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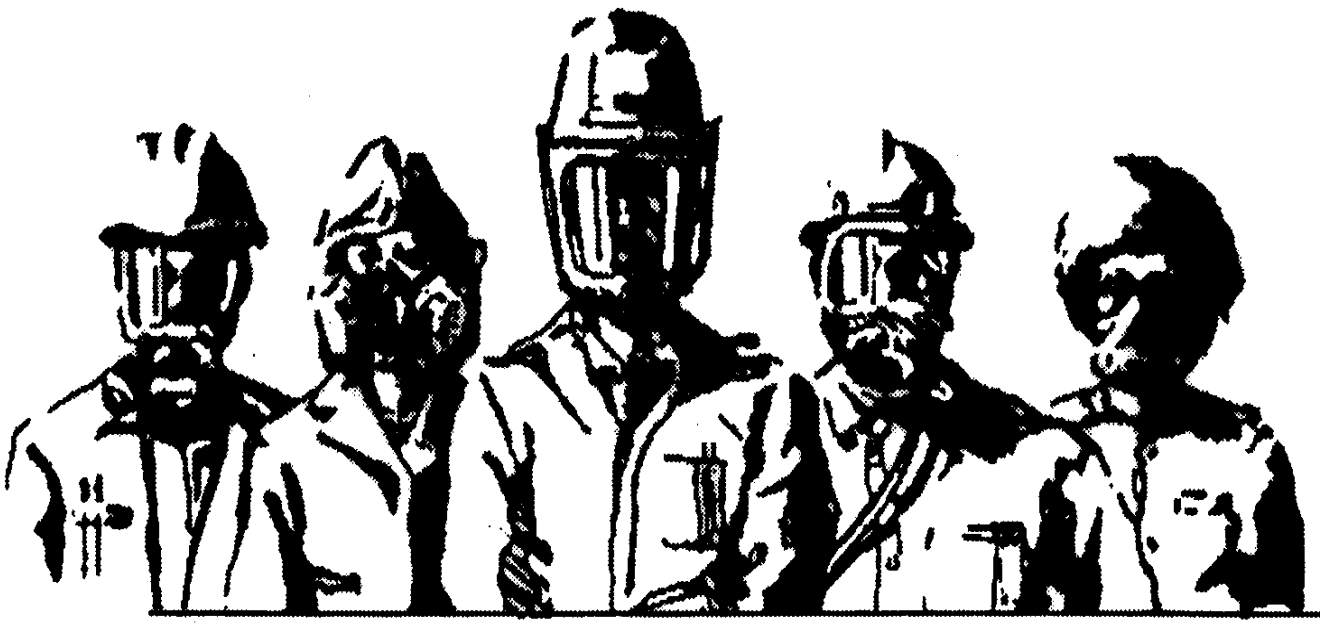

Flow Patterns in Loose-Fitting PAPRs Help Explain Low Protection Factors

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ABSTRACT

Respiratory protection plays an important role in maintenance of wearer health and safety. Previous research has shown that the two loose-fitting PAPRs tested here have very low protection factors. These respirators do not offer the protection that they are supposed to, and the question is why they do not. This investigation was undertaken to determine if these low values could be explained by the flow pathways taken by contaminated air from the leakage points to the mouth. Two loose-fitting powered air-purifying respirators were challenged with a glycerol fog to determine flow pathways and amounts within the facepieces. Fog was drawn from the environment around the respirator by either a steady vacuum (to determine flow pathways) or a breathing machine (to determine inhaled amounts). Movement of the fog within the facepiece was captured by digital video and examined frame-by-frame. It was found that the loose-fitting PAPR without a scarf offered no protection against the fog (protection factor ≈ 1), whereas the PAPR with a scarf allowed up to 1.4 L of inhaled breath before the fog reached the mouth (protection factor > 1). Tilting the head affected the amount of protection given by the PAPR. It was concluded that the presence of the blower was no guarantee of protection and that this PAPR should be worn only in a situation not dangerous to life or health.

Keywords: PAPR, respirator, inward leakage, flow visualization, protection factor

Development and Characterization of a New Test System to Challenge Personal Protective Equipment with Virus-Containing Particles

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ABSTRACT

Previous bioaerosol test systems used in personal protective equipment (PPE) reuse, performance, and handling research were limited in their ability to generate diverse particle size ranges and types. The objective of this study was to develop and characterize a new test system to challenge PPE with virus-containing particles (VCPs). The new system was designed to achieve two specific research objectives: 1) to be capable of delivering VCPs uniformly onto air permeable PPE such as filtering facepiece respirators (FFRs) and surgical masks (SMs) and 2) to be capable of performing simple VCP filtration tests. The test system consists of two aerosol generators, an exposure chamber, a breathing simulator/head form, and several aerosol detection systems.

The test system was validated against the two objectives using two experimental scenarios involving droplet nuclei and droplet VCPs. The size distribution from the droplet nuclei experiments was 0.02 - 10.3 μm, with 96% of particles between 0.2 - 4.0 μm and a mass median diameter of 0.60 μm with a geometric standard deviation (GSD) of 1.64. The size distribution of the droplets was 0.54 - 100 μm, with 83% of particles < 10 μm and a median [Dv(50)] of 5.03 μm. The amount of viable MS2 deposited on the respirators met ASTM E2720 and E2721 loading requirements, with > 97% found on the outer and middle layers of the N95 FFR models. Average filtration efficiencies were highest for the P100 FFRs (99.91 - 99.94%), followed by N95 FFRs (96.57 - 98.18%) and SMs (78.69 - 80.43%). These data indicate that the test system was able to meet the study objectives and will serve as a versatile tool for standards development and for research studies related to PPE reuse and handling.

Keywords: Bio-aerosol respirator testing system, viral droplets, droplet nuclei, loading density, uniformity, filtration efficiency

Performance Studies on Respiratory Protective Devices in the Workplace – Part I: Variation in Measures of Performance

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ABSTRACT

Results gathered from workplace performance studies have provided the basis for many of the assigned protection factors (APFs) for respiratory protective devices (RPDs) that we have today. The lack of a harmonised approach to workplace performance studies has partly been responsible for the huge differences in APFs that can be seen across the world. This variance in APFs has both operational and economic implications for the employers, RPD users, manufacturers and suppliers. APFs play a vital role in the correct selection of RPD and therefore must stand up to scrutiny. With a new suite of ISO RPD Standards on the horizon there is a need and the opportunity to revisit the topic of APFs to ensure that they are fit for purpose. This first paper discusses the issues surrounding workplace performance studies, how APFs were derived and the need for a harmonised approach to future workplace studies. A second paper discusses the key elements of workplace performance studies and makes recommendations with the aim of taking the harmonisation of APFs forward.

Keywords: Respiratory protective devices, assigned protection factors, workplace protection factors, performance

The Effect of Flow Pattern on Collection Efficiency of Respirator Filters

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ABSTRACT

This study investigated the effect of cyclic flow pattern on the aerosol penetration through selected respirator filters. Two National Institute for Occupational Safety and Health (NIOSH)-approved commercial respirator filters (a P95 and a N95) were challenged with an inert aerosol and the aerosol penetration was measured under four cyclic waveforms: two sinusoidal, a trapezoidal, and an exponential waveforms. The minute ventilation was 50 L/min for each of the waveforms. The measured penetration increased with the peak inhalation flow rate (PIFR), with the highest penetration measured with the exponential waveform. Equivalent penetrations were measured with the two sinusoidal waveforms even though they had different tidal volumes and breathing rates. Similar penetrations, within a factor of two, were measured with the sinusoidal and trapezoidal waveforms, due to their similar PIFRs. A secondary objective was to compare filter performance under constant (32 to 320 L/min) and cyclic flow conditions (minute ventilation ranged from 16 to 130 L/min). The penetrations measured under cyclic flow were generally an order-of-magnitude higher than those measured under constant flow with an equivalent minute ventilation. The primary outcome was the development of a method to estimate filter performance for a range of cyclic flow conditions once the constant flow relationship is established.

Keywords: Filtration, Respirator filters, Aerosol penetration, N95, Constant flow, Cyclic flow, Breathing flow