

exposure occurring during a wearing period for workers wearing half-facepiece respirators represented, was 0.5%, with a 95% confidence interval of 0.01 to 2.7%. If we consider 50% in-facepiece sampling errors, the probability of overexposure was 2.9% with a 95% confidence interval of 1.1 to 6.3%. Based on this analysis, our professional judgment is that the current APF of 10 for half-facepiece respirators is appropriate.

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### SIMULATED WORKPLACE PERFORMANCE OF N95 RESPIRATORS. C.C. Coffey, D.L. Campbell, NIOSH, Morgantown, WV

The National Institute for Occupational Safety and Health (NIOSH) has received many inquiries about the face-fitting characteristics of the new N95 respirators. These inquiries raised the issues of how well do these respirators fit, whether N95 respirators have to be fit-tested, and whether they can be quantitatively fit-tested. In response, researchers of the NIOSH Certification and Quality Assurance Branch evaluated the performance of 12 N95 respirator models on a panel of 25 subjects with varying face sizes. The performance of each respirator model was assessed in two ways: first, on the panel of 25 subjects not fit-tested and, second, after removing from the panel those subjects failing a fit-test. Total penetration, the combination of filter penetration and face seal leakage, was measured for each panel member. The 95th-percentile of the total penetration values was then computed for each model. The 95th-percentile of the total penetration that is typically used to indicate overall respirator performance indicates that 95% of the wearers can expect to have a total respirator penetration less than this value. The 95th-percentile total penetration without fit-testing for the 12 respirators ranged from 5 to 77%. A properly fitted half-mask respirator is expected to have a total penetration less than 10%. When the first donning was used as a surrogate fit-test to screen out poor fits, the 95th-percentile of the total penetration decreased to 2 to 4%, a significant increase in protection. Therefore, this study suggests that this level of protection is achieved only when fit-testing is performed to screen out poor face fits. The results also indicate that fit-testing is an essential element of a respirator program. Without fit-testing, the protection provided by this class of respirator is unreliable.

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### FILTER EFFICIENCY DEGRADATION IN N95 RESPIRATORS CAUSED BY SODIUM CHLORIDE AEROSOL. M.S. Bergman, E.S. Moyer, NIOSH, Morgantown, WV

The National Institute for Occupational Safety and Health (NIOSH) investigated effects of periodically loading small masses of sodium chloride (NaCl) aerosol on the filtration efficiency of N95 filtering facepiece respirators. NIOSH certifies that N95 respirators must provide at least 95% filtration efficiency as per the 42 CFR 84 test criteria. N95 respirators are specified for protection against solid and water-based particulates (i.e., nonoil aerosols). New N95 respirators from three different manufacturers were loaded with  $5 \pm 1$  mg NaCl aerosol 1 day a week, over a period of 17 weeks. Aerosol loading and penetration measurements were performed using the TSI 8130 Filter Tester.

Respirators were stored uncovered on an office desktop outside of the laboratory. To investigate environmental and temporal effects of filters being stored without NaCl exposure, control respirators were stored on the desk for various lengths of time before being initiated into weekly testing. For all manufacturers' respirators, the controls showed similar initial penetrations on their day of initiation to those of the study samples on day 1. As the controls were tested weekly, they showed similar degradation rates to those of the study samples. Results show that some of the manufacturers' models had penetrations of greater than 5% when exposed to intermittent NaCl aerosol loads. This data suggests that service time recommendations should account for efficiency degradation with intermittent, low-level loading of NaCl aerosol. It is concluded that periodic loading of small masses of NaCl aerosol onto N95 respirators has a significant degrading effect on filter efficiency. Furthermore, it is noted that effects of storage time and storage atmosphere in this study are much less significant.

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### AN EVALUATION OF PRESSURE-MONITORED USER SEAL CHECKS IN DETECTING INDUSTRIAL RESPIRATOR LEAKAGE. A.G. Freeman, R. McKay, University of Cincinnati, Cincinnati, OH

This report describes a new portable method to quantify the in-mask pressure changes that occur when respirator wearers conduct user seal checks. This method was used to examine the patterns of these pressure changes during user seal checks comparing leaking and intact respirators.

Positive and negative pressure user seal checks are the most commonly employed means for respirator wearers to regularly assess respirator fit in the workplace. In this study, the in-respirator pressure differentials were measured and recorded using a computerized data collection system as subjects performed pressure-monitored negative and positive pressure user seal checks (PM-NPUSCs and PM-PPUSCs). Two different model half-face respirators were probed with a leak hole that, when uncovered resulted in a quantitative fit factor averaging just less than 100 in an otherwise well-fitting mask. Twenty subjects wearing two different model half-mask respirators, leaking and not leaking, were monitored as they underwent PM-NPUSCs, PM-PPUSCs, and quantitative fit-testing using a TSI Portacount. A subject that maintained a pressure differential greater than 5 cm of water for at least 5 seconds was deemed to have a well-fitting, nonleaking mask using the PM-NPUSC and PM-PPUSC methods. The PM-NPUSC method in the first model (brand A) of respirator was 100% sensitive and 100% specific in detecting respirator leakage. The PM-PPUSC was also 100% sensitive in these respirators, but not adequately specific. Using the second respirator model (brand B), the PM-PPUSC and PM-NPUSC methods were 100% sensitive but uniformly unable to correctly detect nonleaking respirators.

In conclusion, the PM-NPUSC shows promise as an accurate and practical means for wearers to semiquantitatively determine the quality of their user seal check, the adequacy of the respirator fit, and whether the respirator is functioning properly. With further study, this

method may serve to complement traditional positive and negative pressure user seal check methods in the workplace.

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### TELEPHONE COMMUNICATIONS WHILE WEARING A RESPIRATOR. A.T. Johnson, W.H. Scott, C.G. Lausted, University of Maryland, College Park, MD; D.M. Caretti, U.S. Army Chemical Research, Development, and Engineering Center, Aberdeen Proving Ground, MD

Respirators have been found to inhibit oral communication between wearers. However, information about communication effectiveness has not been known when a telephone is used as the communication means. In addition, communications results probably depend on the types of speech diaphragm (for speaking) and hood (for hearing) used. These tests were performed to determine how well monosyllabic words could be transmitted with two hood materials and three speech diaphragm arrangements when using the telephone.

Twelve pairs of subjects were selected from the student body at the University of Maryland. All were fluent native speakers of American English. Each participant wore a U.S. Army M-40 air-purifying respirator mask with standard hood. Treatments consisted of six combinations of three speech diaphragms and two hood materials plus a control where no respirator or hood was worn. The three speech diaphragms consisted of the standard (SD), diaphragm with a layer of sound-absorbent material (WD), and diaphragm plus U.S. Army amplifier/speaker (AD). The two hood treatments were the standard hood (SH) and hood with a wool ski cap worn underneath (WH). Subjects sat in separate rooms in contact by telephone. A computer with screen was located in each room. Whenever the talker from each pair was ready, a word from a randomly selected Modified Rhyme test (MRT) list would appear on the talker screen. This word was then spoken into the telephone, and the listener repeated the word as heard. When both agreed that the word had been correctly received, the listener indicated this by typing the word into the computer. The roles of talker and listener then reversed for the next word. A total of 60 words were sent by each talker. In this way, both accuracy and time could be monitored.

Results indicate that, for both time and accuracy, all other conditions were worse than the control. The transmission time was more than twice as long for all conditions compared with the control ( $6.2 \pm 1.8$  sec), and accuracy was about 10% less for all conditions compared with the control ( $99.1 \pm 3.0\%$ ). The amplifier seemed to decrease transmission time ( $AD=12.9 \pm 9.4$  sec;  $SD=14.0 \pm 8.3$  sec), and decrease accuracy ( $AD=89.5 \pm 10.4\%$ ;  $SD=91.4 \pm 10.8\%$ ), but the differences were not statistically significant. Hood material did not significantly affect time ( $SH=12.5 \pm 6.8$  sec;  $WH=16.1 \pm 2.2$  sec) or accuracy ( $SH=89.4 \pm 11.3\%$ ;  $WH=88.2 \pm 11.7\%$ ). The conclusion is that mask configuration other than mask materials greatly degrades telephone communications in the workplace.

**Abstracts**

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