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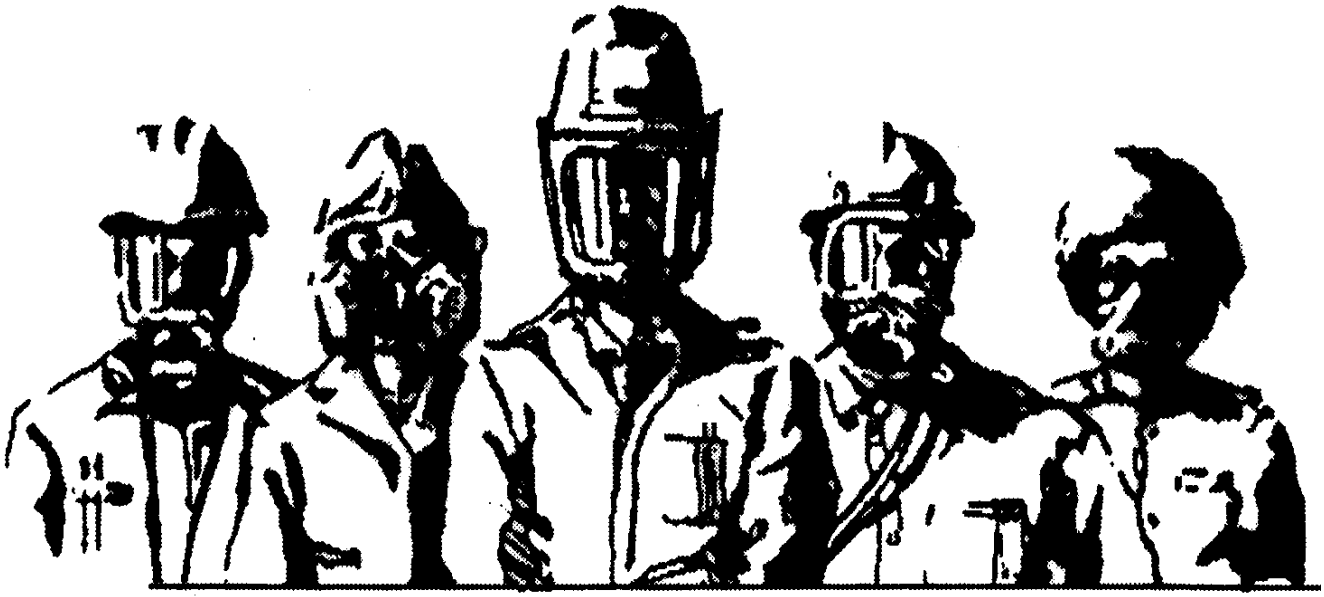

Respiratory Protection for Oxygen Deficient Atmospheres

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ABSTRACT

This article describes several aspects of oxygen (O_2) deficiency with an emphasis on respirator programs and respirator selection. The Occupational Safety and Health Administration's (OSHA) 29 CFR 1910.134[a] and ANSI/ASSE Z88.2-2015 (Z88.2) have much in common. However, their exposure criteria and terminology used for describing levels of O_2-deficiency and the approaches to assessing O_2-deficiency differ. These differences can have a significant impact on an employer's respirator program and respirator selections for workplaces at altitudes above sea level.

Under certain circumstances, Z88.2 leads to a more conservative respirator selection than OSHA because its O_2-deficiency criteria and hazard assessment approach relies directly on partial pressure of oxygen (PO_2)[b] at all altitudes. Z88.2 defines an O_2-deficient atmosphere as either immediately dangerous to life or health (IDLH), or non-IDLH based on the atmosphere's PO_2 and defines respirator selection for these two O_2-deficient atmospheres. Unlike Z88.2, OSHA does not directly access the biologically significant aspect of an atmosphere's PO_2 in its hazard assessment. OSHA defines an O_2-deficient atmosphere based upon a percentage of oxygen. OSHA does not use the term "O_2-deficient IDLH"; however, OSHA considers any atmosphere with less than 19.5% O_2 as IDLH and defines respirator selection for IDLH atmospheres. Although OSHA does not use the term "PO_2" in their respirator standard, OSHA's exceptions to O_2-deficient IDLH respirator selection policy are based on PO_2 altitude-adjusted, O_2 percentage criteria.

This article provides descriptions of OSHA and Z88.2 requirements to evaluate workplace oxygen deficiency, their approaches to O_2-deficiency hazard assessment, and describes their significance on respirator programs and selections. Alternative solutions to wearing respirators for protection against O_2-deficiency resulting solely from high altitudes are also discussed. Selection and implementation of alternative solutions by

[a] The Federal Register, which includes the final rule is referenced instead of 29 CFR 1910.134 because the Federal Register includes the preamble to the OSHA Respirator Standard, which will be referred to as the 1998 Preamble.
[b] Partial pressure (e.g., PO_2), measured in millimeters of mercury (mmHg), refers to the pressure a particular gas exerts in a mixture of gases.

the employer and their Physician or other Licensed Health Care Professional (PLHCP) are not covered by either respirator standard. Appendix A provides information about the physiological effect of wearing respirators and the mechanics of respiration, which is an important consideration in lower O_2 atmospheres.

Keywords: Respiratory protection, Oxygen Deficient Atmospheres, Respirator program, Z88.2 standards.

Asbestos Fibre Sampling through a Facepiece Visor to Measure Workplace Protection Factor

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ABSTRACT

Background: In France, the occupational limit value for asbestos (WHO definition + fine asbestos fibres) was reduced from 100 f/L to 10f/L, as analysed by analytical transmission electron microscopy, on 1st July 2015. This reduction associated with the change in analytical method to evaluate exposure to asbestos fibers in July 2012 required occupational assessment of the efficacy of respiratory protective devices used by operators during asbestos removal.

Objective: The preliminary work for this sampling campaign was to develop a CE-certified prototype standard facepiece integrating asbestos fibre sampling in line with standard XP X 43-269 (2012).

Methods: Numerical simulations and tests with live subjects and dummy heads were performed to verify the performance parameters of each model of modified mask including sampling in the visor (2 supplied air and 2 powered assisted RPDs).

Results: This article presents the results of the laboratory tests through which this way of sampling inside the facepiece was validated.

Conclusion: All the models of modified mask developed are appropriate for use in occupational settings in the limited framework of the INRS study.

Keywords: asbestos, sampling inside mask, PAPR, supplied air respirator, protection factor.

Physiologic Effects from Using Tight- and Loose-Fitting Powered Air-Purifying Respirators on Inhaled Gases, Peak Pressures, and Inhalation Temperatures During Rest and Exercise

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ABSTRACT

The goal of this investigation was to evaluate the physiologic stresses of powered air-purifying respirators (PAPRs) used by workers in many industries (e.g., health care, automobile repair, public safety, building trades, etc.) during rest and three levels of energy expenditure. Twelve men and twelve women wore one tight-fitting and three loose-fitting PAPRs at rest (REST) and while walking for four minutes at oxygen consumption ($\dot{V}O_2$) rates of 1.0 l·min^{-1}(LOW), 2.0 l·min^{-1} (MODERATE), and 3.0 l·min^{-1} or maximum (HIGH). Minimum inhaled carbon dioxide concentration (F_ICO_2), maximum inhaled oxygen concentration (F_IO_2), peak inhalation pressure, and end inhalation temperature were measured continuously breath-by-breath. Repeated measures analysis of variance found that neither the main effect of gender, nor any interactions involving gender were significant. The highest minimum F_ICO_2 among PAPRs occurred for MODERATE and HIGH energy expenditures while wearing the loose-fitting PAPR with the largest dead space. The lowest maximum F_IO_2 was observed during HIGH intensity energy expenditure also for the loose-fitting PAPR with the largest dead space. Among all PAPR models, peak inhalation pressures were negative at $\dot{V}O_2$ > LOW, suggesting that peak inhalation flow was greater than blower flow. Results using the variables reported here suggest that PAPRs used at various levels of energy expenditure may be tolerated among healthy workers. Further research is needed to determine the source of supplemented air when inhalation flow exceeds blower flow.

Keywords: PAPR, respiratory protection, inhaled gas, peak pressure, overbreathing, inhaled temperature, personal protective equipment.

Breathing Recording Aimed to Provide Appropriate Test Flow Rate on Performance Evaluation of Respirators for Elementary School Children

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ABSTRACT

Against the background of concerns over health problems such as the bird flu pandemic and $PM_{2.5}$ air pollution in Japan, there is increasing interest in the development of respirators for elementary school children that provide the same level of protection as respirators for adults. The respiratory volumes of respirator wearers have a major effect on respirator performance, and vary significantly depending on the wearer's physique and level of activity. To facilitate the creation of a protocol for the evaluation of respirator for elementary school children, we recorded breathing patterns under conditions that simulate their daily activities at school. Two types of breathing recording masks were used to accommodate a wide range of facial characteristics. These masks can record breathing patterns by measuring the changes in air pressure generated by breathing. Twenty-one elementary school children ranging from grade 1 to 6 participated in this study. Breathing patterns and heart rates were recorded while the subjects performed five exercises: (1) Sitting, (2) Writing on a blackboard, (3) Stepping, (4) Carrying a school chair, and (5) Running. The average exercise intensity, as derived from heart rates, increased from 7 to 54 %HRR as the activity level increased. Similarly, average respiratory inhalation minute volumes and peak flow rates increased from 8 to 21 L min^{-1}, and from 27 to 65 L min^{-1} respectively. Moreover, the peak flow rate at a light exertion level, which is the condition under which children are expected to use respirator, was 60.6 L min^{-1}. Consequently, a test flow rate of approximately 60 L min^{-1} may be appropriate for the performance evaluation of respirators for respiratory protection in children.

Keywords: Elementary school children, Breathing pattern, Heart rate, Exercise intensity, Dust mask.