaminant concentration (C_i) that occurs during inhalation, and is determined by simultaneous concentration measurements during the time the respirator is worn. There are several sources of particulate loss that result in the overestimation of the true WPF. A model is presented to "estimate" these losses so that an adjusted or **"unbiased"** WPF can be calculated. This model requires three measurements: C_0 , C_i , and the ambient aerodynamic mass frequency particle size distribution (PSD). Both C_0 and C_i are expressed in units of **"mass per unit volume."** There are four steps to the calculation of the unbiased WPF. First, the in-facepiece PSD is estimated using the ambient PSD and a particle leak penetration curve. Second, the fraction of the in-facepiece PSD that will deposit in the lung is estimated using the in-facepiece PSD and a **"reference worker"** total lung deposition curve. Third, the fraction of the in-facepiece PSD that will deposit at the inlet of the sampling probe during both inhalation and exhalation is estimated using the in-facepiece PSD, the exhaled in-facepiece PSD, and published inlet deposition data. Last, the adjusted in-facepiece concentration is calculated using the estimates from steps two and three. The adjusted WPF, WPF_a , is then calculated as the ratio of the measured ambient contaminant concentration and the adjusted in-facepiece concentration.

"Workplace Protection Factor Evaluation of Respiratory Protective Equipment in a Primary Aluminum Smelter," A. Gaboury, D. H. Burd, and R. S. Friar, *Applied Occupational and Environmental Hygiene*, January, 8(1): 19–25, 1993.

A study was performed at the Arvida Works of Alcan to determine the suitability of a **helmeted** Powered Air Purifying Respirator (PAPR) in a primary aluminum smelting plant using the horizontal stud Soderberg process. Participants in the test program were worker volunteers drawn from various jobs performed by the anode crews. The research protocol was developed to complement the work methodologies used by Alcan with as little change as possible in their work schedules. Half the crews wore dual cartridge half-mask negative pressure respirators and the other half wore helmeted PAPRs. The dual cartridges half-mask negative pressure respirators were equipped with organic vapors/acid gas cartridges and dust/mist/fumes or dust/mist prefilters; the PAPRs were equipped with organic **vapors/HEPA** filter cartridges. B(a)P was selected as the measurable contaminant. Under the conditions of this study—that is, strict adherence to the test protocol—we found that 95 percent of the Workplace Protection Factors (also called the 5th percentile) were above 275 for helmeted PAPRs and above 9 for dual cartridges half-mask negative pressure respirators. However, if results under less than ideal worker compliance conditions brought Workplace Protection Factors down by a factor of 10, then the helmeted PAPRs would still provide adequate respiratory protection in this study. The results indicate that the B(a)P concentrations expressed as time-weighted average exposure were significantly less than $0.5 \mu\text{g}/\text{m}^3$ for both types of respirators.

"Determination of Inspiratory Pressures and Flow Rates for Work Rate-Dependent Quantitative Respirator Fit Testing," Clifton D. Crutchfield, Trinh K. Pham, and Mark D. Van Ert, *Applied Occupational and Environmental Hygiene*, February, 8(2):103–107, 1993.

Quantitative respirator fit testing is used to select respirators for individual workers *and* to gain insight into potential contaminant leakage. Current fit test exercises are designed to primarily challenge the respirator facepiece-to-face seal. Inspiratory pressure across any break in the seal is also an important determinant of the amount of leakage through the break. Fit tests conducted at resting respiratory patterns may not be representative of leakage that occurs at respiratory patterns employed in the workplace. By design, the controlled negative pressure fit test method can control the driving force for leakage into a respirator by selecting a challenge pressure that represents actual use inspiratory pressures. In this study, mean inspiratory pressures and flow rates were determined for males and females working at external work rates of 0, 180, 360, and 540 kg m/min. Effects of mask type and breathing resistance were determined using both half-masks and full-face respirators equipped with cartridges of relative low, medium, and high breathing resistance. Inspiratory pressure was found to be strongly dependent on work rate and cartridge resistance. Mask type and gender also had significant effects on mean inspiratory pressure. Inspiratory flow rate was significantly **affected** by work rate and mask type. Data from the study can be used to conduct work rate-dependent fit testing with the controlled negative pressure method.