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Stockpiled N95 Filtering Facepiece Respirator Polyisoprene Strap Performance

Dana R. Rottach and Zhipeng Lei

National Institute for Occupational Safety and Health, National Personal Protective Technology Laboratory, Pittsburgh, Pennsylvania 15236

* Corresponding author and E-mail: iyq7@cdc.gov

ABSTRACT

Long term storage of personal protective equipment (PPE) in stockpiles is increasingly common in preparation for use during public health emergency responses. Confidence in PPE requires an understanding of the impact of time in storage on all aspects of PPE effectiveness, including protection against inward leakage. Disposable N95 filtering facepiece respirators (FFR) typically rely upon inexpensive elastomeric head straps to provide an effective seal between the filter body and the wearer's face. Annual fit testing provides a measure of assurance that a model fresh from the manufacturer will prove effective, but seal quality may degrade during long term storage. This study examines the stability of a selection of polyisoprene elastomer straps taken from various ages of common N95 FFRs. The tension of the straps at a predetermined strain of 150% was found to differ according to age for one respirator model, though whether due to age or due to manufacturing variations could not be determined. The straps from one manufacturer were found to have notable variation in length, indicating that minor variations in strap tensile properties may not result in significant differences in respirator seal quality. Based on our observations, prolonged storage may affect the tensile properties of headstraps for some models of N95.

Keywords: filtering facepiece respirators, stockpile respirators, respirator straps, tensile properties.

Work of Breathing for Respiratory Protective Devices: Method Implementation, Intra-, Inter-Laboratory Variability and Repeatability

William P. King[1], Margaret Sietsema[2], Caitlin McClain[1], Susan Xu[1] and Helion Dhrimaj[3]

[1] National Institute for Occupational Safety and Health, National Personal Protective Technology Laboratory, Pittsburgh, Pennsylvania 15236
[2] University of Illinois at Chicago, Chicago IL
[3] North Carolina State University, Raleigh, NC

* Corresponding author and E-mail: bwq5@cdc.gov

ABSTRACT

As part of development of performance standards, the International Organization for Standardization (ISO) technical committee, ISO/TC 94/SC 15 Respiratory protective devices (RPD), adopted work of breathing (WOB) to evaluate airflow resistance for all designs (classes) of respiratory protective devices. The interests of the National Institute for Occupational Safety and Health's (NIOSH) National Personal Protective Technology Laboratory (NPPTL) are to compare the proposed WOB method and results for current RPD with those for present resistance methods. The objectives here were to assemble a method to meet the ISO SC15 standards, validate operation and conformance, and assess repeatability of WOB measurements for RPD. WOB method implementation and use followed standards ISO 16900-5:2016 and ISO 16900-12:2016. Volume-averaged total work of breathing (WOB_T/V_T where V_T is tidal volume) determined for standard orifices was analyzed for variation and bias. After fabrication and assembly, the method gave preliminary verification orifice results that met ISO requirements and were equivalent to those from other laboratories. Evaluation of additional results from RPD testing showed tidal volume and frequency determined compliance. Appropriate adjustments reduced average absolute bias to 1.7%. Average coefficient of variation for WOB_T/V_T was 2.3%. Over 97% of results obtained during significant use over time met specifications. WOB_T/V_T for as-received air-purifying and supplied-air RPD were repeatable ($p<0.05$). WOB_T/V_T for unsealed half mask air-purifying RPD was an average of 31% lower compared to sealed. When experimental parameters were appropriately adjusted, the ISO WOB method implemented by NIOSH NPPTL consistently provided ISO-compliant verification WOB_T/V_T. Results for appropriately sealed RPD were reproducible.

Keywords: work of breathing; resistance; respirator; respiratory protective device.

Qualitative Analysis of Origins and Evolution of an Elastomeric Respirator-based Hospital Respiratory Protection Program

Stella E Hines[1], Nora Mueller[2], Marc Oliver[1], Patricia Gucer[1], Melissa McDiarmid[1]

[1] The University of Maryland-Baltimore, School of Medicine, Department of Medicine, Division of Occupational and Environmental Medicine
[2] The University of Maryland-College Park, School of Public Health, Department of Behavioral and Community Health

* Corresponding author and E-mail: shines@som.umaryland.edu

ABSTRACT

Elastomeric respirators (elastomerics) may serve as one alternative to disposable N95 respirator use in healthcare. We explored factors which drove elastomeric adoption and continued use in a large academic medical center. We conducted semi-structured and focus group interviews in 2015 with a) 11 leadership key informants (KIs) with involvement in the respiratory protection program (RPP) when elastomerics were introduced and b) 11 healthcare workers (HCWs) recruited from hospital departments assigned to use elastomerics. Interview transcripts and responses were open-coded to capture emergent themes, which were collapsed into broader categories and iteratively refined. Factors identified by leadership KIs as influencing elastomeric adoption included: 1) N95 shortages during 2009's H1N1 influenza pandemic and 2) the presence of trained, certified safety professionals who were familiar with respiratory protection requirements. Factors identified as influencing ongoing use of elastomerics included: 1) cleaning/decontamination practices, 2) storage, 3) safety culture, 4) HCW respirator knowledge, and 5) risk perception. HCW users expressed dissatisfaction related to breathing, communication and cleaning of elastomerics. Other themes included convenience use of N95s rather than assigned elastomerics, despite perceptions that elastomerics are more protective. Through semi-structured and focus group interviews, we learned that 1) leadership introduced elastomerics due to necessity but now face challenges related to ongoing use, and 2) HCWs were not satisfied with elastomerics for routine care and preferentially used N95s because they were conveniently available at point of use. Although the impetus behind incorporation of elastomerics was clear, the most complex themes related to sustainability of this form of RPP. These themes were used to inform a broader questionnaire and will address the utility of elastomerics as a feasible and acceptable practical alternative to N95s in healthcare.

Keywords: elastomeric respirator, N95 respirator; respiratory protection program; 2009 H1N1; pandemic; healthcare; reusable respirators; storage; decontamination; comfort; safety.

Evaluation of a New Instrument for Aerosol Quantitative Fit Testing

Bingbing Wu[1*], Maija Leppänen[1,2*], Michael Yermakov[1], and Sergey A. Grinshpun[1#]

[1] Center for Health-Related Aerosol Studies, Department of Environmental Health, University of Cincinnati, PO Box 670056, Cincinnati, OH 45267-0056, USA
[2] On leave from University of Eastern Finland, Department of Environmental and Biological Sciences, PO Box 1627, 70211 Kuopio, Finland

* Equal contributions
[#] Corresponding author and E-mail: sergey.grinshpun@uc.edu

ABSTRACT

Millions of workers exposed to various hazards perform fit testing to assure anticipated protection of their respirators. This testing has been conducted for about two decades mainly with a TSI PortaCount®, an instrument that measures the aerosol concentrations inside and outside the respirator using a condensation nuclei counting principle. Recently, a new fit testing instrument, Fit Tester (MT-05U) was developed for quantitative fit testing based on the optical particle counting (OPC). The objective of this study was to explore if this type of particle counter can be used for quantitative respirator fit testing. The study was performed in accordance with the American National Standards Institute (ANSI) and the American Industrial Hygiene Association Z88.10-2010 criteria for evaluating new fit test methods with the TSI PortaCount® as the reference apparatus. The overall fit factors were measured with the two instruments operating in parallel with respirators donned by 26 subjects performing the standard OSHA exercises during fit testing. The experiments were conducted with three types of high-efficiency particulate filtering respirators: P100 filtering facepiece, and two elastomeric respirators, half facepiece and full facepiece. The results showed that the MT-05U can correctly identify an inadequate fit of the tested respirators as compared with the reference instrument (with a sensitivity between 0.98 and 1.00, exceeding the ANSI requirement of ≥ 0.95). The other advisory ANSI requirements/recommendations for statistics (i.e., predictive value of a pass, specificity, predictive value of a fail, and kappa statistics) were also met. Due to the difference in operational particle size ranges of the two instruments, fit factors within pair comparison measured by MT-05U were generally lower than fit factors measured by PortaCount®. In conclusion, the new OPC-based MT-05U showed an acceptable performance in quantifying a respirator fit and, thus, can serve as an alternative method for respirators equipped with high-efficiency filters.

Keywords: quantitative respirator fit testing, optical particle counter (OPC), condensation nuclei/particle counter (CNC/CPC), filtering facepiece respirator, elastomeric half facepiece respirator, elastomeric full facepiece respirator.

Pre-World War I Firefighter Respirators and the U.S. Bureau of Mines Involvement in WWI

David Spelce[1], Timothy R Rehak[2], Richard W. Metzler[3], and James S. Johnson[4]

[1] 921 LeShea Court, Chesapeake, VA

[2] National Institute for Occupational Safety and Health, National Personal Protective Technology Laboratory, Pittsburgh, PA

[3] Richard W. Metzler Inc., 810 Longvue Drive, Houston PA

[4] JSJ and Associates, 7867 Cypress Creek Court, Pleasanton, CA

Corresponding author E-mail: Spelce@cox.net

ABSTRACT

The U.S. Bureau of Mines (USBM) was established on July 1, 1910 with a mission to address the previous decade's coal mine fatality incidence rate of greater than 2,000 annually. The need for federal government involvement to assure dependable and safe mine rescue respirators was recognized by the USBM with the first respirator approval being issued in 1919. Prior to this, some occupations exposed individuals to inhalation hazards. Firefighters, in particular, had a critical need of respiratory protection. This article provides a brief summary of pre-World War I (WWI) (1914 to 1918) respiratory protection for firefighters based largely on the work of Bruce J. Held. Also discussed is the then newly established United States Bureau of Mines' (USBM) role with the U.S. War Department during WWI for protection against chemical warfare agents.

Keywords: work of breathing; resistance; respirator; respiratory protective device.