AN EVALUATION OF GLOVE BAG CONTAINMENT IN ASBESTOS REMOVAL

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PREFACE

Under the Occupational Safety and Health Act of 1970, the National Institute for Occupational Safety and Health (NIOSH) has been given a number of responsibilities including the identification of occupational safety and health hazards, evaluation of these hazards, and recommendation of standards to regulatory agencies to control the hazards. Located in the Department of Health and Human Services (formerly DHEW), NIOSH conducts research separate from the standard setting and enforcement functions conducted by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards. The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering has been given the lead within NIOSH to study the engineering aspects relevant to the control of these hazards in the workplace.

In 1984, researchers from the Division of Physical Sciences and Engineering conducted a pilot study to survey the use of engineering controls in asbestos removal. A major recommendation from that study was to obtain documentation of the effectiveness of control techniques in current use. The use of glove bags was selected as the first control to be evaluated. Because the Environmental Protection Agency (EPA) also needed information as to the efficacy of glove bag removal technology, a joint study of the control of asbestos emissions from pipe lagging removal was conducted in June and July of 1985.

This report presents an evaluation of glove bag control techniques used to contain the emission of asbestos fibers during the removal of asbestos-containing pipe lagging. The data were obtained during week-long surveys in each of four public school buildings. Reports detailing the specific conditions and operations observed at each pipe lagging removal site surveyed were prepared.[1-4] Copies of these reports may be purchased from the National Technical Information Service (NTIS), Port Royal Road, Springfield, Virginia 22161.

ABSTRACT

This report examines the effectiveness of the glove bag control method to prevent asbestos emissions during the removal of asbestos-containing pipe lagging. Glove bags have been used for asbestos removal without supplemental engineering controls or respiratory protection. This study has two objectives: (1) to evaluate the efficacy of glove bags to contain asbestos fibers, thereby protecting abatement workers from exposure to asbestos and preventing subsequent contamination of the building and environment during the removal of asbestos-containing materials; and (2) to evaluate aggressive vs. nonaggressive sampling methods for determining the efficacy of asbestos abatement.

Workplace airborne asbestos exposures were determined during asbestos removal operations in four public schools. The same work crew removed asbestos-containing pipe lagging in all four schools. Personal exposures to airborne fibers were determined using NIOSH Method 7400 phase contrast microscopy (PCM) methods. Exposure measurements determined from personal samples indicated short-term exposures as high as 9.0 f/cc (9,000,000 f/m^3) and time-weighted average exposures of 0.3 f/cc (300,000 f/m^3) occurred during asbestos removal operations.

In conjunction with the U.S. Environmental Protection Agency (EPA), additional evaluations were made to measure residual work site contamination resulting from incomplete glove bag containment. Airborne asbestos contamination was determined in the work area before and after removal. Aggressive and nonaggressive sampling techniques were used for collecting area samples both before removal, and after removal and subsequent cleaning. Sample analysis was performed using both PCM and transmission electron microscopy (TEM) methods. Samples taken during nonaggressive sampling procedures and analyzed by PCM typically indicated concentrations below 0.01 f/cc (10,000 f/m^3), both for pre- and post-removal. TEM analysis of side-by-side samples detected much higher asbestos concentrations than PCM for both pre- and post-removal because PCM does not detect fibers less than about 0.25 µm in diameter.

Higher fiber concentrations were also observed when TEM analysis was compared with PCM analysis for both nonaggressive and aggressive sampling. In addition, samples collected by aggressive sampling demonstrated a greater magnitude of asbestos contamination following asbestos removal with glove bags compared to the pre-removal samples. The choice of sampling method (aggressive or nonaggressive) and of analytical method (PCM or TEM) could thus have an effect on the perceived level of asbestos contamination. It could lead to different conclusions regarding the presence or absence of low level asbestos contamination.

Exposure concentrations found at these four schools indicate that glove bags, as used during this study, did not completely contain the asbestos being removed. In three of the four facilities studied, workers were exposed to airborne asbestos concentrations above the OSHA PEL. The asbestos concentrations observed in the last of the surveys indicated that glove bags may provide some degree of containment under certain conditions. Although worker training and experience are important components of a reliable system of control measures, the present study does not provide a basis to specify conditions under which adequate containment can be assured. It is prudent to assume that the use of glove bags results in unpredictable exposure levels that may present an exposure hazard to workers and contamination of the work site.

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GLOSSARY

NOTE: This study was conducted using both NIOSH and EPA analytical methods. In general, NIOSH methods were used for occupational exposures. Both NIOSH and EPA methods were used to determine asbestos abatement evaluations. For PCM samples analyzed by Method 7400,[17] the total count is reported as fibers. For TEM samples analyzed by the revised Yamate Method,[19] separate counts are made for fibers, bundles, clusters, and matrixes and the sum of these categories is reported as structures. The original NIOSH Method 7402[20], in place at the time of this study, also followed this method of reporting. (In May 1989, a revision of Method 7402[21] was issued, wherein only particles fitting the definition of Method 7400 are counted and are reported as fibers.) The terminology used in the present study is fibers for PCM results and structures for TEM results.

Abatement	Removal or otherwise treating ACM to prevent contamination of buildings with asbestos.
Aggressive sampling	A sampling method using blowers and/or fans to keep particulates suspended during the sampling period.
Amended water	Water containing wetting agents, penetrants, and/or other agents to enhance the wetting of ACM and thereby reduce the generation of dust.
Asbestos	A group of impure magnesium silicate minerals which occur in fibrous form. These heat and chemical resistant materials with high tensile strength have been fabricated into a multitude of forms to utilize these characteristics. The more common mineral forms are known as: actinolite, amosite, anthophyllite, chrysotile, crocidolite, and tremolite.
Aspect ratio	The ratio of the length to the width of a particle or fiber.
Bundle	EPA:[11] A structure composed of three or more fibers in a parallel arrangement with each fiber closer than one fiber diameter. NIOSH:[20] A compact arrangement of parallel fibers in which separate fibers or fibrils may only be visible at the ends of the bundle. Asbestos bundles having aspect ratios of 3:1 or greater and less than 3 µm in diameter are counted as fibers.

Cluster	EPA:[11] A structure with fibers in a random arrangement such that all fibers are intermixed and no single fiber is isolated from the group. Groupings must have more than two intersections. NIOSH:[20] A network of randomly-oriented interlocking fibers arranged so that no fiber is isolated from the group. Dimensions of clusters can only be roughly estimated and clusters are defined arbitrarily to consist of more than four individual fibers.
Field Blank	A clean filter cassette assembly which is taken to the sampling site, handled in every way as the air samples, except that no air is drawn through it.
Fiber	EPA:[11] A structure having a minimum length equal to 0.5 µm and an aspect ratio (length to width) of 5:1 or greater with substantially parallel sides. NIOSH:[14] "A Rules" - Count only fibers longer than 5 µm. Measure the length of curved fibers along the curve. Count only fibers with a length-to-width ratio equal to or greater than 3:1. "B Rules" - Each fiber must be longer than 5 µm and less than 3 µm in diameter . . . with a length-to-width ratio equal or greater than 5:1.
f/cc	Fibers per cubic centimeter.
f/m^3	Fibers per cubic meter.
Filter background level	The concentration of structures per square millimeter of filter that is considered indistinguishable from the concentration measured on a blank (filters through which no air has been drawn).
Grid	An open lattice for mounting on the sample to aid in its examination by TEM. The term is used by the EPA to denote a 200-mesh copper lattice approximately 3 mm in diameter.
Intersection	Nonparallel touching or crossing of fibers, with the projection having an aspect ratio of 5:1 or greater.
Lpm	Liters per minute.
Matrix	EPA:[11] Fiber or fibers with one end free and the other end imbedded in or hidden by a particulate. The exposed fiber must meet the fiber definition. NIOSH:[20] One or more fibers attached to or imbedded in a nonasbestos particle.
Nonaggressive sampling	An environmental sampling method performed in a quiescent atmosphere.

Operations & Maintenance Program (O&M P)	A program of training, work practices, and periodic surveillance to maintain friable ACBM in good condition, ensure cleanup of asbestos fibers previously released, and prevent further release by minimizing and controlling friable ACBM disturbance or damage.
Pipe lagging	ACM used to insulate pipes carrying heated or refrigerated liquids or vapors.
Poly	Polyethylene sheeting.
Structure	A microscopic bundle, cluster, fiber, or matrix which may contain asbestos.[11]
s/cc^3	Structures per cubic centimeter.
s/mm^2	Structures per square millimeter.

ACRONYMS

ACBM Asbestos-containing building material.

ACM Asbestos-containing material.

AHERA Asbestos Hazard Emergency Response Act.

CV Coefficient of variation.

EDXA Energy dispersive X-ray analysis.

EPA The Environmental Protection Agency.

FAM Fibrous aerosol monitor.

HEPA High efficiency particulate air -- a designation for a type of filter capable of filtering out particles of 0.3 μm or greater from a body of air at 99.97 percent efficiency or greater.

LOD Limit of detection.

LOQ Limit of quantification.

MSHA The Mine Safety and Health Administration.

NIOSH The National Institute for Occupational Safety and Health.

OSHA The Occupational Safety and Health Administration.

PBZ Personal breathing zone. Breathing zone samples are commonly collected by a device secured to the lapel of a worker's uniform.

PCM Phase contrast microscopy.

PEL Permissible exposure limit, an OSHA standard designating the maximum occupational exposure permitted, as an 8-hour TWA.

REL Recommended exposure limit, the NIOSH recommendation for maximum occupational exposure.

RSD Relative standard deviation.

SAED Selected area electron diffraction.

SEM Scanning electron microscope or microscopy.

STD Standard deviation.

STEM Scanning transmission electron microscope.

TEM Transmission electron microscope or microscopy.

TWA Time-weighted average.