Fit Test Evaluation of an Advanced Respirator Headform

Michael Bergman, Ziqing Zhuang, Joseph Wander, David Hanson, Brian Heimbuch, Michael McDonald, Andrew Palmiero, and Ronald Shaffer

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

New respirator test headforms are needed to evaluate N95 filtering facepiece respirator (FFR) fit against biological aerosols. The objective of this study was to develop a medium size static (i.e., non-moving) advanced headform for fit testing N95 FFRs.

Methods: An advanced respirator fit test headform was developed based on the anthropometric dimensions of new digital headforms developed by the National Institute for Occupational Safety and Health. The advanced headform also simulates the physical properties of human skin and facial tissue depth. Quantitative fit tests using a TSI PORTACOUNT Pro+ respirator fit tester were performed on seven N95 FFR models of various sizes and designs (cup, flatfold, and trifold).Two methods of FFR donning were performed for fit testing: "Method A" where FFRs were carefully donned on the headform following the respirator manufacturer's instructions, and "Method B" where the donning technique was enhanced by viewing real-time fit factor data output from the PORTACOUNT. For each method, four replicate FFR samples were tested for each of the seven models; each replicate was tested for two donnings resulting in 56 total tests for each donning method. Each fit test was composed of three one-minute exercises: "Normal Breathing" (11.2 lpm), "Deep Breathing" (20.4 lpm), and finally "Normal Breathing." Fit factors for each exercise and the "Overall" fit factor result were recorded. Analysis of variance tests were used to determine if log-transformed fit factors were statistically different among FFR models, test exercises, and donning methods.

Results: For each FFR model and each donning method, there was no significant difference (P-value > 0.05) between "Normal" and "Deep Breathing" log-transformed fit factor results. For the "Overall" log-transformed fit factor results, there was a significant difference among all FFR models for both donning methods. Additionally, for the "Overall" log-transformed fit factor results, there were some significant differences within certain models for the different donning methods.

Conclusions: FFR fit on the medium size static headform varies by FFR design and size. The N95 FFR models which are expected to achieve fit factors (FFs) > 100 on human subjects are capable of achieving FFs > 100 on the advanced headform. A screening technique improves the consistency of correctly performing the FFR donning procedure. No conclusions can be drawn about N95 FFR fit on people based on FF results obtained using the advanced headform. Further research is needed to correlate fit factors obtained with the headform to those obtained with similar sized human test subjects.