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Exposure to Airborne Asbestos During Abatement of Ceiling Material, Window Caulking, Floor Tile and Roofing Material

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Asbestos abatement is a major environmental industry in the United States and other countries, especially those that are identified as developed (Hoskins 2001). Historically, asbestos-containing materials (ACM) have been associated with a number of occupational diseases; although, past exposures were much greater than that experienced in today's industrial environment (Yarborough 2006), especially the abatement industry. Occurrence of diseases associated with asbestos has resulted in removal of various types of building materials that are ACM. Unfortunately, for most types of abatement, there is limited information on exposure. It is common to have only a few samples collected on a project or those that are collected routinely performed improperly. In addition, there is little information in the published literature on exposure levels for various types of ACM and in some cases only a few samples have been collected with authors' attempting to use these as the basis of historical concentrations. As with concerns from the past (Lange and Thomulka 2001), information on exposure concentrations experienced by workers in this industry will be critical for evaluating potential disease scenarios, especially since one of the major asbestos diseases, lung cancer, is greatly influenced by tobacco consumption (i.e. smoking) (Yarborough 2006). This becomes a great importance since those in the asbestos abatement industry may have the highest percentage of smokers of any categorizable occupational group (Lange et al. 2006).

Since there is a latency period of 10–40 years for asbestos-related diseases (Yarborough 2006), with the abatement industry starting around 1987 (Lange et al. 1987) after passage of a United States Environmental Protection Agency (EPA) regulation; any diseases related to exposure in this occupational group should begin to emerge based on this time frame. However, based on recently published exposure levels, disease related to exposure in this group is not likely to occur (Lange 2005). However, as mentioned, due to the high smoking rate, respiratory disease will be a major occurrence with many claiming causation due to asbestos. Thus, there is currently a gap on information relating to exposure associated with the asbestos abatement industry.

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Materials and Methods

Air samples were collected using 25-mm diameter electrically conductive extension cowl cassettes consisting of mixed cellulose ester filters [0.8 μm (pore size)] and analyzed by phase contrast microscopy (PCM) as previously described (Lange and Thomulka 2001). Personal, including excursion limit (EL), and area (perimeter and background) samples were collected with a flow rate of 2 and 10 L (nominal) per minute, respectively. Samples, personal and EL, were collected in the breathing zone, which was defined as a two foot radius around the head. Personal sample results were reported as a time-weighted average (TWA) and area (perimeter and background) samples as a task-length average. All area samples were collected for at least 2 h. Background samples were collected in the general work area before the start of work and perimeter samples outside the work area, but in close proximately, usually within 10 ft of the containment structure. No background samples were collected from project C. Excursion limit samples were collected for 30 min for a total of 60 L.

Plaster and floor tile/mastic (FT/mastic) abatement involved establishment of critical barriers and full enclosure with a decontamination chamber (three stages and negative air filtration – NAF). Caulking removal did not include removal of windows; although, had a critical barrier enclosure around the window with no NAF. Roofing was performed without any containment. Wet methods were employed for plaster only, with other work generally following the Occupational Safety and Health Administration (OSHA) requirements for asbestos.

Any value reported below the detection limit was included in calculations at one-half of this value (Oehlert et al. 1995). The detection limits, in fiber per cubic centimeter (f/cc), for area/personal and EL samples were 0.1 and 0.08, respectively. Asbestos abatement was performed in various schools located in the eastern part of the United States in 2000. Materials abated contained more than 1% asbestos, which by regulatory definition is characterized as ACM. Determination of asbestos in a building material was preformed by polarized light microscopy. Final clearance samples (five) were aggressively collected from the work area of each project and analyzed by transmission electron microscopy (Environmental Protection Agency 1987).

Exposure results are expressed in f/cc – TWA – personal or f/cc-30 min/day (EL), and summarized as: measures of central tendency, arithmetic and geometric means (AM, GM); standard and geometric deviations (SD, GSD); and range. Probability of overexposure was determined for at least 5% of employees' that may be exposed above OSHA's occupational exposure limit (permissible exposure limit – PEL – 0.1 f/cc-TWA). A graphic method was used in performing computations (Leidel et al. 1977; Lange and Thomulka 2001). The OSHA EL criterion is 1.0 f/cc-30 min/day.

Results and Discussion

Air sample concentrations for each project are shown in Table 1. All exposures, including the highest individual

Table 1 Summary statistics for air samples, in f/cc, involving abatement of various types of materials

Type of sample	Nos. of samples	AM	GM	SD	GSD	Range
Project A – FT/mastic[c]						
Personal	11	<0.01	<0.01+	ND	ND	<0.01–<0.02
Excursion	7	<0.08	<0.08+	ND	ND	<0.08
Background	7	<0.01	<0.01+	ND	ND	<0.01
Perimeter	53	<0.01	<0.01	ND	ND	<0.01–<0.03[b]
Project B – FT/mastic[c]						
Personal	14	<0.01	<0.01+	ND	ND	<0.01–<0.02
Excursion	18	<0.08	<0.08+	ND	ND	<0.08
Background	4	<0.01	<0.01+	ND	ND	<0.01
Perimeter	60	<0.01	<0.01+	ND	ND	<0.01–<0.02
Project C						
Roofing						
Personal	11	<0.01	<0.01+	ND	ND	<0.01
Excursion	11	<0.08	<0.08+	ND	ND	<0.08
Perimeter	43	<0.01	<0.01+	ND	ND	<0.01–<0.02
Window caulking						
Personal	2	<0.01	<0.01+	ND	ND	<0.01
Excursion	2	<0.08	<0.08+	ND	ND	<0.08
Perimeter	7	<0.01	<0.01+	ND	ND	<0.01–<0.02
Plaster						
Personal	13	0.02	0.02	0.02	1.9	<0.01–0.05
Excursion	14	0.09	0.08	0.05	1.7	<0.08–0.24
Perimeter	85	<0.01	<0.01[a]	ND	ND	<0.01–<0.02

[a] All samples were the same concentration, or below the detection limit, and do not allow calculation of a SD or GSD

[b] One sample had a reportable value of 0.02; approximate project duration for A, B and C were 6, 9 and 11 days, respectively

[c] Limited wet methods used

measurement, were below the OSHA PEL and EL, with most of the samples below detection limits. The highest exposure levels were associated with plaster abatement, which are more likely to be in a friable condition when removed. Perimeter, background, similar airborne concentrations were observed for FT/mastic, roofing and window caulking. Exposure concentrations observed in this investigation are similar to that reported in other published asbestos abatement exposure studies (Lange and Thomulka 2000a, b, 2001, 2002; Lange 2001). All work areas (regulated areas) passed the final clearance criteria of less than 70 structures/mm^2. Background levels, using PCM, have been defined as <0.01 f/cc.

The probability of overexposure regarding personal and EL samples for projects A, B, roofing and window caulking is <5%. For plaster, the EL probably is also <5% and for personal measurements about 20%. Based on these results and that of other investigations (Lange and Thomulka 2001), there is little likelihood that workers performing these operations will experience elevated exposure to airborne asbestos.

These results, along with that of previous studies (Lange and Thomulka 2001; Lange 2005), indicate that the exposure received from this type of work does not pose a "significant" risk for an asbestos occupational disease. Much of the regulation of asbestos is based on the precautionary principle (Yarborough 2006), which when evaluated in regard to these and others sample results (Lange and Thomulka 2001) is greatly over reaching. During these activities workers were required to wear respirators, which would not provide benefit against airborne contaminants as a result of the concentrations being low. Use of these devices, however, do increase strain on the respiratory system (Lange and Thomulka 2001). Science, especially the medical sciences, has moved steadily towards an evidence-based approach. The environmental and occupational sciences have not taken full realization of this concept, with many aspects remaining in the area of anecdotal information. This is especially true for many of the regulations, including those regarding ACM. Recent studies (Yarborough 2006) have indicated that the most common type of asbestos used in the US, chrysotile, carries little risk associated with exposure, even at levels well above the PEL; although, other reports do suggest a risk (Joshi and Gupta 2004). There has been a suggestion that this material be re-introduced in building products. It has great benefits in commercial and industrial applications, as an example, in fire prevention. Using this example, inclusion of chrysotile in fire protection related materials would likely save many lives in the US and other countries, with few if any, when used appropriately, asbestos related diseases occurring.

There is little hazard associated with ACM that are non-friable. This is by the definition of not being able to be crumbled or pulverized to powder by hand pressure. Even though these materials can be broken, based on the current exposure data, no exposure occurs, especially when compared to area/perimeter sampling. As previously suggested, the current regulatory scheme related to these and other types of ACM can be considered as a form of regulating science. Even plaster does not result in elevated exposure concentrations that can be considered an occupational hazard. Current exposure data does not support inclusion of caulking, roofing and FT/mastic as regulated ACM (Lange 2001). This investigation, along with others (Lange and Thomulka 2001), support the findings in this study. Thus, the asbestos industry is over-regulated and appears to have become more related to its bureaucracy, rather for protection of those potentially exposed. A re-evaluation of the hazards associated with asbestos, especially that of chrysotile, is needed. This is most evident in regard to the recent scientific evidence (Yarborough 2006), which reports that there is little or no risk relating to chrysotile. Thus, the abatement industry can be considered as an example of over-regulation.

Since these occupational groups have a high rate of smoking, estimated to be around 80% (Lange et al. 2006), this habit will be responsible for future disease associated with this population. Resources spent on the current regulations would be more efficiently utilized in smoking prevention. This would result in a greater reduction of future disease than strict regulation of asbestos abatement, with some materials warranting de-regulation and re-introduction as commercial/industrial products (Yarborough 2006).

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