

RESPIRATOR PERFORMANCE TERMINOLOGY

The following terms were developed by the American Industrial Hygiene Association Respiratory Protection Committee to represent respirator performance in various contexts. They should be used properly in research studies, publications and all other discussions of respirator performance to ensure clarity of meaning. In each term, C_o represents the measured or estimated concentration of contaminant in the air outside the respirator. C_i represents the measured or estimated concentration of contaminant in the air inside the respirator. The comments clarify, and are considered to be a part of, their respective definitions.

Assigned Protection Factor (APF)

The minimum expected workplace level of respiratory protection that would be provided by a properly functioning and used respirator or class of respirators to properly fitted and trained wearers when all elements of an effective respirator program are established and are being implemented.

Comments

When sufficient data exist, APF is based on statistical analysis (usually the lower 5th percentile) of a population of workplace protection factor measurements. The APF should be achieved at least 95% of the time a respirator is properly worn. APFs have also been established using simulated workplace protection factors or other information. The APF takes into account all potential sources of facepiece penetration (e.g., face seal penetration, filter penetration, valve leakage). It does not account for factors that degrade protection such as poor maintenance, failure to follow manufacturer's instructions, and failure to wear the respirator during the entire exposure period.

Effective Protection Factor (EPF)

A measure of the protection provided by a properly selected, fit tested and functioning respirator when it is worn for only some fraction of the total exposure period in the workplace.

Comments

EPF is the ratio of the contaminant concentration outside the respirator to that in the air actually inhaled. It is determined by sampling outside the respirator and in the breathing zone during the total exposure period, regardless of whether the respirator is being worn. While the respirator is worn, breathing zone sampling is done from within

the respirator. EPF is strongly influenced by non-wear time, regardless of the respirator's WPF.

EPF may also be estimated by correcting appropriately measured workplace protection factors (WPF) for the time that the respirator is not worn during the exposure period using the following formula. It can be validly applied only if the air contaminant concentration is relatively constant over the exposure period.

$$EPF = \frac{T_s}{\frac{T_w}{WPF} + T_{nw}}$$

Where:

T_s = Shift or exposure duration (hours).

T_w = Number of hours respirator is worn.

T_{nw} = Number of hours that respirator is not worn.

Fit Factor

A numeric expression of how well a tight-fitting respirator fits a wearer during a fit test.

Comments

Fit factor represents the ratio of a challenge agent outside the respirator to the challenge agent that leaks into the respirator. Fit factors are most commonly aerosol or gas concentration ratios expressed as C_o/C_i , but can also be derived using air flows or other challenges. This definition is not meant to preclude the use of novel methods.

Laboratory Protection Factor

A laboratory measurement of respirator performance on test subjects when one or more of the conditions for a SWPF is not met.

Comments

These studies can be used to examine individual aspects of respirator performance. Examples include, evaluation of particle penetration through improperly selected filters, performance of tight-fitting respirators that are not fit tested, and improper air flow to atmosphere supplying respirators.

Program Protection Factor (PPF)

An estimate of the respiratory protection provided to a worker in the context of a specific respirator program.

Comments

PPF represents the contaminant concentration which the wearer would inhale if the respirator were not worn (C_o) divided by the contaminant concentration inside the respirator as the respirator is used in the context of the existing respirator program (C_i). The inside of the respirator concentration may be estimated indirectly from biological monitoring as the airborne concentration expected to produce the measured biological index (*except for contaminants with significant risk of skin absorption or ingestion, or if there is a substantial background level in body fluids from non-occupational sources*). The program protection factor is a measure of the effectiveness of the site's respirator program. Factors which may affect the program protection factor are the activity of the wearer in that setting, the motivation of the wearer, the fit of the respirator, respirator selection, the respirator design, training, maintenance, storage, supervision, program administration and monitoring, and any other variable that affects program effectiveness. If any of these program elements are deficient, the program protection factor will be adversely affected.

Qualitative Fit Factor (QLFF)

An estimate of the minimum fit factor for a specific tight-fitting respirator to a specific individual when a validated qualitative fit test is passed, i.e., the test agent is not detected by the subject's senses.

Comments

A validated qualitative fit test is one that meets the sensitivity criteria of ANSI standard Z88.10 or is listed in 29 CFR 1910.134. For example, currently accepted qualitative fit tests provide an estimated fit factor of 100.

Quantitative Fit Factor (QNFF)

The fit factor established during a quantitative fit test for a specific tight-fitting respirator to a specific individual.

Comments

QNFF is intended to represent facepiece to face seal leakage. Leakage from other sources (e.g., air purifying elements, damage, etc.) is intended to be essentially zero.

QNFF is measured with specialized instrumentation while the subject performs prescribed test exercises.

Simulated Workplace Protection Factor (SWPF)

A measure of respirator performance that is done in a laboratory using test exercises designed to simulate work. The respirator must be properly selected, fit tested, worn and used.

Comments

SWPF is determined by simultaneously measuring a test atmosphere concentration outside (C_o) and inside (C_i) a properly functioning respirator. Immediately sequential C_o and C_i samples are acceptable. If the test atmosphere concentration is well controlled, C_o samples may be shorter than C_i samples. Filter and/or cartridge penetration may or may not contribute to the C_i measurement. It may also be desirable to match the exposure and environmental conditions (e.g., temperature, humidity, etc.) to those of the workplace.

Workplace Protection Factor (WPF)

A measure of the protection provided in the workplace, under the conditions of that workplace, by a properly selected, fit tested and functioning respirator while it is correctly worn and used.

Comments

WPF is a direct measurement of respirator performance in a specific work environment. It represents the workplace contaminant concentration outside the respirator (C_o) divided by the contaminant concentration inside the respirator (C_i). C_o and C_i must be measured simultaneously, only while the respirator is properly worn and used during normal work activities. Immediately sequential C_o and C_i samples of similar duration are acceptable when integrated sampling methods are not available, but must be used with caution. Filter and/or cartridge penetration may or may not contribute to the C_i measurement. C_i measurements made using respirators that are poorly maintained, improperly used, or not worn during the entire exposure period are inappropriate for WPF determination

Respirator Performance Measurements Made Using Manikins

Manikin Filter Efficiency Factor (mFEF)

The concentration of an airborne challenge outside a respirator divided by the concentration of the challenge that enters the respirator through its filter media. Airflow rate, airflow pattern (e.g., continuous, sinusoidal, etc.) and environmental conditions must be specified. It is measured with the respirator sealed to a manikin.

Manikin Fit Factor (mFF)

An expression related to the amount of leakage measured through the face or neck seal of a respirator mounted to a manikin under specified airflow and environmental conditions. If the challenge to the seal is an airborne substance, it is the ratio of its airborne concentration outside the respirator divided by the concentration that enters the respirator through the seal. If the challenge is airflow or air pressure, conditions and assumptions for quantifying leakage must be specified. Leakage from other sources (e.g., air purifying elements) must be essentially zero. The respirator may 1) Be mounted to the manikin without sealants; 2) be partially sealed to the manikin; or 3) be sealed to the manikin with artificially induced leaks.

Manikin Total Penetration (mTP)

The fraction of an airborne challenge that enters a respirator mounted to a manikin from any source. Common sources of penetration include, but are not limited to, the face seal and the filter medium. Airflow rate, airflow pattern and environmental conditions must be specified. The respirator is not sealed to the manikin.