spread respiratory diseases. Both coughing and sneezing are audible and visible. In this work, the mechanisms and characteristics of aerosol generation from "silent" breathing were experimentally investigated and validated. **Methods:** An Exhaled Breath Aerosol Monitoring system, composed of a condensation particle counter and an aerosol-free chamber with flow rate over 200 L/min, was the backbone of the experimental set-up. The subjects were asked to respire through a mouthpiece and a pneumotachograph connected the aerosol-free chamber. In order to monitor the aerosol concentration during inhalation and exhalation, a condensation particle counter with a sampling rate at least 1 Hz was connected to the tube between the mouthpiece and the pneumotachograph. A nose clip was used to force the respiration through mouth only. Subjects were asked to perform a variety of breathing patterns generated by a cylinder-piston type breathing simulator in order to study the breathing pattern dependency. **Results:** From monitoring data of exhaled breath of 10 healthy male subjects, we found that under sedentary condition (low tidal volume, low breathing frequency), the aerosol concentration of the exhaled breath decreased from near room air down to zero after several breaths. It is necessary to clean up the aerosols in the functional residual volume, although it would take much longer time. The decay rate also depended on subjects. The aerosol generation rate increased with increasing the tidal volume and breathing frequency. **Conclusions:** In addition to sneezing and coughing, quiet breathing can also generate aerosol particles. Administering nebulized therapeutic materials to change the mucus properties might help to diminish the aerosol generation rate.

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N95 Respirator and Surgical Mask Efficacy for Cough Aerosols

J. Szalajda, W. King, NIOSH, Pittsburgh, PA; J. Reynolds, W. Lindsley, NIOSH, Morgantown, WV.

Objective: Few studies have been done to quantify the incremental impact of personal protective equipment (PPE) such as N95 filtering facepiece respirators (FFR) and surgical masks on aerosol transmission of viruses like influenza. During a pandemic, health care workers and the general public will have increased reliance on PPE for personal protection. Controlled studies are needed to assess the efficacy of PPE use in preventing airborne disease transmission. This project measures how well surgical masks and disposable FFR protect health care workers from aerosols produced by a coughing patient. **Methods**: The system is contained in a room-sized environmental chamber and has three main parts: (1) a simulator that discharges an aerosol-laden cough through a head form (called the coughing head form); (2) a second head form (called the breathing head form) connected to a breathing machine to simulate respiration and that can be fitted with PPE; and (3) aerosol particle counters to measure concentrations in the coughing and breathing systems and several room locations. The efficacy of surgical masks and respirators versus no mask was evaluated along with the influence of parameters including protection factor, breathing rate, relative position, cough frequency, and turnover rate. **Results:** Preliminary results show that the aerosol exposure is highest with no PPE, followed by surgical masks, and the least exposure seen with N95 FFR. With N95 FFR the magnitude of exposure also depended on the protection factor. The differences are seen regardless of breathing rate and the relative position of the head forms. **Conclusions:** Our results provide a better understanding of the efficacy of surgical masks and FFR when exposed to aerosols generated by a cough and enable NIOSH to provide research-based recommendations for effective respiratory protection strategies with surgical masks and FFR in health care settings.

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Factors Affecting the Location and Shape of Face Seal Leaks on Half Mask Respirators

R. Oestenstad, University of Alabama at Birmingham, Birmingham, AL.

Objective: The purpose of this study was to determine if gender, different respirator brands, and repeated fit tests affected the location and shape of face seal leak sites on half mask respirators. **Method:** A method of identifying the location and shape of respirator face seal leak sites on a half mask respirator during a fit test by the deposition of a fluorescent tracer was used to conduct multiple fit tests with three brands of respirators by 20 female and 21 male subjects. Data were analyzed by categorical and repeated measures statistical methods. **Results:** The categorical analysis found that none of the test factors had a significant effect on the location and shape of leaks. Multivariate, repeated measures analysis found some significant effects of the study factors on leaks, but facial dimensions had greater effects, and that there were significant differences between facial dimensions of subjects with a leak and those without. Significant differences in leak site distributions between this and a previous study may have been due to differences in racial composition and facial dimensions of subjects in each study. **Conclusions:** Twice as many diffuse leaks than point leaks were observed, indicating that slit-like leaks would be most appropriate on mannequins used in laboratory respirator leakage studies and in respirator flow and penetration models. Since study factors had no significant effects in the categorical analysis, significant effects for facial dimensions were found in the multivariate analysis, and differences in leak site distributions between this and a previous study may have been affected by differences in facial dimensions indicate that the shape of an individual's face may be the most important determinant of leak sites on a half mask respirator.

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Effect of Fit-Testing and Particle Size on the Protection Offered by N95 Filtering Facepiece Respirators Against Fine Particles in a Laboratory Setting

T. Reponen, S. Grinshpun, R. McKay, University of Cincinnati, Cincinnati, OH; S. Lee, Feng Chia University, Taichung, Taiwan; E. Johnson, 3M, St. Paul, MN.

Objectives: This study investigates the effect of fit-testing and particle size on the laboratory-based protection factors (PFs) of four models of N95 filtering facepiece respirators (A, B, C, and D). The challenge aerosol represented the size of naked viruses and bacteria (0.04-1.30 μm). **Methods:** Standard respirator fit-testing was followed by particle size selective measurement of PFs while 12 subjects (3 for Respirator D) wore respirators in a test chamber. Sodium chloride particles were aerosolized using a Collison nebulizer. Particle concentration was measured inside and outside the

respirator using an Electrical Low Pressure Impactor. Each respirator-subject combination was repeated three times (n = 36 for Respirators A, B, and C; n=9 for Respirator D). PF-values obtained for all tested subjects were compared to those who passed fit-testing. **Results:** The fit-test passing rate was 100% for Respirator A, 8% for Respirator B, 92% for respirator C, and 67% for Respirator D. About 29% of subject-respirator combinations had size-selective PF values below 10. When only subjects who passed the fit-test were included in the analysis, the PFs improved with 9% having values less than 10. On average, the geometric mean PFs over the entire particle size range were 1.4 times (29.5/21.5) higher when only data for those who passed fit-testing were included. The largest difference (21.8/10.3 = 2.1 times) between the two data sets was observed for respirator B, which had the highest fit-test failing rate. The minimum PFs were observed in the particle size range of 0.08-0.2 μm for all respirator models independent of fit-test status. **Conclusions:** Overall PFs increased, when subjects who did not pass fit-testing were excluded from analysis. The results support the value of fit-testing but also show that PFs varied by particle size regardless of fit-test status.

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Laboratory Study to Assess Causative Factors Affecting Temporal Changes in Filtering-Facepiece Respirator Fit: Part I - Study Protocol

Z. Zhuang, S. Lynch, R. Roberge, NIOSH, Pittsburgh, PA; S. Benson, EG&G Technical Services, Inc., Pittsburgh, PA.

Objective: In an effort to address questions regarding the Occupational Safety and Health Administration's annual fit testing requirement, a study was initiated to assess respirator fit and facial dimension changes as a function of time for a representative sample of 220 subjects wearing filtering-facepiece respirators and to investigate factors that affect such changes. The objective of this pilot study of 10 subjects was to investigate the variation in test data of a fit test protocol. **Methods:** Each subject was trained to don and doff a filtering-facepiece respirator model using standardized videos. Total inward leakage was measured with the TSI Portacount instrument during five exercises. Filter penetration for each respirator was also measured. Face seal leakage was then calculated. The study included only subjects who (a) passed the fit test and (b) demonstrated, through a series of nine donnings, that they achieved adequate protection. A subject was considered to have achieved adequate protection when, after nine trial donnings, the 90th percentile face seal leakage was 0.05 or less. Following the respirator fit tests, 13 traditional face measurements, height, weight, and a 3-D scan were collected. The same data were collected 2 and 4 weeks later. **Results:** The mean face seal leakage of the 9 donnings for individual subjects ranged from 0.202% to 0.997% for the first test cycle, from 0.231% to 1.059% for the second test cycle, and from 0.248% to 2.234% for the third test cycle. The mean change in face seal leakage for the 10 subjects was 0.044% between Cycles 1 and 2, and was 0.229% between Cycles 1 and 3. **Conclusions:** Although variability was observed between donnings and cycles, adequate fit was maintained for all 10 subjects. Scan data showed subject faces remained the same over a period of 4 weeks.

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Evaluation of Desorption Requirements for Powered Air Purifying Respirator Concept Standard

M. Parham, Y. Ding, E. Potter, A. Staubs, Tyco / Scott Health & Safety, Monroe, NC.

Objective: Cartridge use conditions, both contaminant and environmental, depart significantly from those used for certification testing. This study seeks to determine if NIOSH's proposed Powered Air Purifying Concept for Part P adequately verifies the risk of a cartridge to desorb contaminants under normal use. **Methods:** The concept standard details a three stage sequential process for desorption testing: exposure to the contaminant, storage, and exposure to clean purge air. This testing is carried out under constant temperature and relative humidity. In this study we baseline the performance of a representative PAPR cartridge under these conditions for Isobutane, Cyclohexane, and Ammonia. Using a design of experiments approach, we intermittently expose the cartridge to low levels of the contaminant that are within the maximum use concentration limit for PAPRs. Storage time, temperature, and relative humidity are varied to simulate commonly encountered field conditions, and the purge time, temperature, and relative humidity are varied to simulate diurnal environmental condition changes. For each of these trials the cartridge is monitored for breakthrough of the contaminant. **Results:** For the conditions referenced in the standard, there was no measurable effect on desorption for either constant or intermittent exposure with the same mass loading. Extreme storage conditions were found to promote measurable desorption but this was dependent upon recovery time and the adsorption potential for the contaminant. Strong transients in temperature and relative humidity also were found to promote desorption. **Conclusions:** The study conducted has determined the operating range for which the proposed method determines desorption potential of a PAPR cartridge. Cartridge use recommendations are made to minimize desorption risk.

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Evaluation of Reuse on Performance of Filters Against Long Duration Intermediate Exposures of Wildlan Fire Inhalation Hazards

A. Staubs, M. Parham, Y. Ding, E. Potter, Scott Health & Safety, Monroe, NC.

Objective: Define limitations of repeated use of respirators used in operationally relevant environments for wildland firefighting. This study will determine if reuse of air-purifying cartridges is permissible for intermittent exposure to byproducts of combustion and measured exposure levels of contaminants, taking into account increased absorbed dose attributed to high work levels typical of wildland firefighting over an 8-hour time-weighted average. **Methods:** Proposed NFPA 1984 Standard on Respirators for Wildland Fire Fighting Operations defines requirements for air-purifying and powered air-purifying gas capacities based on current NIOSH guidelines for 42 CFR Part 84 compliance at higher flowrates. During field studies conducted to characterize the environment for wildland firefighting, Carbon Monoxide is found to be prevalent in all environmental conditions with intermittent exposures to other contaminants resulting from combustion or emissions from forest

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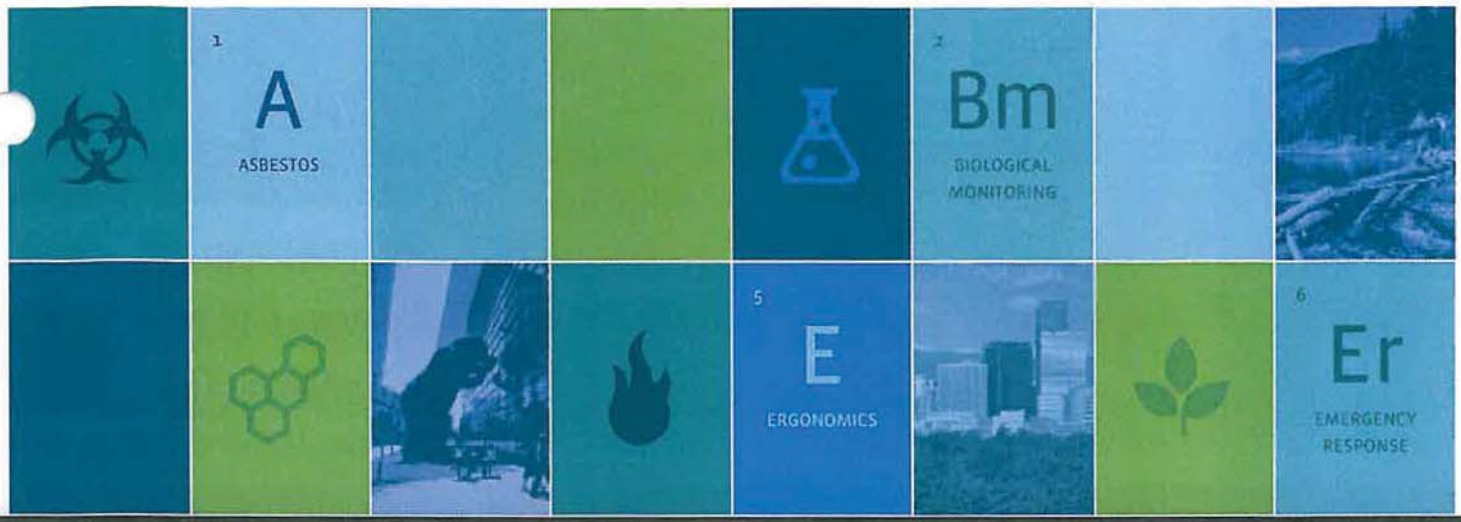

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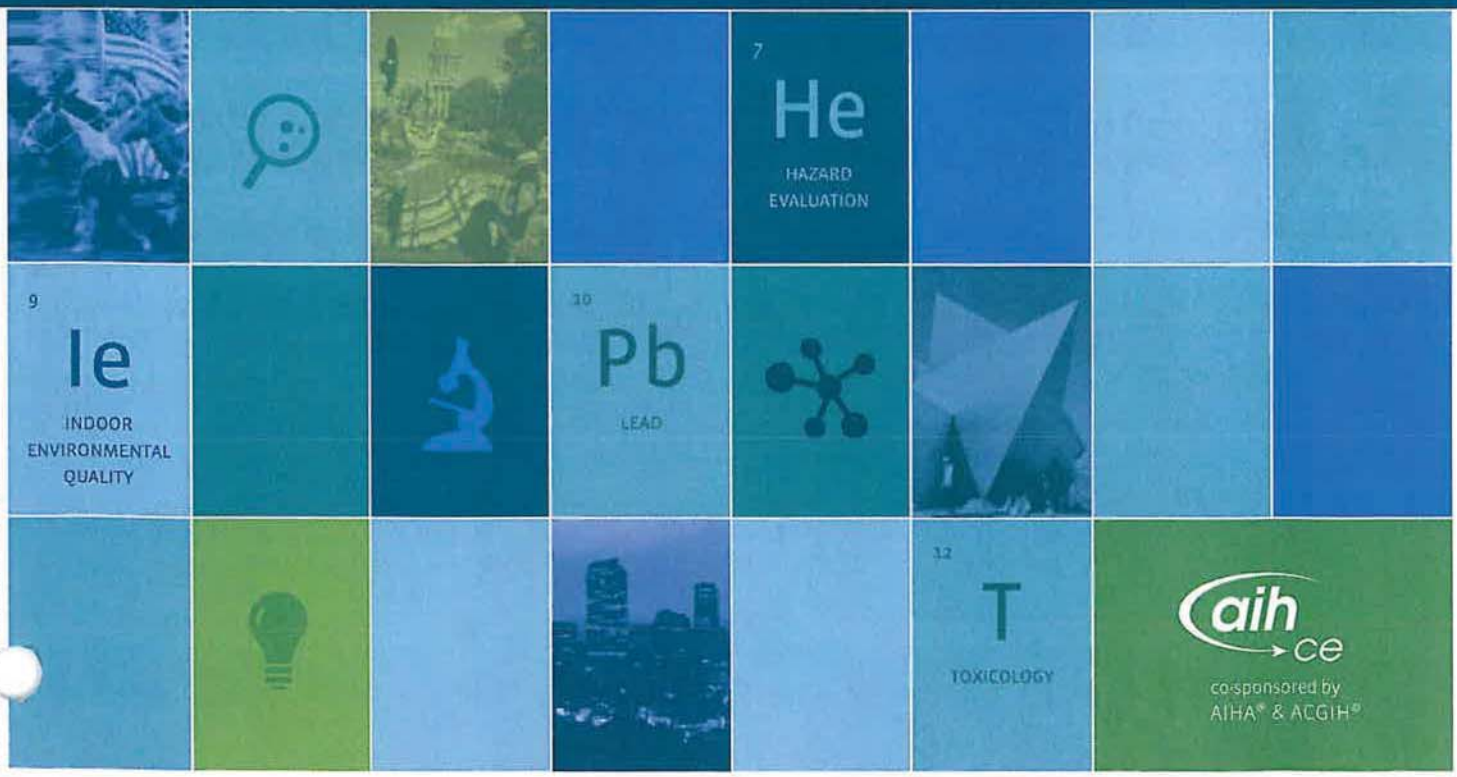

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