Key Uncertainties for Determining Clean Up Standards for *B. anthracis*

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Response Concentrations/Clean Up Standards

- We can not feasibly achieve zero risk
- Even if we insist on zero measured spores the measurement process will only provide a certain level of confidence that spores are below a particular concentration
- Using an integrated fate-transport and dose-response model we can link risk levels to environmental concentrations
- Set environmental concentration action levels that are informed by risk estimates

Key Uncertainties for Determining Clean Up Standards for *B. anthracis*

The response concentration values for *Bacillus anthracis* spores are affected by many factors including:

- Decision to be made
  - Retrospective exposure assessment (air release)
  - Prospective exposure assessment (surface release)
- Values of decision maker
  - What level of risk should mitigation be undertaken?
- Parameter uncertainties
  - Surface concentration of *anthracis* spores,
  - Human inhalation rate,
  - Dimensions of the office
  - Deposition velocities and resuspension velocities of *anthracis* spores,
  - *Bacillus anthracis*' dose response,
  - Properties of the HVAC system.

Objective

- To investigate how clean up standards for *anthracis* spores on various surfaces are affected by uncertainty in a variety of inputs:
  - Only the tracked surface is analyzed as an example
  - For further information see Hong 2009 M.S. thesis

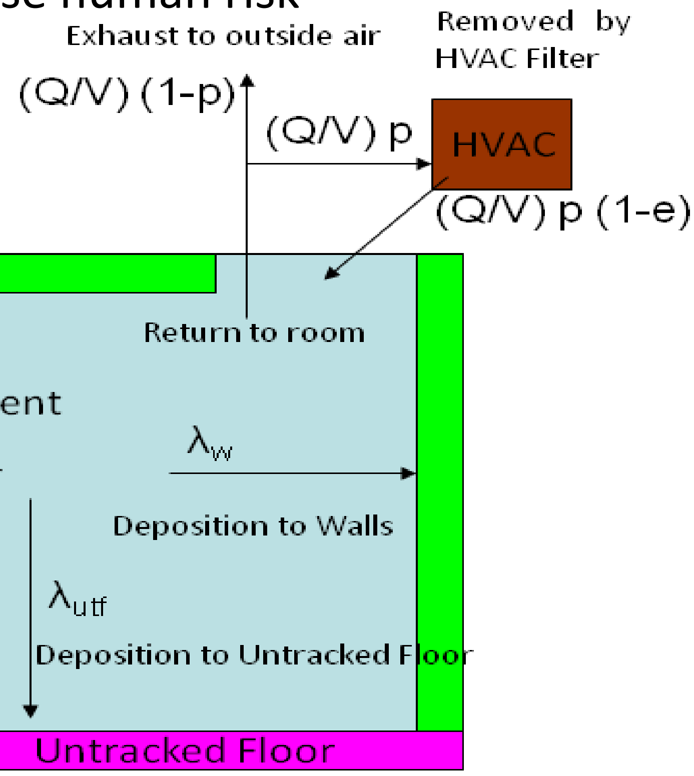
Method

Bacillus anthracis spores are released in the following office suite with 6 internal compartments:

1) air, 2) tracked floor, 3) untracked floor, 4) walls, 5) ceiling,

6) HVAC, and human nasal passages.

Completely mixed model not appropriate for near vicinity of release, high dose animal models used to estimate low dose human risk



Using surface concentration to estimate risk (retrospective scenario)

- Only inhalation risk is considered here
- The risk due to inhalation can be estimated by concentrations on surfaces (tracked floor, untracked floor, walls, HVAC filter and nasal passages):
- When $t_a = t_1 = 0$ and $t_b = t_2$

$$C_{tf} = \frac{\lambda_{tf} V}{A_{tf}} \int_{t_a}^{t_b} C_{air}(t)dt$$

$$\text{dose} = \text{Inh} \int_{t_1}^{t_2} C_{air}(t)dt$$

$$\frac{A_{tf} C_{tf}}{\lambda_{tf} V} = \int C_{air}(t)dt = \frac{\text{dose}}{\text{Inh}}$$

$$C_{tf} = \frac{\text{risk} \times \nu_{tf}}{r\ \text{Inh}}$$

Retrospective exposure assessment: Spores released in the air

Clean up standard for various surfaces

Equation used to compute clean up standard	Surface
$C_{uf} \approx \frac{\text{risk } v_{uf}}{\text{r Inh}}$	Untracked floor
$C_{w} \approx \frac{\text{risk } v_{w}}{\text{r Inh}}$	Walls
$C_{f} \approx \frac{\text{risk e p Q}}{\text{r Inh } A_{f}}$	HVAC filter
$C_{n} \approx \frac{\text{risk } e_{n}}{\text{r } A_{n}}$	Nasal passages

Prospective exposure assessment: Spores are released on the tracked floor

- The risk considered here is due to inhalation of spores resuspended from the tracked floor;

- Only the initial concentration on the tracked floor will be linked with future risk;

- $C_{tf} = \dfrac{\text{risk } V}{r \text{ Inh } \Gamma}$

Parameters

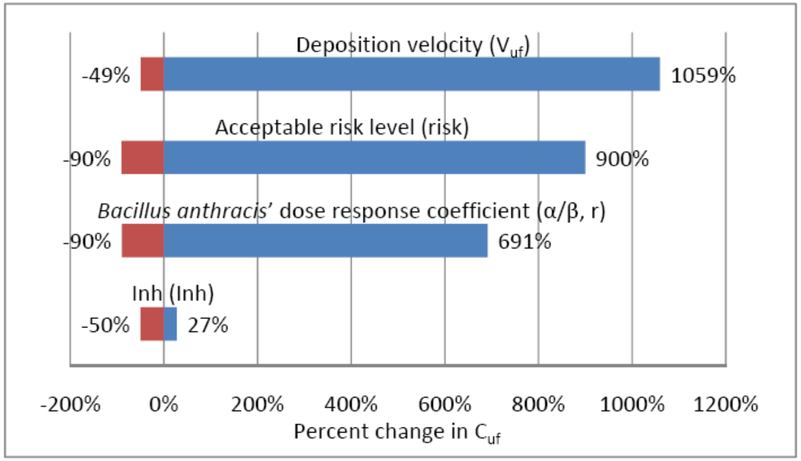
35 parameters are created to model the fate and transport of released *Bacillus anthracis* and estimate the mortality risk due to inhalation, which could be categorized into the following groups:

Parameter category	Number of parameters with ranges	Total number of parameters
Size of releasing area	0	7
Particle movement	9	13
HVAC property	5	11
Risk estimation	4	4

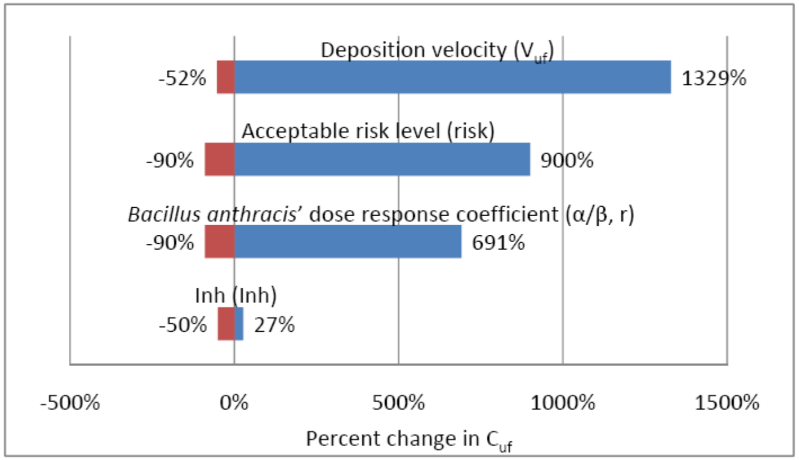
Method

- Sensitivity analysis will be applied to both scenarios, in order to better understand the impact of these factors and identify dominant parameters in the process of deciding clean up standard.

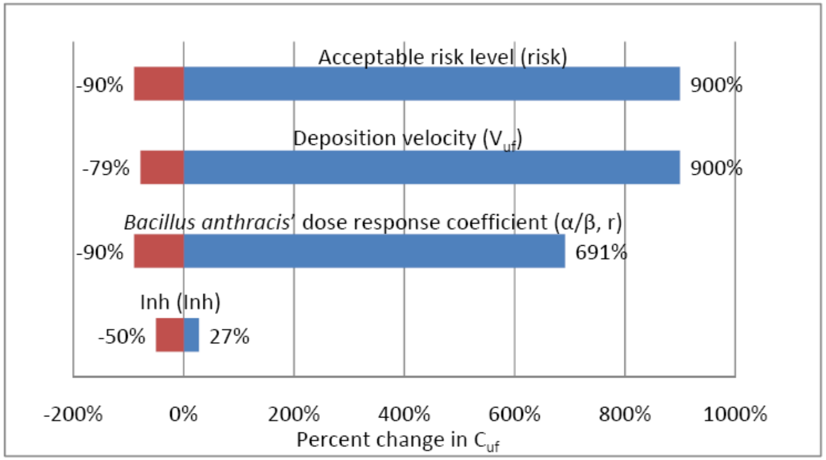
Uncertainties in standards for untracked floor (retrospective)



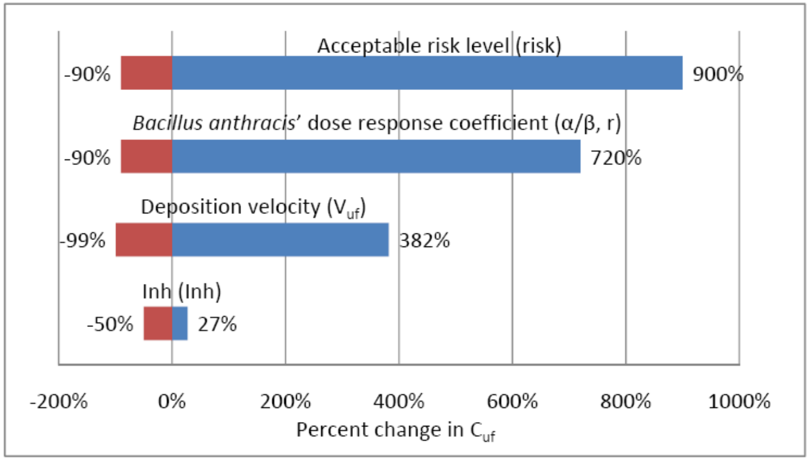
•**One-way Tornado Graph for C_{uf} (1 µm)**



•**One-way Tornado Graph for C_{uf} (3 µm)**

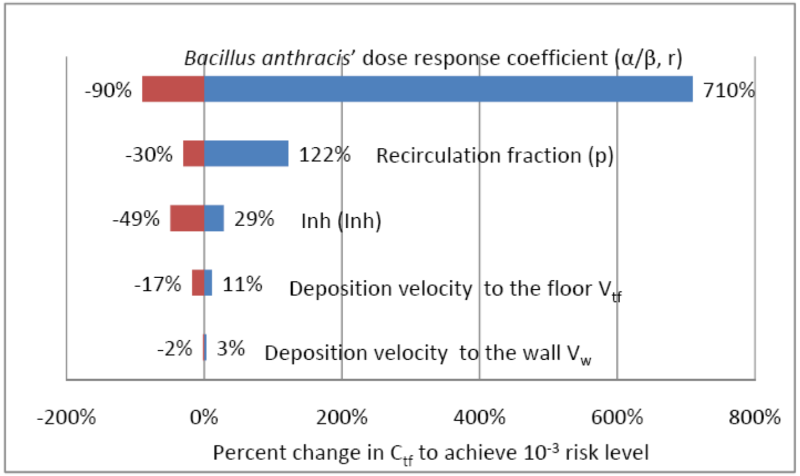


•**One-way Tornado Graph for C_{uf} (5 µm)**

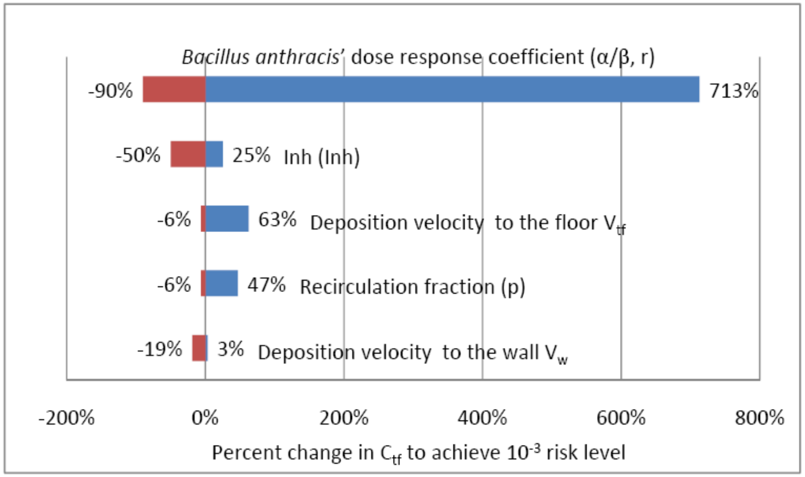


•**One-way Tornado Graph for C_{uf} (10 µm)**

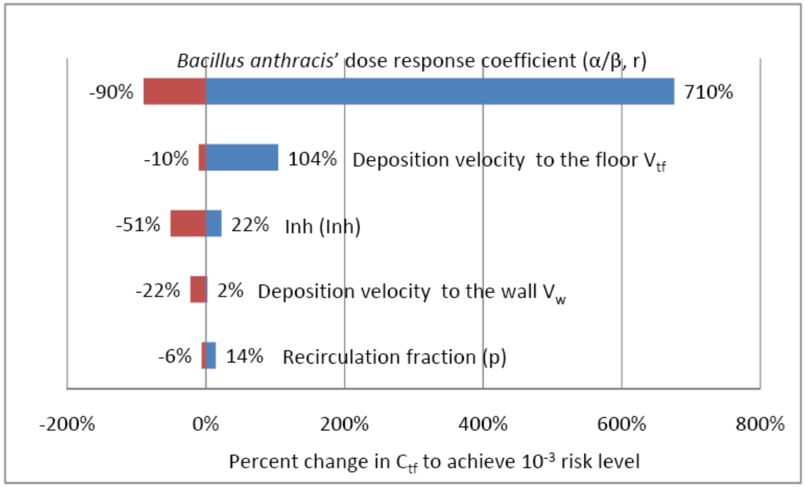
Uncertainties in standards for tracked floor (prospective)



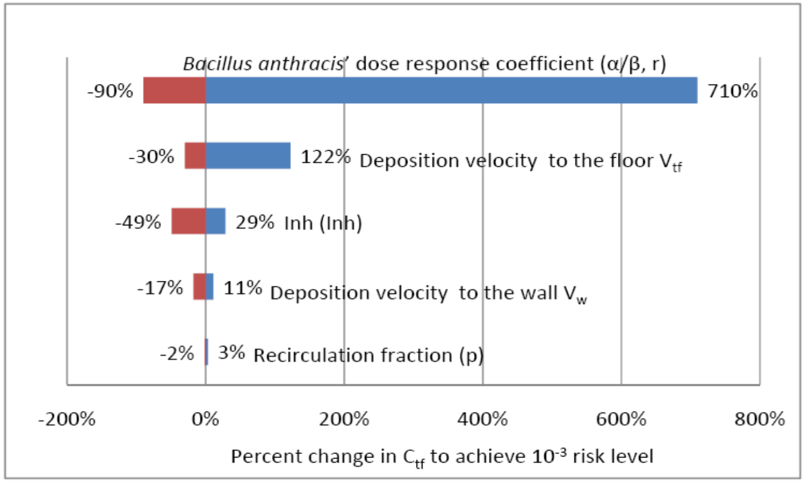
•One-way Tornado Graph
for C_{tf} (1 μm)



•One-way Tornado Graph
for C_{tf} (3 μm)



•One-way Tornado Graph
for C_{tf} (5 μm)



•One-way Tornado Graph
for C_{tf} (10 μm)

Discussion

- Key uncertainties assessment
  - Allowable risk level (value uncertainty)
  - *Bacillus anthracis*' deposition velocity (variability vs. uncertainty)
  - Dose-response coefficient (variability vs. uncertainty)

- Which of these uncertainties are reducible?

- Sampling efficiency not considered here but valid questions remain (Skolnick and Hamilton 2004)

Skolnick, E. B. and R. G. Hamilton (2004). Legacy science suggests improved surface testing practices for detection of dispersed bioagents in bioterrorism response. 2004 National Environmental Monitoring Conference. Washington, DC.

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Question?