

Appendix G. Estimation of Fiber Detection Limit Using the NIOSH Membrane Filter Method (P&CAM 239)

The NIOSH Membrane Filter Method for measuring airborne fibers is used to determine compliance with the OSHA exposure standard for asbestos. The lowest level at which fibers can be reliably detected (detection limit) is reported to be 0.1 fibers per cubic centimeter.* However, the detection limit depends on total volume of air sampled and decreases as the volume increases. For uses of this method other than determining compliance with OSHA, a detection limit should be calculated in conjunction with specifying a sampling time and a sampling rate.

Based on a study of counting fibers with phase contrast microscopy, NIOSH has specified that at least 10 fibers must be observed in 100 microscopic fields.† The lower detection limit (expressed in fibers per cubic centimeter) can be calculated from this value as follows:

$$DL = [(10 \text{ fibers}/100 \text{ fields})/V] (FA/MFA) (1 \text{ liter}/1,000 \text{ cm}^3)$$

where:

DL = detection limit in fibers/cubic centimeter

V = volume of air sampled in liters

FA = effective collecting area of the filter in square millimeters (typically 855 mm²)

MFA = microscopic field area in square millimeters (typically 0.003-0.006 mm²)

For a sampling time of 8 hours at a rate of 2 liters per minute, the V is 960 liters and, assuming FA is 855 and MFA is 0.003 square millimeters, the DL is approximately 0.03 fibers per cubic centimeter:

$$V = (2 \text{ liters}/\text{min}) (60 \text{ min}/\text{hour}) (8 \text{ hours}) = 960 \text{ liters}$$

$$DL = \left(\frac{10 \text{ fibers}/100 \text{ fields}}{960 \text{ liters}/\text{filter}} \right) \left(\frac{855 \text{ mm}^2/\text{filter}}{0.003 \text{ mm}^2/\text{field}} \right) \left(\frac{1 \text{ liter}}{1,000 \text{ cm}^3} \right)$$

$$DL = 0.0297 \text{ fibers}/\text{cm}^3$$

Because of differences between microscopes, the size of field of view may vary. Most microscopes have an MFA at the 100 x magnification between 0.003 and 0.006 mm². For an MFA of 0.006 mm², the DL in the above example would be 0.0148 fibers/cm³.

The effective collecting area will also vary with the filter size. The FA is 855 mm² for a 37 mm filter.

*Leidel NA, Boyer SG, Zumwalde RD, Busch KA. February 1979. *USPHS/NIOSH Membrane Filter Method for Evaluating Airborne Asbestos Fiber*. Washington, DC: National Institute of Occupational Safety and Health.

†The coefficient of variation (standard deviation divided by the mean) is reported to be 41 percent when counting an average of 10 fibers per 100 fields. (Leidel, *op cit.*)