Evaluation of Respirator Face Seals on Non-Encapsulating Protective Ensembles by Outward Leakage Method

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Background

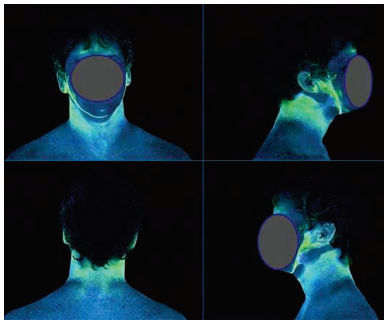
Chemical protective ensembles commonly referred to HAZMAT suits are the combination of protective elements that protect against specified threats. The highest level of protection for these ensembles are full encapsulating, single piece suits. In contrast, non-encapsulating ensembles offer protection by combining specific elements such as respirators, garments, gloves, and boots. The combination of these element creates interfaces and gaps between elements creating areas of susceptibility. Currently, methods that test entire ensembles for susceptibility are costly, inward leakage tests such as the Man-In-Simulant Test (MIST), the Particle Inward Leakage Test, and the Liquidtight Integrity test. The novel concept of outward leakage would create a cost effective, widely available, in-field method for evaluating the particulate protection of protective ensembles.

Concept

The concept of outward leakage is to use a concentrated particulate or smoke simulant introduced into the inside of an ensemble to create a measurable or visual indication of leakage outside of the ensemble. In this experiment an aerosolized smoke is pumped into a holding chamber, this chamber is then pressurized to gradually release the smoke into a manikin donned with selected full protective ensembles. The smoke simulant amalgamates into the air in the suit and creates a moderate airflow. This airflow permits the smoke simulant to penetrate through interfaces, gaps, and materials in the ensemble that would also be subject to inward leakage.

Outward vs Inward Leakage

Outward leakage through a firefighter hood



Fluorescing particles deposited under a firefighter hood

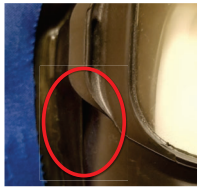
NFPA 1994
Class 2
Ensemble

Intended Results

The results of this experiment are meant to identify fundamental and specific problems that exist between a protective suit's face seal and the respirator. Variability of factors includes the size, shape, and thickness of the face seal; the geometry, malleability, and structure of the respirator. By identifying common factors leading to outward leakage, it would be possible to assess the performance of a suit/respirator combination similar to existing inward leakage methods.

Preliminary Results

Early data indicates that there are two important factors affecting outward leakage of an ensemble's face seal/respirator interface. The first consideration is protrusions and nonconformities such as side straps on the respirator creating gaps underneath the face seal (bottom, left). The second consideration is the malleability of the respirator allowing the face seal to 'crush' the respirator creating gaps with the face seal (bottom right).



Future Work

Future work will take results from outward leakage and compare them to existing inward leakage tests using the same suit/respirator combinations.