THREAT AGENT DEFEAT MODELING AND TESTING USING WMD SIMULANTS

A Singular Test Capability For The Measurement Of Environmental Persistence Of Biological Threats And Simulants In Aerosol And On Surfaces

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Background: A key parameter when modeling threats posed by biological materials is their persistence, specifically the loss of viability/infectivity while exposed to environmental conditions during aerosol transport and/or while settled on surfaces. The availability of quantitative persistence data needed for threat characterization models has been restricted by test limitations in such ways as biological particle size and state, time duration, environmental conditions, and containment status.

Purpose: In support of the Probabilistic Analysis for National Threats Hazards and Risks (PANTHR) program within the Department of Homeland Security (DHS) Science and Technology Directorate (S&T), Battelle has developed, demonstrated, and delivered a test fixture that can be used to quantify the environmental persistence of current and emerging biological threats in a high-containment setting without many of the constraints of previous test capabilities. The test capability can be applied to support simulant selection for model-validation studies and other efforts where materials requiring high-containment cannot be used.

Methods: Starting with work performed by Battelle in 2013-2015 to indefinitely suspend 1-10+ µm biological particles on 2-µm microfibers (a simulated aerosol state), the capability has been improved and expanded to include aerosol collection onto non-porous and porous substrates within a singular test fixture operated in a Class III BSC within a high-containment laboratory.

Results: Test results have demonstrated successful aerosol loading of up to 10-µm aerosol particles onto three types of surfaces: 2-µm microfibers (to represent indefinite aerosol suspension), non-porous substrates, and porous substrates; followed by exposure to controlled temperature, humidity, and solar light environmental conditions for durations of up to several days within the same test fixture.

The test fixture holds 18 independent samples for conducting time-phased exposure evaluations. Aerosols can be loaded with ≤0.25 log variability (95% CI) across the 18 samples for microfibers and initially tested non-porous (stainless steel) and porous (Arizona Test Dust) substrates. Achievable exposure conditions range from 10-50°C with 0-70% RH and include incident simulated solar light that can be spectrally shaped to mimic desired conditions. Exposure uniformity across the 18 samples (within 1% solar intensity, 1° temperature, 5% RH) ensures each sample is subjected to consistent conditions. The test fixture design could be expanded to include more complex conditions (such as inclusion of ozone and other atmospheric contaminants).

Conclusions: The singular test fixture has been demonstrated to solve many of the limitations associated with previous test capabilities designed to generate quantitative biological persistence data, including the use of particle sizes of 1-10+ µm without the confounding issues of particle loss, the ability to achieve actual aerosol settling onto many type of substrates, which is more realistic compared to liquid inoculation of test material onto substrates; and the ability to operate within high-containment.

Impact to DTRA: This capability provides the defense community with a test fixture to quantify biological material persistence in aerosol and on porous/non-porous surfaces across a wide range of environmental conditions without particle size limitations. This capability can improve biological threat models by providing/refining persistence data for current and emerging threats using both simulants and agents.