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Airborne Exposure to Lead During Remediation and Cleaning of a Gun Range and Cutting of Lead Plates

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Lead remediation has become a major occupational activity in the United States and in other locations throughout the world. This activity is regulated by the US Occupational Safety and Health Administration (OSHA) and some state governments (Lange and Thomulka, 2000). Lead has been well recognized as an environmental and occupational pollutant (Ilgren E 2001; Gaga et al., 2002). A previous study reported that projects involving lead do not comply with applicable regulations (Lange et al., 1998) and exposure during renovation and abatement may greatly exceed the OSHA permissible exposure limit (PEL) (50 ug/m^3) and action level (AL) (30 ug/m^3) (OSHA 2001; Lange and Thomulka, 2000). Historical exposure data provide information for hazard assessment related to work practices/controls.

This investigation reports on personal and area exposure concentrations during remediation and cleaning of an indoor gun range and burning lead plates. The gun range and plates involved two separate projects.

MATERIALS AND METHODS

One project involved cleanup and remediation of lead contamination at a gun range. Lead at the gun range was from use of lead bullets in firearms. The range was employed for target practice and consisted of 10 lanes with a 50-foot length to target (concrete floor). Cleaning and remediation employed use of HEPA vacuums and wiping with tri-sodium phosphate. Final clearance was performed by visual inspection. Area and personal samples were collected during the remediation, final cleaning (cleaning) and outside the work area. The second project involved burning with torches (cutting for removal) lead plate covers (about 20, 3 feet in diameter, 1 inch thick). The plates consisted of lead with a mixture of other metals. Only personal samples were collected during this project. All samples were usually at least 6.5 hours in length or more. Samples were reported as task-length averages (TLA) (Lange and Thomulka, 2003). All workers were training in lead remediation as required by OSHA. Both projects required about four days each to complete.

Work practices were employed as required by the OSHA lead standard. Air samples were collected as previously described using low flow personal pumps (Lange and Thomulka, 2003). Samples were analyzed by atomic absorption spectroscopy (NIOSH 7105).

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Table. Summary statistics for exposure, in ug/m^3, during remediation of a gun range and burning lead plates.

Type of Sample	Number of Samples	AM	GM	SD	GSD	Range
Personal$^{+,\wedge,X}$	8	296 (176)	226	253	2.2	18-780
Area$^{+,\wedge,Y}$	6	58 (75)	18	93	5.8	<2-240[a]
Cleaning$^{+,X}$	3	12 (9)	10	8	1.9	6-21
Outside area$^{+,Y}$	4	5 (2)	5	2	1.8	2.3-6.4[b]
Personal$^{*,\wedge,X}$	5	1,165 (532)	1,122	602	1.6	497-4,130

$^{+}$ gun range; * burning lead plates; () is CI value, [a] one value was <2.0; [b] one value was <7.1; $^{\wedge}$ are non-normally distributed, others were not tested; personal and area samples are noted, while cleaning was personal measurements and outside was area measurements; indicates ^{X}personal sample and indicates ^{Y}area (stationary) sample measurement.

Exposure data were reported as statistics of location (arithmetic mean – AM, geometric mean – GM) and variability (standard deviation – SD, geometric standard deviation – GSD, range). Outliers, using transformed (log) and non-transformed data, and distribution were determined using the Grubbs and Shapiro-Wilk tests. Confidence intervals (CI) was determined, using non-transformed data, for AM using a technique for non-normal populations (Daniel, 1991). Confidence coefficient (probability) of exceeding at least 5% of the daily exposure average was determined using a graph method (Leidel et al., 1977).

Statistical comparison was performed using the Wilcoxon-Summed Ranked test. Values reported below a detection limit were included in calculations at this number (Lange and Thomulka, 2000). All statistics were at 95%.

RESULTS AND DISCUSSION

The highest exposure levels were associated with burning of plates. AM results for area and personal exposure for both projects exceeded the OSHA PEL for lead. GM personal samples for both projects exceed the PEL as well. No exposure value for cleaning and outside area exceeded the AL. Summary statistics for exposures are shown in the Table. Based on these exposure results, those working inside the lead abatement area, with the exclusion of cleaning, would be required to employ personal protective equipment (PPE), including respirators. Since the outside levels were low, this suggests that engineering controls were effective in controlling emissions during remediation (Lange and Thomulka, 2000).

As previously reported (Lange and Thomulka, 2000), air samples for lead are non-normally distributed. There were no outliers, for transformed or non-transformed, for these data. Personal samples were statistically

higher in concentration than area and cleaning samples. Area samples were also statistically higher when compared to cleaning samples.

These data are highly variable as indicated by SD and GSD. Probability of overexposure for the gun range with a half-mask (HM) (protection limit of 500 ug/m^3) and full-face (FF) or powered air-purifying respirator (PAPR) (both with a protection limit of 2,500 ug/m^3) is about 0.8 and 0.05, respectively. For cleaning the gun range, without any respiratory protection the probability is 0.2 (for no respirator) and less than 0.05 with a half mask. Burning, the probability of exceeding its protection level with a FF or PAPR is about 0.45.

These results indicate that remediation of lead at a gun range exceeds the PEL and has a good probability of exceeding the protection limit for a HM respirator. Area samples support the finding of exposure levels above the PEL. This would suggest that FF or PAPR's be used during remediation at gun ranges. Cleaning after remediation does not appear to result in exposure levels sufficient to warrant respiratory protection. However, other forms of PPE would be required.

Burning lead plates resulted in very high exposure levels. The probability of exceeding the protection factor for FF and PAPR's is elevated, although the AM and GM did not exceeded the set protection limit. It may be prudent to employ air-supplied respirator systems for burning lead materials.

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