

Wet Vacuum-Based Sampling of *Bacillus* spores on Selected Indoor and Outdoor Surfaces

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Introduction



A release of hazardous biological material in an urban area would require sampling for characterization and post decontamination using various methods depending on the surface types. Individual methods are material dependent for application and limited for sampling area (1 – 4 ft² per sample). This study evaluated commercial wet vacuums as a sampling tool and this method is widely available, applicable on various surfaces, and easy to operate.

Technical Approach

Phase I: Evaluation of Wet Vacuum Cleaner Operational Parameters

The tested parameters are:

Sampling Liquid Type

- deionized (DI) water
- phosphate-buffered saline with Tween® 20 (PBST)
- DI water with Tween® 20 at 0.05% concentration

Contact Time

- 1 sec where the liquid was pulled immediately following spraying
- 30, 100, and 300 sec.

Liquid Volume

- Effect of liquid volume applied for sampling on spore recovery at a constant elapsed time.

Phase II: Commercially-Available Wet Vacuum Cleaner Evaluation

As part of Phase II tests, various commercial wet vacuums were evaluated for their effectiveness on spore surface sampling on realistic conditions using the results of Phase I.

Testing and Sampling Approach

For both Phase I and Phase II tests, aerosol deposited *Bacillus* spores (10⁶-10⁷) were used on surface coupons. The sampling efficiencies of the selected wet vacuums were compared to the recoveries obtained by currently-used surface sampling methods.

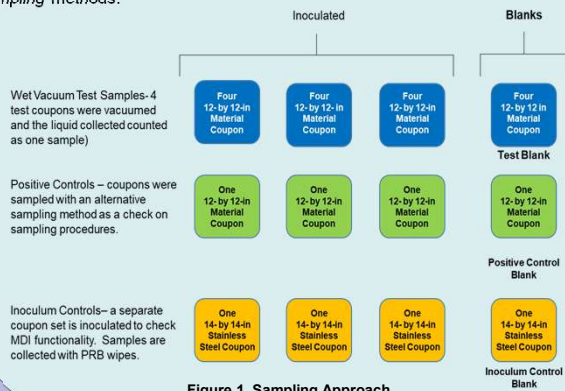


Figure 1. Sampling Approach

Tested Materials and Wet Vacuums

Phase I



Figure 2. Modified Wet Vacuum from Dry Vacuum



Figure 3. 28 x28 in Test Coupons

Phase II



Figure 4. Commercial Wet Vacuums



Figure 5. Phase II Test Coupon Schematic

Spore Preparation and Inoculation

Inoculation of Coupons

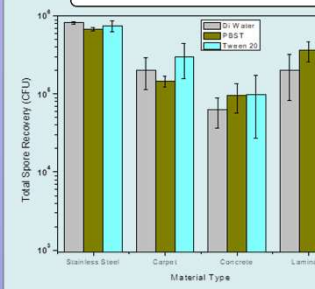


Figure 6. Phase I Carpet Coupon with Skirt and ADA.

Test coupons for Phase I and Phase II were inoculated with approximately 10⁶-10⁷ aerosolized spores on the same day using an aerosol deposition method.

Test Results

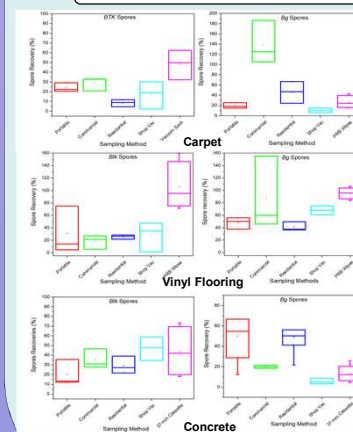
Phase I Summary



1. DI water-Tween liquid solution achieved the highest recovery among the tested liquid types. (Figure 7).
2. Concrete surface tests showed a marked effect of elapsed time on the spore recovery effectiveness. Concrete surfaces needs to be vacuumed as soon as the liquid is applied.

Figure 7. Spore Recovery for Material/Liquid collection Combination

Phase II Summary



Recoveries (%) for the wet vacuums (independent of material type and surrogate type), varied between 32 ± 20 % for the portable, 25 ± 26 % for Shop-Vac, 33 ± 17 % for the residential, and 55 ± 52 % for the commercial vacuum.

The overall results show that sampling via wet vacuum is a viable sampling methods. All wet vacuum cleaner spore recoveries were within an order of magnitude of the material-specific sampling methods (PRB wipe, vacuum sock, and 37 mm cassette).

Figure 8. Sampling Efficacy of the Various Sampling Methods for Btk and Bg Spores inoculated on Concrete