CONTROLLING FIBER RELEASES FROM PLASTERS CONTAINING <%1 ASBESTOS

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Introduction

The regulatory definition for asbestos containing material (ACM) in most areas of the United States is 1% (by weight). After appropriate sample preparation, bulk samples are typically analyzed by polarized light microscopy (or PLM, i.e., NIOSH Method 9002, EPA 600/R-93/), methods developed for materials such as friable fireproofing and thermal insulation where the asbestos content is often >> 10%. However, for samples with asbestos concentrations near or below 1% (the lower limit of detection for PLM), these methods are recognized as highly unreliable. Unfortunately, many building materials, including plasters and certain joint compounds, contain asbestos in concentrations ranging from 0.1-1%.

Laboratories analyzing bulk samples by PLM routinely report samples containing < 1% as either "trace" or "none detected". Since these results are widely interpreted as meaning "no asbestos present", few industrial hygienists have performed employee exposure assessments or implemented exposure controls for work with plasters or other building materials containing these low levels of asbestos.

We initiated a study of low concentration asbestos-containing plasters in buildings at Yale University and their potential to liberate fibers during routine maintenance operations. We concluded this work by evaluating several practical control methodologies for minimizing the release of asbestos fibers from low-level asbestos-containing plasters.

Materials and Methods

Asbestos-in-Plaster Determinations

1. Plaster wall surfaces in approximately 200 buildings at Yale University evaluated for asbestos concentration.
2. Samples collected by cross-sectional coring with hollow diamond tipped bit, and analyzed visually by low-power magnification under dissecting microscope (Figures 1 - 3). Each layer isolated and analyzed separately.
3. Samples analyzed by gravimetric reduction (Dr. Eric Chatfield, Chatfield Technical Consulting, Mississauga, Ontario, Canada), using a method that reliably quantitates asbestos to 0.1% by weight.
4. Plasters in buildings constructed between 1925 and 1945 contained asbestos in nearly all base coat layers (2-layer plaster systems) or middle (brown) coat (3-layer systems). Asbestos (chrysotile) concentrations range from 0.2 - 0.6%. Other plaster layers typically did not contain asbestos.

Task/Control Screening

1. Discussions with Physical Plant staff identified 4 common operations and maintenance tasks that intrude upon plaster walls: fastening materials with screws, drilling holes for anchor placement, coring small holes in walls, and chiseling off sections of plaster for small electrical installations.
2. We screened and then tested on asbestos containing plaster using a variety of coring, drilling, slotting, and surface grinding tools that could meet Physical Plant operational needs and also be fitted with local exhaust (Figure 4).
3. Preliminary screening consisted of visual observations (video tape) and real-time measurements of dust generated from use on 1/2 inch thickness gypsum board (Figure 5). Gypsum board was chosen as test substrate since its dust is essentially non-toxic, and is readily observable and measurable.
4. Based upon preliminary screening, the most successful tool/control combinations were tested on a plaster wall containing 0.5% asbestos.

Plaster Test Location

1. Small classroom within building built early 1930s selected for actual asbestos-plaster exposure evaluations.
2. Walls consisted of two-layer plaster system (base and finish coats only) applied directly over terra cotta blocking. Finish coat covered with multiple layers of paint. (Figure 1)
3. Plaster base coat approximately 3/4 to 1 inch thick and contained 0.5% chrysotile asbestos (range 0.4-0.6%), while finish coat (1/16 to 1/8 inch thick) contained < 0.1% asbestos. Asbestos concentration determinations made by Chatfield method.
4. Room prepared as standard asbestos abatement enclosure, with HEPA filtered exhaust, sealed plastic barriers, and restricted entry.

Task/Exposure Evaluations

1. Routine maintenance and renovation operations on plaster performed within containment using standard asbestos abatement techniques and protective equipment. Enclosure exhaust deliberately turned off during task evaluations to maximize airborne fiber concentrations.
2. Duration for each activity assessment (typically 1 - 2 hours) determined by target level of sensitivity, anticipated nuisance dust levels, and sampling pump flow rates.
3. After each test run, walls and flooring of enclosure HEPA vacuumed, and room air purged for > 10 min (minimum ten room air volume changes).

Detailed Task Descriptions

1. Fastening with Screws (Figure 6): Metal framing studs fastened to walls with 2" self-tapping sheet rock screws. Screws passed through plaster into supporting terra cotta blocking. Screws set with standard 3/8-inch power drill driver at rate of about one every 10 seconds. Control method evaluated: covering wall with duct tape prior to setting screws.
2. Anchor Hole Drilling and Wall Coring (Figure 7-10): Holes drilled through plaster and supporting terra cotta blocking with 1/2" and 1 1/2" bits using industrial-sized impact hammer drills. Smaller drill used to model anchor hole drilling, larger drill used to assess hole coring. Rubber bellows shroud that extended around drill bit and connected to HEPA filtered vacuum (flow rate ca. 80 cfm through shroud), was evaluated as control on smaller drills. For coring work, 2 inch hollow diamond tipped bit (that could be fitted to HEPA vacuum and exhausted through bit center) evaluated as replacement for large standard solid bits for coring.
3. Manual Chiseling (Figure 11): 8" x 8" section of plaster stripped (dry) from supporting terra cotta blocking with hammer and chisel. No control technique evaluated. Physical Plant staff, however, concur that a large (5-6" diameter) hollow diamond tipped bit (as described above) could effectively replace hammer and chisel in this task, with benefit of local exhaust.

Figure 1

Figure 2

Figure 3

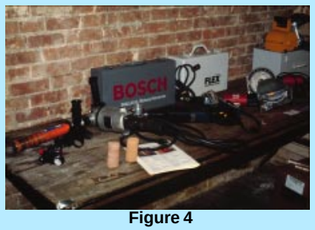

Figure 4

Figure 5

Figure 6

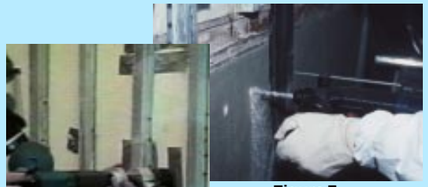

Figure 7

Figure 8

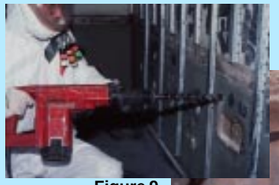

Figure 9

Figure 10

Figure 11

Figure 12

Materials and Methods (con't.)

Exposure Monitoring

- Personal (breathing zone) asbestos fiber air samples collected and analyzed by NIOSH Method 7400 (Figure 12). Since this method assumes all counted fibers to be asbestos, transmission electron microscopy (Yamate - EPA Level II method) was used to verify presence of asbestos on samples.
- Total air volumes collected adjusted according to dust (and hence overloading) generated by task, and ranged from ~ 50 L for uncontrolled dusty tasks to ~ 1200 L for well-controlled low dust tasks.
- At least three replicate samples collected for each task assessment, and at least one field and laboratory blank submitted for each sampled task.

Table 1
Asbestos Exposures During Plaster Intrusions (0.5% chrysotile)

TASK	DESCRIPTION	CONTROL METHOD	PERSONAL EXPOSURE (fpcc)		
			Mean	±SD	Range
Screw Setting	Continuously fastening metal studs to plaster wall with sheet rock screws. Screws passed through plaster into substrate.	None	0.0157 (n=4)	0.013	0.010- 0.018
	As above	Duct tape used as plaster barrier for screw setting	0.006 (n=3)	0.0023	0.0032-0.0073
Hole Drilling	Continuously drilling holes through plaster and substrate. Plaster debris dry swept.	None	0.22 (n=5)	0.05	0.15-0.27
	As above	Local exhaust through rubber bellows surrounding drill bit	0.008 (n=7)	0.004	0.003-0.015
Manual Chiseling	Removing 8" x 8" section of plaster from substrate with hammer and chisel over 30 minutes. Plaster debris dry swept.	None	0.30 (n=8)	0.21	0.11-0.68
Coring	Continuous coring holes though plaster and substrate with 2" diameter hollow bit.	Local exhaust through bit	0.068 (n=4)	0.031	0.04-0.11

Results

1. Air sampling data (Table 1) show that many maintenance/minor renovation activities on plaster walls containing less than 1% asbestos can generate personal exposures up to 0.7 fpcc for duration of work activity.
2. Not surprisingly, chiseling generated highest fiber levels (mean = 0.30 fpcc), followed by small hole drilling (mean = 0.22 fpcc), and sheet rock screw fastening (mean = 0.017 fpcc).
3. Tools with local exhaust controls reduced exposures by at least 3-4 fold over similar uncontrolled operations, and by over an order of magnitude for drilling. Fiber exposures during screw fastening could be reduced an additional 70% by first applying duct tape to the plaster as a barrier.

Conclusions

Routine operations and maintenance tasks with plaster surfaces have the potential to exceed the current OSHA PEL for asbestos even when the plaster contains < 1% asbestos. For actual compliance purposes, however, time-weighted average exposures must be calculated; these will be highly dependent upon work frequency and individual task/activity duration. For most of the operations evaluated here, a duration of 4 or more hours will create over-exposures. Tools with local exhaust ventilation at the point of operation are highly effective at reducing fiber exposures. As a separate finding, real time dust monitoring and video taping work activities on simple gypsum board were effective and inexpensive means for evaluating dust control techniques, and highly predictive of work on asbestos-containing plaster.

Since most industrial hygienists and regulatory agencies consider materials with < 1% asbestos as unregulated material, and therefore do not perform exposure evaluations or specify dust controls for work with these materials, our findings have significant implications for plaster intrusive work. Specifically, efforts must be taken to understand the limitations of traditional bulk sample analytical results, and protective work practices extended to "trace" asbestos-containing materials if the work is highly dust generating (i.e., demolition, chopping, large hole drilling or coring, chiseling) or occurs over an extended period of time.

Acknowledgements

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