Abstracts

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Automated Breathing and Metabolic Simulator (ABMS) CO2 Test for Powered and Non-Powered Air-Purifying Respirators, Airline Respirators, and Gas Masks

N.L. Turner, E. Sinkule, S. Hota

National Personal Protective Technology Laboratory, National Institute for Occupational Safety and Health

It has been estimated that several million workers are required to wear respirators. Elevated inhaled carbon dioxide concentration is an inherent aspect of respirator wear. The physiological effects of breathing 3 - 4% inhaled CO2 are hyperventilation and headache. Previous data suggest that CO2 concentrations in nonNIOSH-approved surgical helmets exceed the NIOSH REL of 0.5% and that CO2 levels exceed the NIOSH STEL of 3% in a prototype powered air-purifying respirator operating with the blower turned off. There is currently no NIOSH certification test for CO2 concentrations in air-purifying respirators.

For this study the Automated Breathing and Metabolic Simulator (ABMS), which simulates human metabolism, minute ventilation, and breathing waveforms, was used to characterize average inhaled CO2 in a variety of NIOSH-approved air-purifying respirators. An ABMS CO2 test protocol was developed to test 11 powered air-purifying respirators (PAPR's), 20 airline respirators (SAR's), six gas masks, 27 P-100 air-purifying respirators (APR's), and 26 filtering-facepiece N95 respirators (N95's). The ABMS CO2 protocol consisted of the following levels of O2 consumption, CO2 production, and minute ventilation performed consecutively for a minimum of five minutes each: 0.5, 0.4, and10 L/min STPD; 1.0, 0.8, and 25 L/min STPD; 1.5, 1.3, and 38 L/min STPD; 2.0, 1.9, and 62 L/min STPD; 2.5, 2.5, and 70 L/min STPD; and 3.0, 3.1, and 80 L/min STPD, respectively. The mean across all PAPR models for average inhaled CO2 and O2 ranged from 0.2% and 20.7%, respectively, for the lowest metabolic rate to 0.9% and 20.0%, respectively, for the greatest metabolic rate. The mean across all SAR's for average inhaled CO2 and O2 ranged from 0.5% and 20.3%, respectively, for the lowest metabolic rate to 0.4% and 20.5%, respectively, for the greatest metabolic rate. The mean across all gas masks and APR's for average inhaled CO2 and O2 ranged from 2.6% and 17.5%, respectively, for the lowest metabolic rate to 0.7% and 20.4%, respectively, for the greatest metabolic rate. The mean across all N95's for average inhaled CO2 and O2 ranged from 3.5% and 16.8%, respectively, for the lowest metabolic rate to 2.7% and 18.6%, respectively, for the greatest metabolic rate. These data demonstrate the wide range of average inhaled CO2 concentrations across respirator types and the utility of the ABMS in conducting CO2 testing.

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