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Occupational Exposure During Lead Abatement of Steel Surfaces by Needle Gun Methodology

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Lead abatement is becoming a major industry in the United States (Lange et al. 1998; 1998a). Regulations have been promulgated at both the federal and state levels for lead abatement activities (Lange et al. 1998). Unfortunately, little information has been published on occupational (personal) exposure resulting from various lead abatement practices (Zedd et al. 1993; Conroy, et. al. 1996; Lange et al. 1993; 1997; 1998a; US Department of Housing and Urban Development - HUD, 1995). Exposure is an important factor in determining hazard assessment for a work practice/method (Lange et al. 1997; 1998a). The US Occupational Safety and Health Administration (OSHA) has established both an exposure action level (30 ug/m3) and permissible exposure limit (PEL) (50 ug/m3) for airborne lead (HUD, 1995; Lange et al. 1997; 1998a). Exposure at or above these levels implement requirements for medical surveillance and employment of personal protective equipment (PPE), including respirators (Lange et al. 1998a).

This study reports on personal airborne lead exposure levels of workers performing lead-based paint (LBP) abatement on steel structure surfaces. Steel structures consisted of beams containing LBP that were located inside a building. Exposure results provide some historical (objective) data for LBP abatement from beams using needle gun methodology.

MATERIALS AND METHODS

This study investigated exposure from airborne lead during abatement of LBP from steel structures (beams) in a multi-story office building located in western Pennsylvania. Abatement was undertaken in the fall of 1999. Workers had received training in lead abatement (Lange et al. 1998) and use of needle gun methodology (Lange, 1992; HUD, 1995).

LBP on beams was reported to be <0.5% to about 25% lead. These beams were being abated so renovation activities could be undertaken. Abatement was conducted using needle guns to remove the LBP (HUD, 1995). Needle guns were purchased from a local supplier in western Pennsylvania. Approximately 1,000 square feet were abated during this

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project which was conducted over a seven-day period. Number of personnel at the site during abatement ranged from four to six. One to two needle guns were operated at any given time during work. Neither wetting nor pre-cleaning of surfaces was conducted before or during abatement. The area was restricted and lead signs were placed for notification. Plastic was placed on the floor and nearby surfaces to collect debris from the beams being abated. Waste was collected for disposal and analyzed for lead by the Toxicity Characteristic Leaching Procedure (TCLP) (HUD, 1995). Some abatement of beams containing LBP had been conducted before initiation of this work.

Air samples were collected by one of the authors (JHL) using personal sample collection techniques for lead (Lange et al. 1998a). Samples were collected from the breathing zone employing a low flow pump with a 37 mm mixed cellulose ester filter (closed face) and analyzed by atomic absorption spectroscopy (NIOSH 7105) (Lange et al. 1997). Flow rate was 1 Ipm (nominal) and determined using a calibrated rotometer. Results for airborne lead (ug/m3) were reported as a time-weighted average (TWA) (Lange et al. 1997). Personnel performing abatement were not aware that these data were being collected for a study.

Summary occupational exposure data are reported as statistics of location (arithmetic mean - AM, geometric mean - GM) and variability (standard deviation - SD, geometric standard deviation - GSD, range) (Lange et al. 1997; 1998a). Distribution and presence of outliers were determined using the Shapiro-Wilk (W test) and Grubbs tests (Lange et al. 1997). Transformation of data was performed using natural logarithms (Lange et al. 1997). Confidence interval for AM was determined using a technique for non-normal populations and employed non-transformed data (Lange et al. 1997). Confidence coefficient (probability) of exceeding at least 5% "of the true daily exposure averages" was determined using a graphic method (Leidel et al. 1977; Lange et al. 1997). All statistical calculations were at the 95% level. Sample data were included in calculations at the value reported (Lange et al. 1997).

RESULTS AND DISCUSSION

Occupational (personal) exposure during abatement of LBP from beams is suggested to be below the OSHA action level and PEL (Table 1). The highest reported concentration is also below both exposure limits. CI for the AM is 3.5. When the upper CI is considered, which is 11.0 ug/m3, exposure remains well below the action level. Based on these exposure levels, medical surveillance and PPE would not be required for those conducting LBP abatement using a needle gun. However, this reported exposure does not account for any exposure or uptake of lead that may result from ingestion through a hand-to-mouth route.

Table 1. Summary statistics for personal sample concentrations, in ug/m3 (TWA), for abatement of LBP from beams.

Number of Samples	Arithmetic Mean	Geometric Mean	Standard Deviation	Geometric Standard Deviation	Range
13	7.5	5.0	6.4	2.3	1.7 – 20.9

These sample data were non-normally distributed. Previous studies have also suggested a non-normal distribution for occupational airborne contaminants, including lead (Lange et al. 1997; 1998a; Burstyn and Teschke, 1999). When these data were transformed the distribution was normal; suggesting as reported in previous studies (Lange et al. 1997; 1998a) that airborne exposure is logarithmically distributed. The GSD supports these data being non-normally distributed (Lange et al. 1998a).

All values were above detection limit and neither the highest or lowest value was an outlier.

Variability of these data is considerable based on both SD and GSD. A GSD of around 2.3 represents about a 75% variability among samples (Leidel et al. 1977). However, in comparing this GSD with other airborne exposure studies variability is similar (Lange et al. 1997, 1998a; HUD, 1995). Graphic determination of the confidence coefficient for at least 5% or greater of personal exposure averages exceeding the PEL is around 20%. The confidence coefficient is primarily a function of the day-to-day variation as represented by the GSD (Leidel et al. 1977).

When these summary data are compared to other study results (HUD, 1995), average exposure level is similar to that reported for abrasive blasting (GM of 8.8 ug/m3). However, the GSD reported (HUD, 1995) was 7.6, which is dramatically larger than reported in this and other studies involving LBP abatement (Lange et al. 1997).

TCLP results were 0.2 ppm lead. This value suggests that the leechable lead concentration is below the criterion of 5 ppm lead for defining this debris as a hazardous waste (HUD, 1995).

Results in this investigation suggest that employment of various engineering and work practices involving negative air filtration and wet methods are not required (HUD, 1995) at least as measured by airborne exposure. A previous study (Lange et al. 1997) supported use of negative air filtration and other work practice controls, such as wet methods. It is likely that the importance and implementation of such requirements are highly dependent on the type of activity, condition/content of the LBP and factors related to the substrate being abated (Lange et al. 1993; Burstyn and Teschke, 1999). This investigation also demonstrates some of the difficulty in defining work practices/engineering controls for the lead abatement industry (HUD, 1995). Results from this study support the concept of pilot investigation, especially for large projects. A pilot study can provide data on applicability of different abatement strategies and engineering controls/work practices (HUD, 1995).

Based on samples results reported in this study, it is unlikely that this methodology will result in exposure concentrations that will exceed either the action level or PEL. Data presented in this study do provide historical information for exposure during LBP abatement of beams using a needle gun. However, all LBP projects are not the same, and with only a small number of samples collected and short duration of work, caution must be applied in employing these results to other projects without conducting actual sampling. Additional studies evaluating LBP abatement using different methodologies and under varying conditions are warranted.

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