**Supplementary Information for Measured removal rates of chrysotile asbestos
fibers from air and comparison with theoretical estimates based on gravitational
settling and dilution ventilation**

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Supplemental Figure A: Fiber Distribution by Fiber Length for all Fiber Diameters and by Fiber Diameter for all Fiber Lengths for the Grade 7T Chrysotile Used in the Study.

Supplemental Figure B: Depiction of Grade 7T Chrysotile Fiber Dispersion into the Study Chamber.

Supplemental Table C: Time-weighted Average Normalized Concentrations (TWA Concentration/Initial Concentration): Comparison of Measured Values and the Values Calculated from Decay Curves

In order to compare the fitted and calculated decay curves to the measured values, normalized TWA average estimates were calculated by averaging the decay curve instantaneous concentration estimates during the applicable time periods (i.e. 0 to 5 min, 0 to 15 min, and 15 to 30 min after clothes handling and shake out). Regarding the measured data, a normalized mean was estimated for the decay curve fit using the best estimates for the Equation 1 parameters, as well as using the 95% lower confidence limit (LCL) and 95% upper confidence limit (UCL) estimates of the Equation 1 parameters.

	Decay Curve Fit to Measured Data	Decay Curve Expected from Ventilation Effects Alone	Decay Curve Expected from Non-Ventilation Effects Alone	Measured Data
Time Range	Normalized TWA mean (LCL - UCL) (f/cc)	Normalized TWA (f/cc)	Normalized TWA (f/cc)	Normalized TWA mean (range) (f/cc)
0-5 min	0.68 (0.51 - 0.88)	0.87	0.82	0.58 (0.26 - 0.74)
0-15 min	0.39 (0.25 - 0.62)	0.67	0.57	0.42 (0.17 - 0.82)
15-30 min	0.05 (0.01 - 0.18)	0.28	0.16	0.14 (0.08 - 0.2)

Supplemental Methods Information

Measurement Approach: Estimating the Fiber Decay Constant (k) Using Measured Air Sampling Data

C_0 describes the model initial concentration associated with clothes handling and shakeout immediately before the fiber settling period begins. The initial concentration ($C_{0,measured}$) was estimated from the samples taken during clothes handling and shake out as shown in Equation (a):

$$C_{0,measured} = (5/20)(SO\ 0-5min) + (15/20)(SO\ 0-15min) \quad (a)$$

Since there were two SO 0-15 minute samples per event (left and right lapels), the average of the two values was used in Equation (a).

Whereas $C(t)$ in Equation (1) is an instantaneous concentration at time= t , the measured concentrations in this study were from samples collected over the span of five or 15 minutes. Thus, to fit Equation (1) to the measured data, Equations (b), (c), and (d) were derived to describe the time-weighted average concentrations corresponding to the sampling periods of the study as shown:

$$C_{0-5min} = \frac{1}{5} \int_0^5 C_0 \exp(-kt) dt \quad (b)$$

$$C_{0-15min} = \frac{1}{15} \int_0^{15} C_0 \exp(-kt) dt \quad (c)$$

$$C_{15-30min} = \frac{1}{15} \int_{15}^{30} C_0 \exp(-kt) dt \quad (d)$$

where C_{0-5min} Equation (b) describes the model TWA concentration associated with the Fiber Settling (FS) 0-5 minute samples; $C_{0-15min}$ Equation (c) describes the model TWA concentration associated with the FS 0-15 min samples; and, $C_{15-30min}$ Equation (d) describes the model TWA concentration associated with the FS 15-30min samples.

To determine the model parameters C_0 and k , the following system of equations was solved by using a least squares fit (Huet et al., 1996):

$$C_0 = C_{0,measured} \quad (e)$$

$$C_{0-5min} = \text{FS 0-5 min} \quad (f)$$

$$C_{0-15min} = \text{FS 0-15 min} \quad (g)$$

$$C_{15-30min} = \text{FS 15-30 min} \quad (h)$$

Since each of the six clothes handling and shake out events had a different initial fiber concentration ($C_{0,measured}$), a separate model fit was performed for each of the six events. In addition, a model fit was performed on the combined data from all six events, after first normalizing the concentrations by dividing by $C_{0,measured}$ for the corresponding event such that all initial normalized concentrations were equal to 1.

Modeling Approach: Estimating the Fiber Decay Constant (k) Using Calculated Gravitational Settling Velocity

To evaluate utility of gravitational settling models for estimating the rate of airborne fiber removal, fiber decay curves were generated that relied on calculated estimates of gravitational settling velocity (w_d). The resultant fiber decay curves were compared to the decay rate observed

from the measured airborne chrysotile PCME concentrations. Two approaches were used to calculate gravitational settling velocity: (1) the method from Hinds (1999), which incorporates a unitless shape factor to account for the fibrous shape of asbestos particles, and (2) the method from Sawyer and Spooner (1978), an older gravitational settling model that does not use a shape factor. For the Hinds (1999) method, gravitational settling velocity was calculated using Equation (i):

$$w_d = \frac{\rho_d \times g \times (d_{eff} \times 10^{-6} \text{ m}/\mu\text{m})^2}{18 \times \eta \times \phi} \quad (\text{i})$$

Where w_d is the settling velocity (m/sec), ρ_d is the particle density (kg/m^3), g is the acceleration due to gravity ($9.8 \text{ m}/\text{sec}^2$), d_{eff} is the effective particle diameter (μm), η is the viscosity of air ($1.82 \times 10^{-5} \text{ kg}/\text{m} \cdot \text{sec}$) and ϕ is the shape factor (unitless). The particle density was assumed to be $2.5 \text{ g}/\text{cm}^3$ ($2500 \text{ kg}/\text{m}^3$) (U.S. National Library of Medicine, 2015). For the Hinds approach, the effective particle diameter (d_{eff}) and shape factor (ϕ) were calculated using Equations (j) and (k) assuming the fibers had a cylindrical shape (Hinds, 1999; Johnson et al., 1987):

$$D_{eff} = (1.5 \times D^2 \times L)^{1/3} \quad (\text{j})$$

$$\phi = \left[0.246 + 0.531 \times \Psi + 0.258 \times \left(\frac{D_{eff}}{D_n} \right) - 0.036 \times \left(\frac{D_{max}}{D_n} \right) \right]^{-1} \quad (\text{k})$$

Where D is the fiber diameter (μm), L is the fiber length (μm), D_{eff} is the effective fiber diameter based on a sphere with volume equivalent to the fiber which is treated as a cylinder with

diameter D and length L (μm), D_n is the projected area diameter of the fiber (μm), and D_{max} is the maximum projected area diameter of the fiber (μm), and Ψ is the sphericity factor of the cylinder. The shape factor was estimated as the average value for a cylinder moving from a vertical to a horizontal orientation with D_{max} equal to L and D_n equal to 2*(D+L)/π. Sphericity (Ψ) was calculated using the following equation:

$$\Psi = \frac{6 \times V}{D_{eff} \times SA} \quad (l)$$

Where V is the volume of the fiber (μm³) and SA is the surface area of the fiber (μm²).

The Sawyer and Spooner (1978) estimates of settling velocity were calculated using Equation (m):

$$w_d = \frac{m_p \times g}{3 \times \pi \times \eta \times D_{eff} \times 10^{-6} m / \mu m} \quad (m)$$

Where m_p is the mass of the particle (kg), calculated by multiplying the particle density by the particle volume and assuming that the particle is an ellipsoid with volume (1/6)π(L)(D)². For Sawyer and Spooner (1978), the D_{eff} was calculated using the equations in Appendix B of Sawyer and Spooner (1978) assuming that fibers have an ellipsoid shape (pill shape) instead of a cylindrical shape.

Supplemental Methods References:

Huet, S, A Bouvier, MA Gruet, and E Joliet. 1996. Statistical Tools for Nonlinear Regression, A Practical Guide with S-PLUS Examples. Springer, New York.

Johnson, DL, D Leith, and PC Reist. 1987. Drag on non-spherical orthotropic aerosol particles. J. Aerosol Sci. 18(1):87-97.

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