**AN EVALUATION OF LEAD-BASED PAINT ABATEMENT CLEAN-UP AND CLEARANCE METHODOLOGIES**

**[Executive Summary]**

Prepared by
New Jersey Department of Health
Consumer, Environmental & Occupational Health Service
PO Box 369
Trenton, NJ 08625-0369

January 30, 2001

## Introduction

The New Jersey Department of Health (NJDOH) – Consumer, Environmental and Occupational Health Service, through an agreement with the New Jersey Department of Community Affairs (NJDCA) – Division of Housing and Community Resources, conducted a research study to investigate lead-based paint abatement clean-up work practices and clearance testing methodologies. Funding for this study was provided in a grant from the Federal Department of Housing and Urban Development (HUD) to the NJDCA.

## Background

Deteriorated lead-based paint (LBP) in pre-1978 housing has been identified as a major cause of elevated blood lead (EBL) levels in children between one and six years old (HUD, 1995). Recent studies indicate that relatively low blood lead levels can cause significant damage to the nervous system, such as reduction in intelligence and attention span, learning disabilities and behavior problems (CDC, 1991). Exposure occurs directly from ingestion of paint chips but more often from ingestion of dust generated from deteriorated components containing lead paint (HUD, 1995). Based on 1997 data from the Centers for Disease Control (CDC) and 1990 census data, the New Jersey Department of Health and Senior Services estimates that over 600,000 children in New Jersey under six years of age are at high risk of lead poisoning and that approximately 65% of housing stock in New Jersey may contain lead-based paint.

HUD has initiated a housing redevelopment program to control lead-based paint hazards in low and moderate-income housing. The hazard control activities (such as, window replacement, paint removal, demolition of leaded building components, etc.) can produce dangerous levels of leaded dust and may cause a dwelling to become more hazardous after the activity unless the leaded dust is effectively removed. In any lead abatement project, the final cleaning procedures represent one of the critical operations before occupants return to the unit. The HUD Guidelines (HUD, 1995) outline a series of clean-up procedures that have been shown to be effective for removing leaded dust. These procedures are also required by the current lead abatement regulations in the New Jersey Administrative Code (N.J.A.C. 5:17, "Lead Hazard Evaluation and Abatement Code"). The regulation requires a three step cleaning procedure as follows: (1) HEPA vacuuming of the work area, (2) wet washing/wiping of the work area with a lead specific detergent or trisodium phosphate (TSP), and (3) HEPA vacuuming of the work area after drying. Although these work practices are currently in place, information for determining the effectiveness of each phase of the clean-up and the relative effort required to achieve clearance has been limited.

The HUD Guidelines also require clearance samples to be taken at specific locations within the work area to determine if the area is safe for re-occupancy. These locations are specific for window sills and window wells but can vary for floors. There is little information available which determines that the lead dust level on floors in the location chosen in accordance with HUD Guidelines represents the lead dust level throughout the room where the abatement activity took place.

Analysis of lead dust samples is routinely performed in a laboratory (accredited through EPA=s National Lead Laboratory Accreditation Program) and may take one to several days to perform. This results in hardship to families having to be displaced from their homes for additional days, which also raises the cost of the abatement project. Therefore, portable analytical instruments are sought which may be used for on-site analysis of lead dust clearance samples (Ashley, 1994). An evaluation of a portable Anodic Stripping Voltametry (ASV) instrument is necessary to determine the reliability of on-site results as compared to the laboratory results.

## Study Objectives

This study focused on the following three (3) objectives:

(1) Evaluate and describe the efforts necessary to achieve clearance following lead hazard abatement activities;

(2) Evaluate the spatial deposition of lead dust on dwelling floors following lead abatement and clean up (e.g., HEPA, wet wash and final HEPA) procedure, and;

(3) Evaluate and compare the analytical results using portable ASV technology with results obtained from a certified laboratory.

## Study Design

**Selection of Study Sites** - Municipalities receiving Round I and Round 3 funds from HUD for lead abatement projects in low-income single- and multi-family housing units were identified by the NJDCA. Select units undergoing similar interior abatements were identified by the NJDOH as containing potential study sites. Room(s) with sufficient floor space (approximately 80 $ft^2$) and windows (at least 3) to accommodate the study site sampling scheme were identified in each unit. To ensure that the study sites were to undergo similar interior abatements, NJDOH conducted a preliminary assessment to determine the applicability of each unit as a potential study site. A site visit and review of inspection data were performed to ensure that lead-based painted components were present and scheduled for abatement.

**Wipe Dust Sampling Procedures** - Wipe samples of surface dust were collected from the window sill, window well and uncarpeted floors of the study sites. The area wiped was 1-$ft^2$ for floor samples and half the accessible surface area (left half or right half) for window sill and window well samples. The wipe dust sampling procedures outlined in Appendix 13.1 of the HUD Guidelines were followed for all wipe samples. The amount of lead dust on a surface can be expressed as grams of lead dust per unit area ($g/ft^2$ or $\mu g/ft^2$) and is usually called lead dust loading or lead dust level. For wipe dust samples collected for analysis by the portable ASV unit, the manufacturers' suggested procedures were followed.

**Sampling Scheme** - As recommended in the HUD guidelines (1995), a typical cleaning operation after lead hazard abatement activities consisted of three steps: 1) The area was HEPA vacuumed, 2) The area was washed down/wet wiped, and 3) After drying, the area was again HEPA vacuumed. Sampling consisted of wipe dust samples collected at the completion of the abatement project before any cleaning was performed and after each phase of the 3-step cleaning procedure. The set of samples collected after the second HEPA vacuum served as the clearance samples for the site.

*Floor Sample Location:* The floor sampling area was divided into four quadrants within the room(s) of a study site. The location of the wipe dust samples on floors was determined by following a stratified random selection procedure. Within each of the floor quadrants, the grid to be sampled was chosen by applying a random grid selection method. One sample was collected from each of the four quadrants at the end of abatement activities and after each phase of the cleaning process. For comparison, one additional floor clearance sample was collected from a high traffic area in accordance with the HUD Guidelines (1995). Four sturdy, reusable, 1-$ft^2$ opening plexiglass templates (12" X 12") were used for collecting the wipe dust samples. This provided a constant floor sampling area for all samples and minimized cross contamination. The floor profile was defined by the floor type and surface condition. The floor type was classified as either vinyl, wood or concrete and based upon a visual assessment, the floor surface condition was categorized as smooth, semi-smooth or rough.

*Window Sill and Well Sample Location:* A minimum of three windows in each study site were identified. In order to avoid sampling the same section of the window sills and wells, each window was divided in half allowing for six sampling opportunities without sampling the same surface twice. Windows were alternated during each phase of the cleaning cycle so each window was sampled.

**Data Collection Approach** - The first study objective was to assess and characterize the efforts necessary to achieve clearance following a lead abatement project. As described, wipe dust samples were collected at the end of the abatement project before any cleaning was performed and after each phase of the three step cleaning process. If a sealant was applied, additional samples were collected after this phase. The time to complete each cleaning cycle and the study site dimensions ($ft^2$) were recorded to determine the effort required to achieve clearance. Other items associated with the cleaning, such as, the type of cleaning equipment, type of the detergent used, type and capacity of the HEPA vacuum, number of workers performing cleaning actively, hourly wages and thoroughness of cleaning were also recorded. In order to evaluate the efforts necessary to achieve clearance, the average lead dust level at various cleaning steps were correlated to the cleaning data (i.e., the cleaning duration and procedures). The second study objective was to evaluate the spatial deposition of lead dust on floors at the time of clearance sampling following the lead abatement and subsequent clean-up. The random wipe dust data collected from the four quadrants and the high traffic area at the time of clearance were used to show the distribution of lead dust across the floor in the selected study site.

The third study objective was to evaluate the performance of a portable ASV unit when used for lead dust clearance measurements. The analytical results measured by the ASV unit were compared with those obtained from an accredited laboratory. For windows, one-half the area of one window sill and one half the area of one window well per study site were sampled and analyzed by the ASV unit. For floors, the randomly selected fourth floor sampling grid at the clearance phase, was utilized to collect the side by side floor samples. A sturdy and reusable plexiglass template, with six square (7" X 7") openings, was used for collecting the floor samples.

**Results and Conclusions**

From January 1997 through November 1999, the NJDOH conducted field sampling at the study sites to address the above three aspects of lead abatement work activities. Thirty study sites were in thirteen pre-1978 buildings located in five municipalities. The building type included multi-family apartment complexes, duplexes and single family homes. The buildings were located in low to moderate income neighborhoods and were undergoing lead hazard reduction, as well as, other renovation/remodeling work funded by the state and/or federal government (NJDCA, 1999).

For Study Objective #1, to evaluate and describe the efforts necessary to achieve clearance following lead hazard abatement activities, the conclusions are as follows:

- The field cleaning methods employed by the contractors deviated considerably from the HUD recommended procedure. The walls and ceilings of the work area were not cleaned in 83% of the sites and the HUD recommended 3-bucket wet wash method was not followed in 80% of the sites.
- All three cleaning steps (i.e., HEPA, wet wash and HEPA) removed lead dust from window sills, window wells and floors, however, the rate of removal was inadequate to produce a 100% clearance rate consistently. Therefore, any abbreviated cleaning protocol may not be sufficient to meet the current or the future clearance standards except for smooth floors.
- Clearance criteria values were exceeded more often on floors as compared to window sills and window wells. Using the 1995 Federal Guidance, 33% of floors, 6% of window sills, and 14% of window wells failed the clearance levels.
- All nine sites that had a rough floor surface failed the 1995 Federal clearance standards (high traffic lead dust values). The mean lead dust levels on smooth,

semi-smooth and rough floor surfaces were 17 µg/ft$^2$, 38 µg/ft$^2$ and 339 µg/ft$^2$, respectively. The HUD recommended three step cleaning method, especially the wet wash step, was found to be more effective on smooth floors than on rough floors.

- The total cleaning cost to the contractor was found to be a very small fraction of the total abatement project cost.

For Study Objective #2, to evaluate the spatial deposition of lead dust on dwelling floors following lead abatement and clean-up procedures, the conclusions are as follows:

- The lead dust levels found on floors showed significant variation. Seventy-seven (77%) of the sites had at least a two fold difference between the minimum and maximum lead dust levels and 20% of the sites had a five fold or more difference. Therefore, a single random dust wipe sample taken from the floor may not represent the average lead dust on the floor during clearance.
- The high traffic area appeared to be an appropriate location to take a dust wipe sample to represent the floor lead dust levels during clearance. No significant differences were observed between the high traffic sample and the mean dust levels on the floor.
- There were no noticeable patterns in the distribution of lead dust on floors when comparing samples taken in the corners of the room, around the perimeter and in the center of the room.

For Study Objective #3, to evaluate and compare the analytical results using portable ASV technology with the results obtained from an accredited laboratory, the principal conclusion is as follows:

- The results from this study are inconclusive as to whether the portable ASV unit can be used for clearance testing following an abatement action. The ASV calibration and/or the sampling procedures for windows may have resulted in the poor correlation with the laboratory results.

**Recommendations**

Although the field cleaning practices and characteristics of lead dust levels following an abatement project has been investigated, much remains to be done to clarify several issues that became evident during the course of this study. Specifically:

- The lead abatement industry needs to improve compliance in regard to proper cleaning requirements, and

- Regulators should increase their surveillance of contractors during the cleaning process.

Floor surface roughness was also found to be a critical factor that influenced the clearance lead dust levels. The combination of rough floors and lower clearance standards will pose significant challenges for property owners, lead abatement contractors, and building renovators. With the availability of funding, research should be conducted to evaluate:

- The effectiveness of the wet wash cycle for semi-smooth and rough floors,
- The effectiveness of a floor sealant on rough surfaces to achieve clearance standards,
- The effectiveness of an agitator type of wet vacuuming on rough floor surfaces, and
- Other new and innovative cleaning techniques.

Additionally, further investigation into the cleaning practices and the feasibility of achieving the new clearance standards following maintenance and renovation work is warranted.

The results indicated a significant variation in the distribution of floor lead dust levels during clearance. Additional research should be conducted to determine the most appropriate sample(s) to represent the lead dust level on the floor.

The evaluation to compare the analytical results using portable ASV technology with the results obtained from an accredited laboratory was indeterminate. Further study utilizing ASV as a portable clearance tool is warranted.