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Comparison of Asbestos Exposure in a Containment System With and Without Employment of Glovebags

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Removal of asbestos-containing materials (ACM) in the United States and other countries throughout the world is a common industrial practice (Dobrovolsky, 1998; Maltoni, 1999). These activities result in billions of dollars in expenditure per year by public and private sectors (Hoskins, 2001). The basis of such activity is suggested hazards from asbestos (Jaffery et al 1988; Maltoni, 1999). Regulatory requirements establish much of the work activities, methods and practices for asbestos abatement (Allegheny County Health Department - ACHD, 1996; US Occupational Safety and Health Administration - OSHA, 1999; Lange and Thomulka, 2000). However, recent publications (Lange, 2001) have suggested that these regulatory requirements may actually be anecdotal and lack sufficient scientific testing in determination of effectiveness.

This study collected exposure data during asbestos abatement of asbestos-containing pipe and boiler insulation at an industrial facility. ACM were abated inside a containment structure with and without glovebags. Glovebags were designed for removal of small quantities of insulation, primarily pipe insulation, generally about three feet at a time (OSHA, 1999). Regulatory requirements do not generally allow the bag to be moved along the pipe (ACHD, 1996).

Exposure to workers removing pipe/boiler insulation with and without glovebags was evaluated. Such data provide information on exposure during abatement of similar materials with two different work practices.

MATERIALS AND METHODS

Personal air samples were collected in 2002 from the breathing zone of workers as previously described (Lange and Thomulka, 2000). These samples were analyzed using Phase Contrast Microscopy (OSHA, 1999). Samples were task-length average (TLA). Sample collection rate was 2 lpm (nominal). The location of this project was in a heavy industrial facility in the eastern section of the United States. Insulation on pipes and boilers was identified as ACM using Polarized Light Microscopy (PCM). ACM is defined as a material containing greater than one percent asbestos.

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Abatement practices followed requirements established by the OSHA (OSHA, 1999). Pipe and boiler insulation was abated with and without glovebags. Glovebags were used only once and not moved over the work surface (pipe). Workers were not informed that these data would be used as part of a study.

Exposure results were reported as summary statistics (Lange, 2001). Statistical evaluation was performed using the Wilicoxon Rank Sum test (Lange and Thomulka, 2000). Confidence intervals (CI), at 95%, were determined using a method for non-normal populations (Lange and Thomulka, 2000). Statistical significance was defined at 5%. Any samples below the reportable detection limited were included in calculations at one-half the reported value (Oehlert et al. 1995). Probability of at least 5% of workers exceeding the OSHA Permissible Exposure Limit (PEL) (0.1 f/cc-time weighted average - TWA) was determined using a graphic method as previously described (Leidel et al. 1977). Potential of exceeding the PEL was calculated using TLA's for each sample.

RESULTS AND DISCUSSION

Summary statistics for samples with and without employment of glovebags are shown (table). Exposure levels were descriptive and statistically higher when glovebags were not employed. No single sample (TLA) exceeded the OSHA PEL for airborne asbestos. The upper and lower CIs for exposure levels with and without glovebagging were 0.005 to 0.007 f/cc and 0.018 to 0.028 f/cc, respectively. Thus, the highest exposure value predicted from CIs, with and without glovebagging, does not exceed the OSHA PEL. The highest values reported for all samples was 0.09 f/cc (without glovebag). Probability that 5% or greater of employees will have exposures (TLA) that exceed the OSHA PEL for with and without glovebag use is around 38% and 5%, respectively. If values were adjusted for a TWA the probability of overexposure for both practices become less than 5%. The driving factor for the 38% value for without glovebag using TLA exposures is sample variability (geometric standard deviation - GSD).

GSDs for both with and without glovebag use suggest that exposure samples are non-normally distributed. Previous studies (Lange and Thomulka, 2000) of airborne asbestos have shown a lognormal distribution (non-normal). The exposure difference between glovebag use and non-use is suggested to be significant but not functionally effective when considered for amount of exposure to workers. This statistical difference is suggested to be a type II error (false positive). Occurrence of a false positive event is suggested when there is a statistical difference between exposure measurements for different control practices (engineering controls), but the concentration difference is not likely to be sufficient to cause a biological effect. Since both summary exposures and upper exposure estimates, based on the highest exposure reported and

Table Personal sample summary statistics for boiler/pipe insulation abatement in containment with and without employment of glovebags.

Type of Sample	Number of Samples	Arithmetic Mean	Geometric Mean	Standard Deviation	Geometric Standard Deviation
Without	53	0.023	0.006	0.018	1.9
With	13	0.006	0.016	0.003	2.9

With and without glovebag samples were statistically different at less than 1% ($p < 0.01$), concentration in f/cc, values are TLA

calculated CI, are well below the OSHA PEL, exposure concentrations are functionally the same. Thus, outcome of effect on workers will likely be the same regardless of the work practice employed. This is termed here for occupational studies "functional effect" of exposure based on comparison of work practices.

Lack of functional differences for work practices as measured by exposure outcome has been previously suggested (Lange, 2001). Regulatory or contractual requirements for employing work practices that do not have a functional effect in benefit have been considered legislating of science.

When PCM is used in measuring airborne exposure levels, it has been suggested that this method greatly overestimates the actual level of exposure (Mlynarek et al. 1996). It has been suggested that asbestos responsible for occupational disease requires fiber lengths of greater than 5um (Ilgren, 2001). Thus, asbestos fiber concentrations measured by PCM, even with an overestimation of exposure, support a lack of fiber levels sufficient to likely cause disease from these activities.

Comparison of this study with previous investigations (Lange and Thomulka, 2000) of asbestos exposure supports the concept that worker exposure is low. These exposure levels would not warrant employment of respirator protection (Lange and Thomulka, 2000). OSHA has established different categories of worker projection (I through IV) and based these on potential or anticipated exposure in association with categorization of ACM (OSHA, 1999). Based on the low levels of exposure reported here and in other studies (Lange, 2002) it suggested that these categorical levels be modified with one that includes not only the type of ACM but also its historically information on actual exposure for the work practice employed (Lange and Thomulka, 2000). Such an exposure categorization would be based on the historical concentrations of asbestos and associated work practice than the name or categorization of ACM. Employment of respirators should be based on historical exposure and work practice and not on categorization of ACM (Lange and Thomulka, 2000).

These data suggest that whether glovebags are or are not employed the likelihood of exposure to workers exceeding the OSHA PEL is low.

Results suggest that employment of glovebags in removal of ACM inside containment structures are not warranted based on exposure events. Use of glovebags would appear to increase costs with little if any benefit to occupational protection. The overall goal of occupational monitoring is to evaluate the effectiveness and efficiency of control methods in relation to exposure (health impacts) (Lange and Thomulka, 2001; Gee, 2001).

Recent studies (Lange, 2001) have shown that many regulatory requirements imposed for the asbestos and other industries are not based on scientific data. Employment of practices based on regulations and not scientific evaluation of effectiveness is a legislating of science. Such regulations increase cost and magnify inefficiency. This study, along with others (Lange, 2001), demonstrates the importance of proper evaluation of work practices before establishing regulatory standards. These reported ineffectiveness in practices and techniques require additional evaluation.

REFERENCES

Allegheny County Health Department (1996) Toxic hazardous air pollutants, asbestos abatement. Pittsburgh, PA

Dobrovolsky L (1998) Asbestos in the countries of central and eastern Europe. Indoor Built Environ 7: 122-123

Gee I (2001) Monitoring indoor air pollution. Indoor Built Environ 10: 123-124

Hoskins JA (2001) Mineral fibers and health. Indoor Built Environ 10: 244-251

Jaffery SAMT, Burdett GJ, Rood AP (1988) An investigation of airborne asbestos concentrations in two U.K. buildings: before, during and after removal of asbestos. Int J Environ Studies 32: 169-180

Ilgren EB (2001) Health risks from exposures to asbestos and inorganic metals due to collapse of the World Trade Center: an environmental residential survey. Indoor Built Environ 10: 361-383

Lange JH (2001) Airborne asbestos concentrations during abatement of floor tile and mastic: evaluation of two different containment systems and discussion of regulatory issues. Indoor Built Environ 10: 193-199

Lange JH, Thomulka KW (2000) An evaluation of personal airborne asbestos exposure measurements during abatement of drywall and floor tile/mastic. Int J Environ Hlth Res 10: 5-19

Leidel NA, Busch KA, Lynch JR (1977) Occupational Exposure Sampling Strategy Manual. DEHW (NIOSH) Publication Number 77-173, National Technical Information Service Number PB-274-792. National Institute for Occupational Safety and Health, Cincinnati, Ohio

Maltoni C (2000) Call for an international ban on asbestos. Toxicol Ind Hlth 15: 529-531

Mlynarek S, Corn M, Blake C (1996) Asbestos exposure of building maintenance personnel. Reg Toxicol Pharmacol 23: 213 - 224

Occupational Safety and Health Administration (1996) Occupational Safety and Health Standards, Title 29 Code of Federal Regulations 1910 and 1926. US Department of Labor, Washington, DC

Oehlert GW, Lee RJ, Van Orden DR (1995) Statistical analysis of fiber counts. Environmentrics 6: 115-126