U.S. Department of Housing and Urban Development

Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing

June 1995

U.S. Department of Housing and Urban Development
Washington, D.C. 20410

OFFICE OF LEAD-BASED PAINT ABATEMENT
AND POISONING PREVENTION

TO THE READER:

The U.S. Department of Housing and Urban Development (HUD) has issued these *Guidelines For the Evaluation and Control of Lead-Based Paint Hazards in Housing* pursuant to Title X of the Housing and Community Development Act of 1992. This document replaces the 1990 publication, *Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing*.

These new *Guidelines* are based on the most current scientific research. As ongoing studies are completed, HUD expects to issue revisions and updates that will incorporate advances in technology and more cost-effective methods validated by research and experience. For example, HUD and the U.S. Environmental Protection Agency are sponsoring a statistical study to determine whether reliable paint inspections of multi-family properties can be conducted with fewer units than are recommended in Chapter 7. It is planned that the results of that study and any modifications to Chapter 7 will be available in the fall of 1995. HUD is also preparing a more compact version of the Guidelines—a field guide—that is planned for publication in 1996.

Your comments and suggestions on ways to improve the *Guidelines* would be very helpful to the Department in preparing future revisions. Please send comments to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, HUD—Room B–133, 451 Seventh Street SW., Washington, DC 20410.

Additional copies of the ***Guidelines*** are available for a small handling fee from HUD USER at 1–800–245–2691. Revisions and updates will be available from the same source.

Acknowledgments

The U.S. Department of Housing and Urban Development and the National Center for Lead-Safe Housing wishes to thank the many individuals who helped prepare this document. Experts from the housing, public health, and environmental disciplines volunteered countless hours to provide the Nation with the best possible guidance. Due to their dedication and hard work, this document will further the effort to provide safe affordable housing and reduce childhood lead poisoning.

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Executive Summary

The *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*, hereafter referred to as the *Guidelines*, provide detailed, comprehensive, technical information on how to identify lead-based paint hazards in housing and how to control such hazards safely and efficiently. The goal of this document is to help property owners, private contractors, and Government agencies sharply reduce children's exposure to lead without unnecessarily increasing the cost of housing.

The *Guidelines* address lead hazards posed by paint, dust, and soil in the residential environment. Lead exposures from air emissions, Superfund sites, drinking water, ceramics, home (folk) remedies, cosmetics, food, or other sources are not the focus of this manual.

The *Guidelines* are issued pursuant to Section 1017 of the Residential Lead-Based Paint Hazard Reduction Act of 1992, which is often referred to as Title X ("Title Ten") because it was enacted as Title X of the Housing and Community Development Act of 1992 (Public Law 102–550). The *Guidelines* are based on the concepts, definitions, and requirements set forth by Congress in Title X.

Section 1017 requires the Secretary of the U.S. Department of Housing and Urban Development (HUD) to issue "guidelines for the conduct of *federally supported work* involving risk assessments, inspections, interim controls, and abatement of lead-based paint hazards" (emphasis added). Therefore, the primary purpose of this document is to provide guidance to people involved in identifying and controlling lead-based paint hazards in housing that is associated with the Federal Government. The *Guidelines* may also be useful to individuals in housing that has no connection with the Federal government, as well as day-care centers and public buildings that exhibit conditions similar to those in residential structures.

This document replaces *Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing*, which was issued by HUD in 1990. The *Guidelines* do not replace the *Lead-Based Paint Risk Assessment Protocol*, which applies only to the public and Indian housing program and was published in June 1992. The risk assessment procedures in the *Guidelines* are similar to those of the 1992 document, but the management systems of public and Indian housing authorities require slightly different risk assessment tools.

The *Guidelines* complement regulations, other directives, and other guidelines to be issued by HUD, the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor, and the Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services. Other Federal agencies and State and local governments may also issue regulations and directives pertaining to housing under their jurisdictions. Regulations generally specify minimum requirements for *what* work must be done, *when* the work must be done, and what training and certification workers must have. Certain basic standards as to *how* the work must be done are also usually specified. The *Guidelines* provide more complete guidance than do regulations on *how* activities related to lead-based paint should be carried out and *why* certain measures are recommended. The *Guidelines* are not enforceable by law unless a Federal, State, or local statute or regulation requires adherence to certain parts of this document.

HUD prepared the *Guidelines* in close consultation with EPA, CDC, OSHA, and several other Federal agencies. Most of the writing was done by the National Center for Lead-Safe Housing, with the help of numerous experts and practitioners who served as writers and reviewers.

Readers should be aware that lead hazard control is a rapidly changing field in which new products, methods, procedures, and standards are introduced frequently. The *Guidelines* will therefore be updated periodically, as research and experience provide new information, as technology advances, and as Federal regulations are revised. HUD welcomes comments and suggestions on ways to improve these *Guidelines*. Please send written comments to:

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I. Childhood Lead Poisoning

Childhood lead poisoning has been labeled by CDC as "the number one environmental health hazard facing American children." Current evidence shows that 8.9 percent of American children under age 6 have blood lead levels greater than 10 µg/dL, which is CDC's current threshold of concern (Brody, 1994; Perkle, 1994). Of greatest concern are changes in the brain that cause reductions in IQ and attention span, reading and learning disabilities, hyperactivity, and behavior problems. Adult workers who are exposed to lead also suffer a variety of health problems. Pregnant workers and their fetuses are at special risk.

Because lead has been successfully removed from gasoline and food, CDC believes the foremost source of lead in the environments of young children is house paint applied before the 1978 ban on lead-based paint for residential and consumer use. Closely associated sources of lead are lead-contaminated dust and soil.

II. The Title X Framework

The most difficult question in lead-based paint hazard control derives from resource limitations: How can the cost-effectiveness of lead hazard control be maximized so children's lead exposure in housing can be sharply reduced without unnecessarily adding to the cost of housing?

In confronting this problem, Congress provided in Title X a framework to allow governmental officials, property owners, participants in the real estate industry, and specialists in lead-based paint hazard control to tailor sensible and effective lead hazard control programs to fit the financial and environmental conditions of specific properties. In effect, the immediate goal is to make housing lead-safe rather than lead-free.

This framework, however, is not simple. With the flexibility needed for practicality and cost-effectiveness comes complexity. And with complexity comes the need to learn, share information, and continually improve methods.

III. Definition of "Lead-Based Paint Hazard"

Title X redefines the concept of "lead-based paint hazards." Under prior Federal legislation, a lead-based paint hazard was any paint containing 1 mg/cm^2 of lead or more, regardless of paint condition or location. Title X states that a lead-based paint hazard is "any condition that causes *exposure* to lead . . . that would result in adverse human health effects" and that comes from:

- Lead-contaminated dust.
- Bare, lead-contaminated soil.
- Lead-contaminated paint that is deteriorated or present on accessible, friction, or impact surfaces.

Thus, under this definition, intact lead-based paint on most walls and ceilings would not be considered a "hazard," although the paint should be maintained and its condition monitored to ensure that it does not deteriorate and become a hazard.

Title X acknowledges that some lead-based paint hazards are of more immediate concern than others. In these *Guidelines*, the hazards considered to be of greatest immediate concern are those to which children are most frequently exposed: lead-contaminated dust; deteriorated lead-based paint; and lead-contaminated soil if it is bare, accessible to young children, and/or likely to be blown or tracked into the dwelling. Also of concern are friction, chewable, and impact surfaces with intact lead-based paint. Friction surfaces are subject to abrasion and may generate lead-contaminated dust in the dwelling; chewable surfaces are protruding surfaces that are easily chewed on by young children; and impact surfaces may become deteriorated through forceful contact. Intact lead-based paint on flat surfaces not subject to abrasion, impact, or other disturbances, although of less concern, is still a potential hazard because the paint could deteriorate over time, as a result of age, disturbance (through renovation and repair), or major casualty (such as fire, storms, and water leaks).

Although most efforts to reduce lead hazards in housing will now be aimed at controlling lead-based paint hazards as defined by Title X, there is one notable exception: in public and Indian housing, all lead-based paint must be abated when the housing is renovated or remodeled.

Lead-based paint is any paint, varnish, stain, or other applied coating that has 1 mg/cm^2 (or 5,000 µg/g by dry weight) or more of lead. For the purposes of these *Guidelines*, the terms "leaded paint" and "lead-containing paint" are synonymous with "lead-based paint."

IV. Lead Hazard Control Process

The process of controlling lead hazards begins with suggestions on how property owners can tailor lead poisoning prevention efforts to their own unique dwellings.

A. Planning

In buildings constructed after 1978, it is very unlikely that lead-based paint hazards are present. No further action is recommended, unless a child with an elevated blood lead level is identified. The older the dwelling, the more prevalent and concentrated the lead-based paint. The prevalence of lead-based paint in housing built before 1940 is especially high; after 1940 the use of lead in paint declined steadily. The condition of the building (i.e., its paint and substrates coated with that paint), its projected service life, and funding availability also bear directly on the owner's decision about a specific course of action.

B. Lead Hazard Evaluation

Most lead hazard control efforts begin with an evaluation of the nature and extent of the problem. Evaluations of lead hazards should be conducted through risk assessments, paint inspections, or a combination risk assessment/paint inspection. A risk assessment is an onsite investigation of a residential building to determine the location, severity, and nature of lead-based paint hazards and includes (but may not be limited to) a visual inspection to determine the condition of painted surfaces, the need for structural repairs, and locations for dust, soil, and paint sampling; limited environmental sampling of dust, soil, and deteriorated paint; and a report of the results that identifies acceptable abatement or interim control strategies for controlling any lead-based paint hazards. Risk assessments and inspections can be combined (see Chapters 3 and 5). A paint inspection "means a surface-by-surface investigation of all painted surfaces—interior and exterior, in common areas of multifamily buildings as well as in dwelling units—using portable x-ray fluorescence paint analyzers or laboratory analysis of paint samples to determine the presence of lead-based paint, and the provision of a report on the results."

Inspections to identify the presence of lead-based paint should not be confused with clearance examinations, risk assessments, or investigations of homes with lead-poisoned children. These *Guidelines* also describe a lead hazard screen risk assessment for dwellings in good condition that are unlikely to contain lead hazards (see Chapter 5). This flexibility reduces the cost of evaluating lead hazards.

Paint inspections are particularly useful in developing plans to conduct abatement during renovation or remodeling activities, while risk assessments are often used to confirm that no lead hazards exist or to guide interim control efforts if hazards are identified. Combining these approaches has the advantage of identifying both immediate and potential hazards so owners can understand what work must be done immediately and what work can be done at later, more convenient times (for example, vacancy and rehabilitation).

The *Guidelines* provide detailed procedures and forms for completing both risk assessments and inspections. Slightly different procedures are recommended for owner-occupants and owners of large and small rental properties.

If an owner decides to bypass the evaluation process and correct suspected lead hazards, a clearance process is needed to ensure that all lead-based paint hazards were actually corrected and that leaded dust and soil levels remaining at the conclusion of the project are acceptable. Some jurisdictions, HUD regulations, or EPA regulations may require risk assessments, inspections, and/or clearance examinations. Successful completion of the process may require a certificate documenting the status of the dwelling.

C. Lead Hazard Control

In the Title X framework, there are three types of lead hazard control: interim controls, abatement of lead-based paint hazards, and complete abatement of all lead-based paint. Interim controls are designed to address hazards quickly, inexpensively, and temporarily, while abatement is intended to produce a permanent solution. In the *Guidelines*, "permanent" means having an expected life of at least 20 years.

Interim controls, according to Title X, "means a set of measures designed to reduce temporarily human exposure or likely exposure to lead-based paint hazards, including specialized cleaning" (to reduce lead-contaminated dust), "repairs, maintenance, painting, temporary containment, ongoing monitoring of lead-based paint hazards or potential hazards, and the establishment and operation of management and resident education programs." Interim controls include dust removal, paint film stabilization, and treatment of friction and impact surfaces. Interim controls are appropriate for implementation on a broad scale and may prove cost effective in many cases. Whenever interim controls are employed, ongoing monitoring of lead hazards must be undertaken by the property owner because lead-based paint may still be present and may become hazardous in the future.

Abatement of lead-based paint hazards, according to Title X, "means any set of measures designed to permanently eliminate lead-based paint hazards . . ." Such measures may include "(A) the removal of lead-based paint and lead-contaminated dust, the permanent containment or encapsulation of lead-based paint, the replacement of lead-painted surfaces or fixtures, and the removal or covering of lead-contaminated soil; and (B) all preparation, cleanup, disposal, and post-abatement clearance testing activities associated with such measures." Consistent with its focus on lead-based paint hazards, Title X has redefined the term "abatement" to mean the elimination of "lead-based paint hazards," not necessarily all lead-based paint.

Complete abatement of lead-based paint means the permanent elimination of all lead-based paint, interior or exterior, intact or not intact, using the same methods as those included in the definition of abatement of lead-based paint hazards. Title X requires this for public and Indian housing (leaving unchanged the statutory requirements that have been in place since 1987). Specifically, all pre-1978 public and Indian housing must be inspected, and all lead-based paint identified must be abated (not just lead-based paint hazards). While there is no explicit deadline, abatement in public and Indian housing usually occurs during rehabilitation.

The *Guidelines* take a performance-oriented approach to lead hazard control work. Any construction material or method that meets the performance criteria for interim control or abatement work is acceptable as long as residents and workers are protected, clearance standards are met, the methods used are not expressly prohibited, waste is properly managed, and the effectiveness of the measure is evaluated over time. This permits innovation and should reduce costs.

All interim controls and some abatement methods require ongoing monitoring by owners and residents as well as periodic reevaluation by a certified professional.

As with risk assessment and inspection, a combination of approaches is often best to address lead-based paint in the most cost-effective way in a particular dwelling. For example, it may make sense to stabilize the paint on trim (an interim control), while replacing windows in the same dwelling (an abatement measure). The owner may decide to replace only parts of the windows, such as the sashes and/or interior window sills (sometimes known as stools). Since each case is different, owners are encouraged to seek professional guidance from certified risk assessors and certified abatement supervisors to determine which strategy is best. Risk assessments can target lead hazards and make controls more cost-effective.

Whenever building components such as doors and windows are replaced, the *Guidelines* recommend that they be replaced with products that are more energy efficient. This will help reduce energy consumption and also reduce the length of time it takes for new components to pay for themselves.

1. Encapsulation

Encapsulants include coatings and rigid coverings that are bonded to the existing paint film with an adhesive (they are not mechanically fastened). Because encapsulants rely on adhesion to the existing paint film, their durability depends on the properties of the existing substrate coating. The standards indicated in Title X (Section 1051) defining encapsulant performance have not yet been promulgated. Encapsulants should not be confused with permanent enclosure systems, which are mechanically fastened to the structural system (and not dependent on the substrate coating for their durability) and can be expected to last at least 20 years.

2. Prohibited Methods

Some paint removal methods are known to be extremely dangerous in the residential setting and are prohibited. Prohibited methods include open-flame burning or torching, machine sanding or grinding without a high-efficiency particulate air (HEPA) vacuum exhaust tool, uncontained hydroblasting or high-pressure washing, abrasive blasting or sandblasting without HEPA vacuum exhaust tools, and heat guns that operate above 1,100°F. In addition, HUD does not recommend the on-site use of methylene chloride chemical strippers or dry scraping (except for limited areas). Safer alternative measures that make all these techniques unnecessary are available.

D. Preparation

Before control measures can actually be implemented, a few other planning steps are necessary. The *Guidelines* specifically recommend how to prepare worksites to protect residents. Under certain circumstances, occupants can remain inside the dwelling during the work (although they are never to be permitted within the work area itself while work is under way). A written compliance plan needs to be developed by the lead hazard control contractor/supervisor to comply with the worker protection requirements of the OSHA Lead in Construction Standard.

All abatement workers need to be properly trained by an accredited training provider. Untrained workers can worsen conditions. EPA has developed a training curriculum designed to teach workers to conduct their trade in a lead-safe manner.

The waste that will be generated from the project may also need to be tested and evaluated to determine whether it is hazardous. Both worker protection and hazardous waste requirements are strictly enforced.

E. Cleaning and Clearance

After the work has been completed, thorough cleaning is needed. For dust removal alone, all horizontal surfaces should be vacuumed with a HEPA vacuum and then washed with a lead-specific cleaning agent, trisodium phosphate detergent, or other suitable cleaner. For more involved abatement work, cleaning should be done by HEPA vacuuming all horizontal and vertical surfaces, wet washing, and a final HEPA vacuuming. Work should proceed from clean to dirty areas to prevent recontamination. After cleaning, clearance examinations should always be conducted by certified risk assessors or certified inspector technicians. The clearance examination involves a confirmation that the work was completed, a visual assessment for visible dust, and dust (and perhaps soil) sampling. HUD and EPA have established specific leaded dust standards for clearance purposes. If an owner chooses to bypass the evaluation (going straight to hazard control), a certified risk assessor should perform the clearance examination to ensure that all hazards were addressed and that remaining levels of leaded dust are acceptable.

F. Reevaluation

Some dwellings and control measures will require periodic reevaluations by a certified risk assessor to ensure that hazards have not reappeared. The *Guidelines* provide specific recommended schedules defining the frequency of reevaluations.

V. Other Issues

The *Guidelines* also include information on the special procedures for investigating a lead-poisoned child. This type of investigation is very different from the risk assessment or inspection process described earlier, which are related to the condition of a dwelling rather than the health of an individual child. Investigations of lead-poisoned children should involve close collaboration with the local health department, which may have primary authority over housing conditions and may require sampling for many more sources of lead than would be carried out in a routine risk assessment or paint inspection. Further guidance on this issue will be provided by CDC.

Finally, the *Guidelines* interpret historic preservation requirements and suggest safe procedures for maintenance activities that may disturb surfaces containing lead-based paint.

VI. Innovation and Cost-Effectiveness

Considerable research and innovation is under way. Future editions of these *Guidelines* will incorporate the results of these efforts. The *Guidelines* are a report on state-of-the-art procedures for all aspects of lead-based paint hazard evaluation and control.

Within certain regulatory limits and program funding requirements, the *Guidelines* are a performance-oriented document. At the most basic level, owners can conduct lead hazard control work any way they choose, as long as they protect workers and occupants, comply with clearance standards, monitor over time the effectiveness of the control measures implemented, and do not use prohibited methods. In short, these *Guidelines* describe the best known ways to perform lead hazard control work. The *Guidelines* also permit the flexibility needed to address different kinds of housing and identify specific cost-saving measures to make primary prevention of lead poisoning a reality in millions of homes across the country.

Chapter 1: Introduction

Chapter 1: Introduction

The *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* provide detailed, comprehensive technical information on how to identify lead-based paint and related hazards in housing and how to control such hazards safely and efficiently. The purpose of this document, hereafter referred to as the *Guidelines*, is to help property owners, government agencies, and private contractors sharply reduce childhood exposure to lead without unnecessarily increasing the cost of housing.

The *Guidelines* address lead hazards posed by paint, dust, and soil in the residential environment. Lead exposures from air emissions, Superfund sites, drinking water, ceramics, home remedies, cosmetics, or other sources of lead exposure are not covered in these *Guidelines*.

This document replaces *Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing*, which was issued by the U.S. Department of Housing and Urban Development (HUD) in 1990. (Section I of this chapter includes a description of the differences between the *Interim Guidelines* and the new *Guidelines*.) These new *Guidelines* are applicable to lead hazard evaluation and control in *all* federally associated housing, not just public and Indian housing. Of course, the *Guidelines* may also be useful in housing that has no connection with the Federal Government, as well as day-care centers and public buildings that operate under conditions that are similar to those in residential structures.

The *Guidelines* complement regulations and other directives and guidelines to be issued by HUD, the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor, and the Centers for Disease Control and Prevention (CDC) of the U.S. Department of Health and Human Services. Other Federal agencies, as well as State and local governments, may also issue regulations and other directives pertaining to housing under their jurisdictions. Regulations generally specify minimum requirements for *what* must be done and *when*, minimum training and certification requirements for those conducting the work, and certain basic standards as to *how* work must be done. The *Guidelines* generally provide more detailed information than regulations on *how* activities related to lead-based paint should be carried out and *why* certain measures are recommended.

The ***Guidelines*** are not enforceable by law unless a Federal, State, or local statute or regulation requires that certain parts of this document be followed.

HUD prepared the *Guidelines* in close consultation with EPA, CDC, OSHA, and several other interested Federal agencies. The National Center for Lead-Safe Housing wrote the document, with the help of numerous experts and practitioners who served as writers and reviewers.

Readers should be aware that lead hazard control is a rapidly changing field in which new products, methods, procedures, and standards are being introduced frequently. Therefore, the *Guidelines* will be updated periodically as research and experience provide new information, as technology advances, and as Federal regulations are revised. HUD welcomes comments and suggestions on ways to improve these *Guidelines*. Please send written comments to:

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This introductory chapter explains further the legislative basis for the *Guidelines*, the intended readership, and the relationship of the *Guidelines* to the 1990 *Interim Guidelines* and to Federal regulations. The chapter also includes a brief summary of the problem of childhood lead poisoning, an explanation of the basic concepts that underlie the methods and procedures set forth in the *Guidelines*, and a description of how the document is structured.

I. Legislative Basis and Relationship to Federal Programs and Regulations

A. Legislative Basis

The *Guidelines* are issued pursuant to Section 1017 of the Residential Lead-Based Paint Hazard Reduction Act of 1992, which is often referred to as Title X ("Title Ten") because it was enacted as Title X of the Housing and Community Development Act of 1992 (Public Law 102–550). The *Guidelines* are based on the concepts, definitions, and requirements set forth in Title X. Section III of this chapter describes the framework of concepts and definitions in Title X.

As required by Section 1017, the *Guidelines* are to be used as guidance for "federally supported work," which is defined in the Act as "any lead hazard evaluation or reduction activities in federally owned or assisted housing or funded in whole or in part through any financial assistance program of the Department of Housing and Urban Development, the Farmers Home Administration, or the Department of Veterans Affairs." The term "federally owned housing" is defined in the Act as "residential dwellings owned or managed by a Federal agency, or for which a Federal agency is a trustee or conservator." In this context, the term "Federal agency" includes HUD, the Farmers Home Administration, the Resolution Trust Corporation, the General Services Administration, the U.S. Department of Defense, the U.S. Department of Veterans Affairs, the U.S. Department of the Interior, the U.S. Department of Transportation, and any other Federal agency. The term "federally assisted housing" is defined in the Act as "residential dwellings receiving *project-based* assistance under programs including—

(A) section 221(d)(3) or 236 of the National Housing Act;

(B) section 1 of the Housing and Urban Development Act of 1965;

(C) section 8 of the United States Housing Act of 1937; or

(D) sections 502(a), 504, 514, 515, 516 and 533 of the Housing Act of 1949."

B. Relationship to Earlier HUD Guidelines

These *Guidelines* supersede and replace HUD's *Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing* (HUD, 1990a). For those familiar with the 1990 *Interim Guidelines*, an appreciation of the significant differences in context and scope is important. HUD's 1990 *Interim Guidelines* were based on the legislation at that time, which, as explained in Section III of this chapter, required the identification and abatement of all lead-based paint regardless of condition or location. Also, the *Interim Guidelines* were written for use primarily in conventional public housing settings, which are multifamily developments. The new *Guidelines* cover a broader spectrum of housing types and categories of ownership, and they address the full range of activities involved in evaluating and controlling lead-based paint hazards, as introduced in 1992 by Title X. For example, these *Guidelines*:

- Cover risk assessment methods for evaluating current lead-based paint hazards in addition to inspection methods for identifying the presence of lead-based paint. These risk assessment procedures are similar to the risk assessment protocol published by HUD in June 1992 for use in public and Indian housing, but they call for less data on management, maintenance, and occupancy; therefore, the June 1992 protocol (or its successor) will remain as a requirement for the public and Indian housing program until further notice.

- Include a completely rewritten chapter on paint inspection (Chapter 7) with new procedures based on recent research.
- Focus on correcting lead-based paint *hazards*, as opposed to abatement of *all* lead-based paint (except in public and Indian housing where requirements to abate all lead-based paint still apply).
- Describe new procedures for interim controls to manage lead-based paint in place.

C. Intended Audience

These *Guidelines* have been developed to provide technical guidance to the many individuals and groups involved with or affected by lead-based paint in residential housing units. The audience of these *Guidelines* includes the following:

- Lead-based paint abatement contractors.
- Lead-based paint risk assessors and inspector technicians.
- Lead-based paint training providers.
- State contractor certifying or licensing agencies.
- Residential building owners and managers, including public and Indian housing agencies; private, nonprofit housing development organizations; and private, for-profit landlords, managers, and building owners.
- State and local housing and community development agencies.
- State and local health agencies.
- Building maintenance personnel.
- Architects and designers.
- Federal agency staff.
- Environmental laboratory personnel.
- Real estate agents and brokers.
- Casualty and liability insurers.
- Lenders and appraisers.

These *Guidelines* are not intended for use by untrained persons attempting to control lead-based paint hazards. Under proposed EPA regulations, contractors and individuals must be trained and certified to conduct inspections, risk assessments, and lead-based paint abatement activities.

II. Background on Childhood Lead Poisoning, Sources of Lead in the Environment, and the Evolution of Lead Poisoning Prevention

As understanding of lead's adverse health effects and the sources and pathways of exposure to children has improved, so has recognition of the seriousness of lead-based paint hazards.

A. Childhood Lead Poisoning

Childhood lead poisoning is "the most common environmental disease of young children," (CDC, 1991a) eclipsing all other environmental health hazards found in the residential environment (ATSDR, 1988).

1. Health Hazards

Lead is highly toxic and affects virtually every system of the body. At high exposure levels, lead poisoning can cause coma, convulsions, and death. While adults can also suffer from excessive lead exposures (discussed in Chapter 9), the groups most at risk are fetuses, infants, and children under age 6. At low levels lead's neurotoxic effects have the greatest impact on children's developing brains and nervous systems, causing reductions in IQ and attention span, reading and learning disabilities, hyperactivity, and behavioral problems (Davis, 1993). These effects have been identified in many carefully controlled research studies (National Academy of Sciences, 1993). However, the vast majority of childhood lead-poisoning cases go undiagnosed and untreated, since most poisoned children have no obvious symptoms.

2. Prevalence Rates

In October 1991, CDC formally revised its statement on *Preventing Lead Poisoning in Young Children* (CDC, 1991b). CDC reduced its "intervention level" for childhood lead poisoning from the previous threshold of 25 µg/dL to 10 µg/dL (see Appendix 1 for a description of units of measure for lead in blood, paint, dust, soil, air, and water). This change was based on scientific evidence indicating that adverse health effects can occur at levels as low as 10 µg/dL. Federal agencies estimate that nationwide 8.9 percent (1.7 million) of American children under age 6 have elevated blood lead levels (EBLs) (Brody, 1994; Perkle, 1994). (It should be noted that the 1991 CDC statement did not recommend environmental or medical intervention at the level of 10 µg/dL. It recommended medical evaluation at or above 20 µg/dL and environmental intervention at or above 20 µg/dL or if blood lead levels of 15–19 persist. Various counseling, monitoring and communitywide prevention activities were recommended at levels between 10–19 µg/dL.)

3. Highest Risk Populations

Lead poisoning affects children across all socioeconomic strata and in all regions of the country. However, because lead-based paint hazards are most severe in older, dilapidated housing, the poor in inner cities are disproportionately affected. In many such neighborhoods over half of all young children are lead poisoned. Nationwide, African-American children are twice as likely to be lead poisoned as white children across all income categories (ATSDR, 1988; EPA 1992b).

4. Health Screening

In 1990 CDC called for a phase-in of universal blood lead testing of all young children (unless it can be shown that the community has no lead poisoning problem) because most poisoned children do not exhibit easily identifiable symptoms and virtually all children are at risk (CDC, 1991a). The 1992 *Medicaid Guidelines* called for all children under age 6 to be tested (HCFA, 1992). In 1993 the American Academy of Pediatrics (AAP) also revised its policy to recommend the routine screening of virtually all young children under age 6 (AAP, 1993).

B. Causes of Childhood Lead Poisoning

Today, children in the United States are lead poisoned primarily through ingestion by normal hand-to-mouth activity and, to a lesser extent, inhalation. Because lead is ubiquitous in industrial societies, there are many sources and pathways of lead exposure.

1. Lead in Residential Paint

The foremost cause of childhood lead poisoning in the United States today is lead-based paint and the accompanying contaminated dust and soil found in older houses (CDC, 1991b; Rabinowitz, 1985b; Jacobs, 1994). As early as 1897, lead-based paint was identified as a cause of childhood lead poisoning (Turner, 1897; Reich, 1992). Many countries prohibited the use of lead in residential paints as far back as 1922 (Rabin, 1989). Lead was a major ingredient in most interior and exterior oil house paints prior to 1950, with some paints containing as much as 50 percent lead by dry weight. In the early 1950s, other ingredients became more popular, but some lead pigments, corrosion inhibitors, and drying agents were still used. Lead was first regulated in residential paint in 1972 at 0.5 percent and "banned" in 1978, meaning that paint could contain no more than 0.06 percent lead by dry weight (Reich, 1992; Rabin, 1989).

2. Lead-Based Paint in Housing

HUD estimates that three-quarters of pre-1980 housing units contain some lead-based paint. The likelihood, extent, and concentration of lead-based paint all increase with the age of the building. Fully 90 percent of privately owned units built before 1940, 80 percent of units built between 1940 and 1959, and 62 percent of units built between 1960 and 1979 contain some lead-based paint (HUD, 1990b). Because the greatest risk is in dwellings built before 1950, older housing generally commands a higher priority for lead hazard controls. However, there is evidence that significant amounts of lead-based paint were sold as late as 1971, when New York City's Health Department tested 78 "new" residential paints and found 8 of them to have lead ranging from 2.6 percent to 10.8 percent (NY Times, 1971). See Chapters 3 and 5 for lead prevalence data by year of construction and by building component type.

3. Lead in Surface Dust

The belief that in order to be poisoned children *must* eat lead-based paint chips is unfounded. The most common cause of poisoning is the ingestion—through hand-to-mouth transmission—of lead-contaminated surface dust (Clark, 1991; Bellinger, 1991; Roberts, 1991; Chisolm, 1985; Farfel, 1990; Farfel, 1994). Lead-contaminated dust may be so fine that it cannot be seen by the naked eye. In addition, lead-contaminated dust is difficult to clean up. Leaded dust is generated as lead-based paint deteriorates over time, is damaged by moisture, abraded on friction and impact surfaces, or disturbed in the course of renovation, repair, or abatement projects. Lead can also be tracked into homes from exterior dust and soil. These *Guidelines* address lead in surface dust and soil as well as in paint since Congress also defined lead found in dust and soil to be lead-based paint hazards.

4. Lead in Soil

Children can also be exposed to lead in bare soil. The high levels of lead in soil typically come from deteriorating exterior lead-based paint around the foundation of a house (Ter Harr, 1974; Linton, 1980). The fallout of lead emissions from the combustion of leaded automobile gasoline, lead-based paint, and industrial sources also contributes to lead levels in soil (ATSDR, 1988). In some areas high leaded soil levels result from factory and smelter emissions or deteriorating lead-based paint on steel structures, such as bridges. Bare soil that is contaminated with lead poses a hazard to children who play in it. Lead in soil may also be tracked into a home, increasing interior leaded dust levels. These *Guidelines* address lead-contaminated soil, as well as lead-based paint.

5. Other Causes of Lead Poisoning

Other sources and pathways of lead poisoning in children can include drinking water, point sources (such as smelters or industrial dischargers), ceramics, lead brought home from a parent's workplace, home and folk remedies, cosmetics, and hobbies (such as casting lead sinkers or toy soldiers, making stained glass, loading ammunition, and soldering). For some children these sources may account for their exposure; however, for most children, paint, dust, and soil are the primary sources of lead poisoning.

C. The Evolution of Prevention Approaches

The approach to identifying and responding to lead-based paint hazards in American housing has evolved over the past several decades.

1. Medical Treatment of Poisoned Children (Tertiary Treatment)

During the 1940s and 1950s, deaths from childhood lead poisoning were common. Using chelation therapy (the use of drugs to excrete lead from the body), medical providers attempted to treat symptomatic cases to prevent death, with the assumption that children who survived had been cured. During the 1950s studies in Chicago (Williams, 1952), Boston (1954), New York City (McLaughlin, 1956), and Baltimore (Chisolm, 1956) demonstrated conclusively that children who survived serious lead poisoning were often left mentally retarded or otherwise permanently impaired (Lin Fu, 1982).

2. Screening and Case Management Programs (Secondary Prevention)

Recognition of these neurological problems gave rise to expanded screening and case management programs in many cities and States. Traditionally, the approach to childhood lead-poisoning prevention has been reactive, relying on the identification of a poisoned child to trigger investigation of lead hazards in the home environment.

Based on the belief that children had to eat lead-based paint chips to be poisoned, the typical response to a lead poisoning during the 1970s and early 1980s consisted of removing deteriorated lead-based paint by scraping, uncontrolled sanding, or open-flame burning. Approaches differed slightly from city to city. Some required removal of all lead-based paint to a certain height, such as 5 feet; others required only that deteriorating paint be removed. However, these traditional abatements had one common characteristic: little attention was paid to controlling, containing, and cleaning up leaded dust. In many cases these paint removal methods actually aggravated the problem and increased lead exposures, poisoning workers and children in the process. Several studies found that uncontrolled abatement and inadequate cleanup caused increased blood lead levels (Farfel and Chisolm, 1990; Rabinowitz, 1985a; Amitai, 1987).

3. Primary Prevention

In 1987 Congress concluded that responding to lead-based paint hazards on an individual basis only after a poisoning was inappropriate. The Housing Act of 1987 (P.L. 100–242) directed attention to finding and abating lead-based paint in housing to prevent lead poisoning (primary prevention). The presence of lead-based paint on any and all surfaces was considered to be a hazard, and permanent abatement of all lead-based paint was deemed the only appropriate response. Requirements for action were limited primarily to conventional public and Indian housing, where full abatement of all lead-based paint is completed during substantial rehabilitation or if an EBL child is identified. HUD's 1990 *Interim Guidelines*, which evolved from this statute, properly emphasized the danger of lead-contaminated dust and the need for worker protection and thorough cleanup.

III. The Title X Framework

Title X fundamentally reorganizes the national approach to controlling lead-based paint hazards in housing by focusing attention on lead hazards through the establishment of new requirements for property owners as well as Federal agencies and mandating action to improve the safety and effectiveness of lead-based paint activities.

A. Definition of "Lead-Based Paint Hazard"

Most importantly Title X redefines the concept of "lead-based paint hazards." Under prior Federal legislation, a lead-based paint hazard was defined as any paint containing 1 mg/cm^2 or more of lead regardless of its condition or location. Title X states that a lead-based paint hazard is "any condition that causes *exposure* to lead from lead-contaminated dust; bare, lead-contaminated soil; or lead-based paint that is deteriorated or intact lead-based paint present on accessible surfaces, friction surfaces, or impact surfaces that would result in adverse human health effects." Thus, under this definition, intact lead-based paint on most walls and ceilings is not considered a "hazard," although the condition of the paint should be monitored and maintained to ensure that it does not become deteriorated.

While most efforts to reduce lead hazards in housing will now be aimed at controlling lead-based paint hazards as defined by Title X, Federal law makes one notable exception: in public and Indian housing, all lead-based paint must be abated when the housing is modernized.

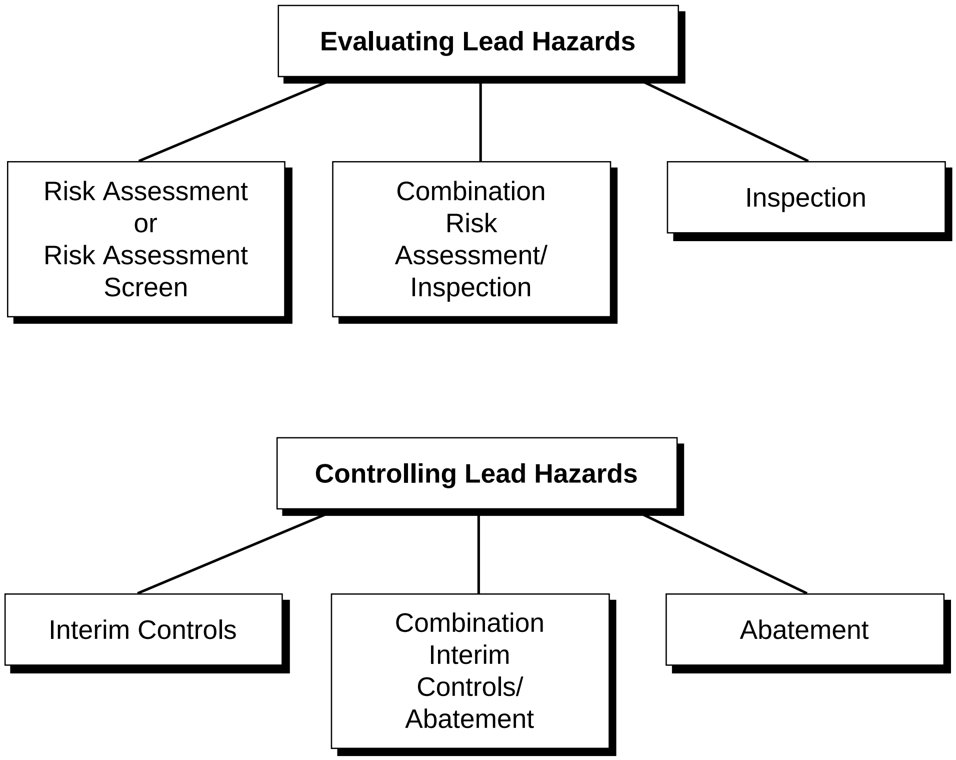
B. Strategic Framework for Lead Hazard Control

As shown in Figure 1.1, Title X's objective of reducing exposures from lead-based paint hazards is accomplished by evaluating and controlling lead-based paint hazards.

1. Evaluating Lead Hazards

Lead hazard evaluation may be accomplished by risk assessment or inspection, or by a combination of the two. The combination approach results in an identification of all lead-based paint *and* lead-based paint hazards.

Figure 1.1 Title X's Lead Hazard Control Framework.



"Paint inspection" is a surface-by-surface investigation of all painted surfaces—interior and exterior, in common areas of multifamily buildings, as well as in dwelling units—using portable x-ray fluorescence (XRF) analyzers and/or laboratory analysis of paint samples to determine the presence of lead-based paint, and the provision of a report on the results.

Inspections to identify the presence of lead-based paint should not be confused with clearance examinations, risk assessments, or investigations of homes with lead-poisoned children.

"Risk assessment" is an onsite investigation of a residential dwelling for lead-based paint hazards and includes, but may not be limited to, a visual inspection; limited environmental samplings of dust, soil, and deteriorated paint; and a report of the results that identifies acceptable abatement and interim control strategies for controlling any lead-based paint hazards identified. Risk assessments and paint inspections can be combined (see Chapters 3, 5, and 7).

2. Controlling Lead Hazards

Title X provides for three types of lead hazard control: interim controls, abatement of lead-based paint hazards, and complete abatement of all lead-based paint.

"Interim controls," according to Title X, are "a set of measures designed to reduce temporarily human exposure or likely exposure to lead-based paint hazards, including specialized cleaning (to reduce lead-contaminated dust), repairs, maintenance, painting, temporary containment, ongoing monitoring of lead-based paint hazards or potential hazards, and the establishment and operation of management and resident education programs." Interim controls include dust

Figure 1.2 Some Lead-Based Paints Had as Much as 50 Percent Lead.

removal, paint film stabilization, and friction and impact surface treatments. Interim controls are appropriate for implementation on a broad scale and may prove cost-effective in many cases. Whenever interim controls are employed, ongoing monitoring of lead hazards must be undertaken by the property owner, as some potential hazards are still present.

"Abatement of lead-based paint hazards," according to Title X, is "any set of measures designed to permanently eliminate lead-based paint hazards . . ." Such measures may include "(A) the removal of lead-based paint and lead-contaminated dust, the permanent containment or encapsulation of lead-based paint, the replacement of lead-based painted surfaces or fixtures, and the removal or covering of lead-contaminated soil; and (B) all preparation, cleanup, disposal, and post-abatement clearance testing activities associated with such measures." Consistent with its focus on lead-based paint *hazards*, Title X has redefined the term "abatement" to mean the elimination of "lead-based paint hazards," not necessarily all lead-based paint.

"Complete abatement of lead-based paint," is the permanent control of all lead-based paint, interior or exterior, intact or deteriorated, using the same methods as those included in the definition of abatement of lead-based paint hazards. Title X requires complete abatement for public and Indian housing (according to the statutory requirements that have been in place since 1987). Specifically, all pre-1978 public and Indian housing must be inspected, and *all* lead-based paint identified must be abated (not just lead-based paint hazards). Abatement usually occurs during rehabilitation or modernization.

C. Requirements To Ensure Quality Control

To ensure that lead hazard control work is carried out safely and effectively, Title X imposes new requirements for consistency and quality control.

1. Training and Certification

Title X requires EPA to promulgate regulations to ensure that all risk assessors, inspector technicians, and abatement supervisors meet minimum training requirements and are certified by an EPA-approved State program (or by EPA in those States that have not sought approval for their lead control program within 2 years after EPA has issued its regulations). All workers and project planners must be properly trained by an accredited training provider. The proposed regulation can be found in the *Federal Register* (Vol. 59, No. 170, P. 45871 September 2, 1994). In addition, it should be noted that the National Lead Abatement Council (NLAC) is establishing the XRF Operators Registry for inspectors who use the XRF instrument.

2. Accreditation of Training Providers

Lead-based paint-related training must be provided by a training program that has been formally accredited either by EPA or by an EPA-approved State program. EPA has developed or is developing model training courses for inspector technicians, abatement supervisors, abatement workers, and risk assessors, and is establishing minimum national criteria for training providers. Also, in an effort to build a national network of training providers, EPA has provided "seed" money grants to five university-based training centers (see Chapter 2).

3. Health-Based Standards

Consistent criteria must be used for identifying lead-based paint hazards and triggering lead hazard control action. Title X directs EPA to identify dangerous levels of lead in soil, dust, and existing paint films.

4. Performance Standards for Testing and Abatement Products

Title X also requires that appropriate criteria, testing protocols, and performance characteristics be developed for lead-based paint testing and abatement products. It is expected that these standards will be developed jointly by HUD and EPA, with technical support from the National Institute for Standards and Technology (NIST). Private-sector organizations such as the American Society for Testing and Materials (ASTM) may also play a role in developing such standards.

5. Laboratory Accreditation

Laboratories analyzing environmental samples of lead in paint film, dust, and soil must follow established protocols and procedures and be accredited through the EPA National Lead Laboratory Accreditation Program (NLLAP). Such laboratories will become "EPA recognized." Property owners, risk assessors, inspector technicians, and contractors should ensure that laboratory analyses are performed by an "EPA-recognized" laboratory.

D. State and Local Regulations

If there is a difference between Federal, State, or local regulations, the more stringent requirements must be observed in any given jurisdiction.

IV. Organization and Use of the Guidelines

Evaluation and control of lead-based paint hazards is an evolving field. For cases in which research has demonstrated that certain techniques are appropriate, references are cited. In some cases, there has been no research done that clearly describes the best approach to solving a specific problem. Recognizing that problems require answers, these *Guidelines* offer advice based on the experience and considered judgment of the authors and reviewers. For cases in which citations are not provided, the reader should assume that the source of the advice is anecdotal and is the best advice that HUD can provide at this time. Those references that are unpublished are available through the EPA National Lead Information Center (see Chapter 2).

A. Chapter Organization

A short summary of steps is provided at the beginning of each technical chapter to alert the reader to especially critical points and action steps. In general, the material is presented in each chapter in order of sequence in a typical project; however, a complete reading and understanding of these *Guidelines* is essential before any project is undertaken. Wherever possible, the *Guidelines* explain the rationale for recommendations and provide a technical description of the action to be taken.

1. Chapters 1–4: Background Information

Understanding the background material is critical to the successful completion of any project. Chapter1 ("Introduction") describes the purpose and application of the *Guidelines*; briefly reviews the hazards of lead-based paint in housing; summarizes major departures from past approaches; and provides context in terms of Federal law, regulations, and agency programs. Chapter 2 ("Where to Go for Help") introduces the types of individuals involved in evaluating and controlling lead-based paint hazards in housing, explains their roles, and summarizes their qualifications. Chapter 3 ("Before You Begin the Project") identifies the critical issues that must be examined to avoid problems and mistakes that can result in project delays and cost overruns. Chapter4 ("Renovation and Lead-Based Paint") provides general advice on how to carry out work in older housing so that lead hazards are not inadvertently created (e.g., by disturbing lead-based paint) and how to combine renovation with abatement work.

2. Chapters 5–7: Hazard Evaluation

Hazard evaluation helps to ensure the selection of the safest and most cost-effective hazard control strategy for each situation. Chapter 5 ("Risk Assessment") provides detailed guidance on how risk assessments are to be conducted in various categories of housing, including protocols for environmental sample collection and interpretation, evaluation of building and paint condition, and methods for sampling a subset of units in multifamily buildings. Chapter 6 ("Ongoing Monitoring") describes how reevaluations are to be performed and provides detailed schedules for when they are needed. Chapter 7 ("Paint Inspection") provides detailed information on methods for testing housing to determine the presence of lead-based paint on a surface-by-surface basis, including the use of portable XRF analyzers and paint-chip sampling for laboratory analysis.

3. Chapters 8–10: Preparation for the Project

The critical steps in preparing to control lead-based paint hazards are covered in Chapters 8–10. Chapter 8 ("Occupant Protection and Containment") provides guidance on the steps needed to ensure that occupants are not endangered and that contamination is not spread. Chapter 9 ("Worker Protection") provides detailed advice on how to comply with the OSHA Lead in Construction Standard while performing work in housing. Chapter 10 ("Hazardous and Nonhazardous Waste") provides detailed, practical advice on methods for segregating, handling, and disposing various kinds of debris to protect the environment and meet hazardous waste requirements at the lowest cost.

4. Chapters 11–15: Hazard Control, Cleanup, and Clearance

Detailed information on how to carry out all aspects of lead hazard control is provided in Chapters 11–15. Chapter 11 ("Interim Controls") provides specific guidance on interim controls: general principles of interim controls, dust removal, paint film stabilization, friction surface treatments, and soil and exterior dust treatments. Chapter12 ("Abatement") covers general principles of abatement such as component replacement, enclosure, paint removal methods, and soil abatement. Chapter 13 ("Encapsulation") describes how to use encapsulants and the status of such products pending the development of performance standards pursuant to Title X. Chapter 14 ("Cleanup") details cleanup procedures for lead hazard control projects. Chapter 15 ("Clearance") explains how to conduct clearance tests after a lead hazard control project to ensure that a unit or area is safe for reoccupancy.

5. Chapters 16–18: Other Issues

Information on addressing lead-based paint hazards in special situations is provided in the final chapters of these *Guidelines*. Chapter 16 ("Evaluation of Houses With Lead-Poisoned Children") describes the special measures that are usually taken by health department staff and others to investigate environmental lead hazards once a child has been identified as poisoned. Chapter 17 ("Maintenance") addresses the range of issues related to lead-based paint as it is encountered in the course of routine maintenance work. Chapter 18 ("Historic Preservation") discusses the special situations and issues surrounding lead-based paint in historic dwellings.

6. Glossary and Appendixes

The definitions of key terms are consolidated in the glossary and deserve special attention because the meanings of several key terms (such as "abatement") differ from common usage. The appendixes provide detailed background information and technical materials.

B. Units of Measurement

- μg/ft²—micrograms per square foot.
- ppm—parts per million by weight (10,000 ppm = 1 percent), equivalent to μg/g.
- ppb—parts per billion by weight (1,000 ppb = 1 ppm).
- μg/g—micrograms per gram of sample, equivalent to ppm by weight.
- percent—percent by weight, used usually for paint (1 percent = 10,000 μg/g).
- mg/cm²—milligrams per square centimeter, used for paint.
- μg/m³—micrograms per cubic meter, used for air.
- μg/dL—micrograms per deciliter, used for blood.

C. Federal Lead Standards

If Federal standards differ from State and local standards, the most stringent standards must be applied.

1. Paint

- 1.0 mg/cm² or 5,000 μg/g (0.5 percent).

2. Leaded Dust Levels for Risk Assessments (by wipe sampling)

- 100 μg/ft²—floors (carpeted and uncarpeted).
- 500 μg/ft²—interior window sills.
- 800 μg/ft²—window troughs (previously called "window wells" in the literature).

3. Dust Levels for Lead Hazard Screen Only

- 50 μg/ft²—floors.
- 400 μg/ft²—window troughs.

4. Leaded Dust Clearance Levels (by wipe sampling)

- 100 μg/ft²—floors (includes carpeted and uncarpeted floors).
- 500 μg/ft²—interior window sills.
- 800 μg/ft²—window troughs (previously called "window wells" in the literature).
- 800 μg/ft²—exterior concrete surfaces.

5. Bare Residential Soil

- 5,000 μg/g—paving or removal criteria.
- 2,000 μg/g—building perimeter and yard.
- 400 μg/g—play areas and high-contact areas for children.

6. Airborne Lead Particulate

- 30 μg/m³—OSHA action level (8-hour, time-weighted average).
- 50 μg/m³—OSHA permissible exposure limit (8-hour, time-weighted average).

7. Elevated Blood Lead Level

- 20 μg/dL (or 15–19 μg/dL in two consecutive samples taken several months apart)—CDC environmental intervention level for individual child.

8. Waste

- 5 ppb (parts per billion) by TCLP test.

Chapter 2: Where To Go For Help—Qualifications and Roles

I. Introduction

No single discipline or profession is responsible for lead poisoning prevention, which involves housing, public health, and environmental dimensions. This chapter provides information on:

- Required expertise and qualifications.
- Sources of assistance for residents or owners.
- Coordination of work among the various professions.

II. Housing

Because lead-based paint hazards are almost always linked to the condition of the dwelling, housing design professionals, housing or building departments, housing contractors, and property owners are often in the best position to complete and maintain any necessary repairs or improvements in the home environment. Ultimately, owners are responsible for authorizing and financing the work. While public health and environmental agencies may occasionally exert primary influence over a dwelling, the role of housing professionals is usually predominant.

A. Owners

Property owners have the primary responsibility for correcting lead-based paint hazards, since they control the dwelling. Owners' responsibilities are listed in Table 2.1 and are distinct from the responsibilities of residents, unless, of course, they are owner-occupants. While owners may choose to delegate authority for lead hazard control projects to project managers, property management companies, environmental consultants, design professionals, or others, they are ultimately responsible for the successful completion of the project. A risk assessor or inspector technician can provide important advice and/or data; however, owners make the final decision regarding the choice of the appropriate lead hazard control treatment. Owners may choose to implement treatments during the vacancy, renovation, or sale of the dwelling (see Chapter 3). Owners are also responsible for ensuring that routine maintenance work is performed safely to prevent the creation of leaded dust hazards. For instance, special cleanup measures may be required for many maintenance jobs that previously involved only a broom sweep. Finally, owners are responsible for determining how projects are to be financed, filling out grant or loan applications (if they are

Table 2.1 Owner Responsibilities

Administering and financing overall project.
Acquiring the necessary expertise from certified risk assessors, inspector technicians, lead hazard control contractors, and trained workers and planners.
Selecting and approving final lead hazard control measures, with input from risk assessors.
Revising routine maintenance work practices to prevent lead hazards from being generated.
Providing information on lead poisoning to residents (HUD, EPA, and local health department pamphlets).
Monitoring conditions to ensure that lead-based paint hazards do not recur and ensuring that the periodic reevaluation is performed by a certified inspector technician or certified risk assessor.
Obtaining waste permits, manifests, etc.
Financing lead hazard evaluation and control.

available in the jurisdiction), and making sure that the project goes smoothly. Public housing authorities have found that a periodic onsite appearance by the owner or owner's representative clearly reinforces the importance of the work being done.

How can owners make certain that abatement or interim control work is done properly? While Title X requires all abatement work to be performed by certified supervisors and trained workers, there is no such requirement for interim control work. Because nearly all forms of lead hazard control work can create hazardous conditions, owners should insist that all such work be done by trained individuals.

The following landlord associations provide information to their members on owner responsibilities:

Council of Large Public Housing Authorities
601 Pennsylvania Avenue NW., Suite 625
Washington, DC 20004
(202) 638–1300

National Association of Housing and Redevelopment Officials
1320 18th Street NW., Suite 500
Washington, DC 20036
(202) 429–2960

National Multi-Housing Council/ National Apartment Association
1850 M Street NW., Suite 540
Washington, DC 20036
(202) 659–3381

B. Residents

If residents are also owners, their responsibilities are the same as those outlined in the section above. If residents are renters, they typically have certain shared responsibilities with the owners in reducing the risk of lead poisoning in children. Generally, owners are responsible for providing properties that are lead-safe and surfaces that are cleanable. Residents are responsible for performing ordinary household cleaning of those surfaces, particularly floors and exterior and interior window sills. If a potential lead hazard develops (e.g., peeling paint), the resident should report it to the landlord. The Centers for Disease Control and Prevention (CDC) recommends that parents have their young children screened for lead poisoning by no later than 12 months of age, either by their pediatrician or the local health department. This service is often provided at no charge to the parent.

The many sources of public information on lead poisoning include:

EPA Lead Information Hotline
1–800–532–3394 (800–LEAD–FYI)
(The Hotline provides many materials, including the EPA lead hazard information pamphlet, which is in both Spanish and English.)

National Lead Information Center Clearinghouse, operated by the National Safety Council
1–800–424–LEAD
(The Clearinghouse provides technical assistance by phone to the general public and professionals.)

Childhood Lead Poisoning Prevention Programs (see Appendix 2)
EPA Regional Offices (see Appendix 3)
Occupational Safety and Health Administration (OSHA) Regional Offices (Appendix 4)

Local Health Departments
Local Poison Control Centers
Local Public or Indian Housing Authorities
Local Housing and Community Development Agencies

HUD Office of Lead-Based Paint Abatement and Poisoning Prevention
1–800–743–5232

C. Property or Project Managers

Property managers and management companies may sometimes act as the owner's designated representative on lead-based paint issues, in which case they assume the owner's responsibilities described above. These individuals are responsible for acquiring the expertise needed to properly handle potential lead hazards by sending staff members to appropriate training programs or by contracting for services with certified risk assessors, certified inspector technicians, or certified abatement project supervisors.

D. Architects/Engineers/ Rehabilitation Specialists

When planning lead hazard control activities in multiple dwellings, an owner may employ architects, engineers, rehabilitation specialists, or other specialists in housing construction. All of these specialists may be considered "planners" (as the term is used in Title X). Title X requires that planners receive training, since most architects, engineers, and rehabilitation specialists do not currently understand the differences between lead hazard control, asbestos hazard control, and ordinary construction work.

Whether or not they are trained and certified as planners, housing specialists should consult a certified risk assessor or certified abatement project supervisor to acquire this expertise on the planning team. If job specifications are developed, they should be reviewed by a certified risk assessor; if no risk assessor is available, a qualified environmental or health scientist should be consulted. A certified individual may be required in some programs and jurisdictions.

Planning for housing rehabilitation without taking lead hazard control into account can greatly increase the cost of the overall effort. For example, a local housing department recently discovered that failing to include lead hazard control in its original rehabilitation project cost millions of dollars more than it would have if abatement had been integrated into the original work (*Washington Post*, 1992).

For many small-scale projects (e.g., single-family homes or projects with less than 5 units), retaining an architect, engineer, or housing rehabilitation specialist may not be feasible or necessary. In this case a certified abatement contractor or supervisor may need to consult directly with a certified risk assessor and the owner.

Collaboration should occur between the owner and persons knowledgeable about lead hazard control work and construction. Ideally an owner should seek guidance from a risk assessor who has demonstrated knowledge about both construction and lead hazard control. However, often a team effort will be required, with contractors providing expertise on construction, and risk assessors providing information on identifying and controlling lead hazards.

Lists of housing professionals are available from:

American Institute of Architects
1735 New York Avenue NW.
Washington, DC 20006
(202) 626–7300

National Society of Professional Engineers
1420 King Street
Alexandria, VA 22314–2794
(703) 684–2800

American Consulting Engineers Council
1015 15th Street NW.
Washington, DC 20005
(202) 347–7474

E. Housing and Code Inspectors

In many jurisdictions some kinds of lead hazards (such as peeling paint) may be identified in the course of ordinary housing or building code inspections. However, most housing and building inspectors do not currently have the training to recognize all kinds of lead hazards (e.g., leaded dust hazards). Individuals engaging in identification of lead-based paint hazards should be certified or licensed by their State or local approving authority as a risk assessor or inspector technician.

F. Lead Hazard Control Supervisors and Workers

Because lead abatement projects are dangerous, they must be managed by certified supervisors and performed by trained workers. Certified asbestos abatement contractors, hazardous waste site contractors, or radon remediation contractors do not necessarily possess the kinds of skills required to perform lead hazard control work safely. Lead hazard control firms should employ professionals with construction and/or general carpentry or building renovation experience, in addition to environmental experience. These firms should also carry general liability insurance, workers' compensation, and other insurance. Bid, performance, and payment bonding and hazardous pollutant insurance coverage may be required by some owners for large jobs.

In a few areas, market forces and government-funded abatement programs have produced a pool of qualified lead abatement contractors. These contractors have invested in training, thus equipping their supervisors and workers with the ability to perform abatement work safely. In addition, these contractors have some experience in completing abatement work that conforms to requirements similar to these *Guidelines*. Many abatement contractors over the past few years have completed abatement projects in public housing under specifications based on HUD's 1990 *Guidelines*. Many of these projects have been monitored by industrial hygienists or professional environmental consultants, who are often a good resource for finding qualified contractors.

Lists of certified supervisors in a given locale may be available from:

The National Lead Abatement Council
P.O. Box 535
Olney, MD 20832
(301) 924–0804 or
(800) 590–NLAC

The Environmental Information Association
1777 Northeast Expressway, Suite 150
Atlanta, GA 30329–2440
(404) 633–2622

Local Health Departments
Local Environmental Agencies
Local Public and Indian Housing Authorities
Local Housing and Community Development Agencies
EPA Regional Lead Training Centers (see Appendix 5)
Other Training Providers (see Appendix 6)

While Title X does not require that interim control work be performed by certified contractors, OSHA requires that workers dealing with lead-containing surfaces be trained (29CFR 1926.62). The EPA worker training curriculum is an acceptable way to train such workers. Since some types of interim controls can produce hazardous conditions if proper controls are not in place, an owner should insist on proper training for all personnel performing this kind of work.

G. Public and Indian Housing Authorities and Other Housing Agencies

Much of the lead hazard control work in this country to date has occurred in housing owned by public and Indian housing authorities, which are local agencies supported by HUD. In addition, local lead hazard control laws have existed for several years in Maryland and Massachusetts. Representatives from housing authorities and these two States can provide various kinds of help and information to owners or residents undertaking lead hazard control work, such as the names of contracting firms.

H. Insurance Companies

All risk assessors, inspector technicians, contractors, consultants, planners, and waste hauling companies may need to be properly bonded and insured. At this time only a few insurance companies provide such insurance. Owners should make certain that any company retained for lead hazard control is insured specifically for lead exposures.

A list of insurance companies that offer lead abatement general and professional liability coverage can be found in Appendix 6. Call the National Lead Information Center at 1–800–424–LEAD for a complete listing.

I. Real Estate Brokers and Agents

Pursuant to section 1018 of Title X, real estate brokers and agents will be responsible for providing buyers with a brochure on lead hazards for residential properties built before 1978. The agents should educate potential buyers and sellers about lead hazards and should encourage risk assessments or inspections of pre-1978 dwellings.

III. Health

A. Public Health

Health professionals (including health care providers and public health professionals) and agencies play a leading role in conducting public education campaigns, enforcing local lead control laws, and identifying those children and workers who have already been poisoned. In some cases health agencies can legally mandate changes in the dwelling when a poisoned child has been identified. However, health care professionals are often limited to providing medical treatment or blood lead screening programs. Reducing exposure (primary prevention) is known to be far more effective than providing medical treatment after poisoning. Because lead hazard control is dangerous work that can exacerbate a given situation if not performed properly, health professionals are often best suited to provide scientific advice and design programs to prevent further poisoning of children or abatement workers.

B. Health Care Providers

Health care providers can provide expertise on medical surveillance and treatment. Pediatricians often perform routine blood lead screening for their young patients, based on the recommendations from CDC and the American Academy of Pediatrics (AAP). Both organizations now recommend that all children under age 6 be screened routinely for elevated blood lead levels (EBLs) using a blood lead test (not the erythrocyte protoporphyrin (EP) test) (CDC, 1991b; AAP, 1993). Any pediatrician or physician treating children under age 6 should be aware of these recommended medical guidelines.

Physicians providing medical surveillance services for adult workers should be board-certified in occupational medicine. Medical surveillance for lead hazard control workers is regulated under the OSHA Lead in Construction Standard (29 CFR 1926.62). Physicians providing medical surveillance for lead hazard control workers should be aware of their legal duties by obtaining and reading the standard, which is available from any OSHA regional office (see Appendix 4). In addition to their legal duties, physicians can provide important counseling for patients who are exposed to lead or who have EBLs.

Organizations that provide information about medical surveillance for lead or blood lead screening include:

Childhood Lead Poisoning Prevention Programs (Appendix 2)

American Academy of Pediatrics
141 Northwest Point Boulevard
P.O. Box 927
Elm Grove Village, IL 60009
(Please request information in writing)

Association of Occupational & Environmental Clinics
1010 Vermont Avenue NW., Suite 513
Washington, DC 20005
(202) 347–4976

American College of Occupational & Environmental Medicine
55 West Seegers Road
Arlington Heights, IL 60006
(708) 228–6850

Local Health Departments
Local Poison Control Centers

C. Public Health Practitioners (Nurses)

Public health practitioners often are the direct point of contact for blood lead screening programs and often play the role of coordinator between parent, child, physician, and environmental inspector in cases of lead poisoning in children. In many circumstances they conduct the actual blood specimen collection in the home, clinic, or hospital. They are also skilled at communicating information on the sources of lead poisoning and practical ways of reducing exposures.

D. Public Health Departments

Many local public health departments conduct lead poisoning prevention services or can arrange for such services. The development of a primary prevention plan, which identifies and removes hazardous sources of lead exposure before children are harmed, is consistent with the recommendations of the 1991 CDC Statement, *Preventing Lead Poisoning in Young Children*.

In addition to preventive services, many public health departments have expanded their efforts beyond identifying and medically treating children who are lead poisoned. Many of them now use environmental case management to address the needs of lead-poisoned children. This includes education, identification of lead sources, immediate and long-term interventions to reduce lead exposure, and evaluation of the effectiveness of such interventions. Increasingly, public health departments are coordinating their efforts with housing and environmental protection departments to provide comprehensive care for children at risk.

Local health department contacts for lead poisoning services can be provided by:

Lead Information Hotline
1–800–532–3394 (800–LEAD–FYI),
Automated Information Service

National Lead Information Center
Clearinghouse
1–800–424–LEAD, Technical Assistance

National Conference of State
Legislatures (NCSL)
1560 Broadway, Suite 1700
Denver, CO 80202
(303) 830–2200

State Public Health Agencies

IV. Environment

While there is a significant overlap with public health departments, environmental professionals and agencies have primary responsibility for ensuring that proposed construction practices in lead hazard control do not harm workers, the environment, or children who return to the dwelling after work is completed. This is accomplished by requiring special equipment, containment, cleanup project monitoring, and waste management. Environmental professionals provide onsite information to owners and health professionals in the form of risk assessments, inspections, clearance examinations, and surveillance of work practices.

A. Risk Assessors and Inspector Technicians

Risk assessors are certified professionals who can identify lead-based paint hazards and provide recommendations to owners on acceptable options for controlling them. Inspector technicians are trained to identify lead-based paint on a surface-by-surface basis. One known jurisdiction now requires risk assessors and inspector technicians to provide “lead-safe” or “lead-free” certificates for specified durations (Rhode Island, 1993).

1. Risk Assessors

As a systematic approach to identifying lead hazards, risk assessment is a recent development in lead poisoning prevention efforts, originating with a nonprofit public housing insurance program (HES, 1991). The system was adopted by HUD in June 1992 for use in public and Indian housing developments (HUD, 1992). In the past few years, numerous public housing authorities have performed risk assessments of their family housing developments that range from conventional multifamily developments to single-family, scattered-site units. The original HUD protocol has been adapted in these *Guidelines* for use in all types of housing situations.

The minimum qualification for a risk assessor is certification by the State or EPA, but there are additional skills and experience that an owner may consider when selecting a risk assessor. This experience may include a background in housing construction, rehabilitation, maintenance, and exposure assessment. Architects, engineers, and code enforcement officials may have such experience. Industrial hygienists and other environmental health practitioners generally are experienced in environmental sampling and interpretation of results.

A risk assessor who also has experience in the management, maintenance, and renovation of housing is more likely to be able to make judgments about the quality of the existing housing stock, the likely effectiveness of hazard controls, and the effectiveness of the existing management and maintenance operations. Such a risk assessor will be able to make practical recommendations about how to modify existing management and maintenance procedures to minimize lead hazards.

Information about locating risk assessors or inspector technicians in your area can be found in Section 3.

2. Inspector Technicians

As with risk assessors, inspector technicians must be certified by the State or EPA. Ideally the inspector technician will also have substantial experience in inspection according to the paint testing procedures in HUD's 1990 public housing guidelines. Thousands of units of public and private housing have been comprehensively tested using this HUD protocol. Firms that have experience working with public housing authorities and childhood lead poisoning prevention programs may be particularly well qualified.

Inspector technicians should be fully trained and competent in the use of portable x-ray fluorescence (XRF) analyzers and be able to explain protocols for their use, since XRF is the principal means of inspecting houses. Protocols should include sampling plans for various types of housing, quality control procedures to ensure reliability of measurements, procedures for confirmatory testing, and the documentation required under these *Guidelines* (EPA, 1993a) (see Chapter 7). They should also provide references from previous inspections.

Another way of testing for lead in paint is the use of spot-test kits. The evidence to support the use of chemical spot-testing methods is incomplete at this time, although further development may permit their use in the future by inspector technicians or risk assessors. These kits may be used if XRF or laboratory paint-chip testing cannot be performed. Up-to-date information on HUD and EPA evaluation of these kits can be obtained by calling 1–800–LEAD–FYI.

It is important to employ a firm or individual with the commitment and ability to address residents' concerns. Inspector technicians also should have the ability to communicate effectively and answer questions clearly.

3. Finding Qualified Risk Assessors and Inspectors

Certified risk assessors and inspector technicians can be identified by contacting the State or local agency responsible for certifying or licensing individuals or by contacting one of the following groups:

The National Lead Abatement Council
P.O. Box 535
Olney, MD 20832
(301) 924–5490

The Environmental Information Association
1777 Northeast Expressway, Suite 150
Atlanta, GA 30329–2440
(404) 633–2622

Housing Environmental Services
130 Bishop Allen Drive
Cambridge, MA 02139
1–800–HES–3313

B. Waste Managers and Environmental Protection Departments

Environmental protection departments are organized at the State and sometimes the local level. These departments are often responsible for regulating hazardous wastes generated within their jurisdictions. Some may also require permits for lead hazard control work. Regional EPA offices can provide guidance on the appropriate regulatory agency for any given area. (See Appendix 3 for a list of EPA regional offices.)

Waste management is a complex area that may require special assistance. The local or State agency regulating waste should *always* be contacted to determine applicable requirements. In most cases lead abatement supervisors or risk assessors can provide the necessary information on how to handle and dispose of any hazardous waste. Since hazardous waste is regulated at the Federal, State, and local levels, owners should take steps to ensure that all applicable regulations are followed and that all necessary manifests (forms) and permits have been obtained. Owners are ultimately responsible for proper waste disposal and should make sure that the transporter and disposer have liability insurance that protects the owner. Sources of information on waste management include:

EPA Resource Conservation and Recovery Act (RCRA)
Superfund/Underground Storage Tanks (UST) Hotline
1–800–424–9346

(The staff of this hotline will provide the latest information about Federal regulations concerning the disposal of hazardous waste.)

National Conference of State Legislatures (NCSL)
1560 Broadway, Suite 1700
Denver, CO 80202
(303) 830–2200

(NCSL can provide information about current State regulations and appropriate State agencies in each area.)

State Hazardous and Solid Waste Agencies (see Chapter 10)

Analytical Laboratories Performing Toxicity Characteristic Leachate Procedure (TCLP) Analysis

Treatment, Storage, and Disposal Facilities

Hazardous Waste Consultants and Brokers

C. Other Environmental Consultants

Although a certified risk assessor should always be used, in those areas where certified risk assessors are not yet available, professionals in a variety of other environmental disciplines can provide advice. Some environmental disciplines have certification or separate licensing programs; however, a professional certification or license in another environmental, engineering, housing, or building inspection field is no guarantee of competence in lead hazard control or detection, although many professionals in these fields will obtain the necessary additional training before undertaking this work. Owners contracting with these individuals should determine if the individuals' previous training, experience, and qualifications are appropriate for housing. In addition, professional liability insurance usually excludes lead hazard control work at this time.

Many (but not all) industrial hygienists are certified by the American Board of Industrial Hygiene after 4 to 5 years of experience, achievement of a college degree, and completion of a 2-day exam. Noncertified industrial hygienists may also be able to provide help.

Registered architects, licensed professional engineers, and environmental consultants generally possess a 4- or 5-year accredited professional degree, several years of experience and internships, and successful completion of 2- to 3-day examinations on the principles and practice of their professions.

Certified safety professionals can provide advice regarding safety issues on construction sites, but may not be qualified to address lead hazard control issues.

Organizations involved with these groups include:

American Board of Industrial Hygiene
(Certified Industrial Hygienists)
4600 West Saginaw, Suite 101
Lansing, MI 48917
(517) 321–2638

American Institute of Architects
1735 New York Avenue NW.
Washington DC 20006
(202) 626–7300

American Industrial Hygiene Association
2700 Prosperity Avenue, Suite 250
Fairfax, VA 22031
(703) 849–8888

American Academy of Environmental Engineers
130 Holiday Court, Suite 100
Annapolis, MD 21401
(410) 266–3311

National Society of Professional Engineers
1420 King Street
Alexandria, VA 22314–2794
(703) 684–2800

D. Suppliers

Suppliers can often provide expert advice on products used in lead hazard control projects, such as high-efficiency particulate air (HEPA) vacuums, personal protective clothing, respirators, containment systems, paint removal products, enclosures, encapsulants, and cleaning agents. Owners or contractors should always question suppliers regarding the limitations of the product and obtain references from previous customers.

Local suppliers can be found by consulting the yellow pages or one of the following trade organizations:

The National Lead Abatement Council
P.O. Box 535
Olney, MD 20832
(301) 924–5490

The Environmental Information Association
1777 Northeast Expressway, Suite 150
Atlanta, GA 30329–2440
(404) 633–2622

E. Laboratories

Analysis of lead-based paint, soil, or dust samples in the laboratory is difficult. Any laboratory performing analysis of lead for lead hazard control work in housing should participate in the EPA's National Lead Laboratory Accreditation Program (NLLAP), which is currently administered by the American Association for Laboratory Accreditation and the American Industrial Hygiene Association. To gain accreditation under NLLAP, laboratories must participate in the Environmental Lead Proficiency Analytical Testing Program (ELPAT) administered by the American Industrial Hygiene Association, and meet other requirements. Other organizations may be recognized as having a competent proficiency testing program in the future. Laboratories must successfully pass the onsite visit and be rated as proficient in ELPAT to be recognized by EPA. Owners, contractors, inspector technicians, and risk assessors should request a copy of the accreditation certificate and should verify with the appropriate organization that the laboratory under consideration does in fact perform adequately. Currently about 200 laboratories are participating in NLLAP. To identify accredited laboratories in any given area, contact:

American Association for Laboratory Accreditation
656 Quince Orchard Road
Gaithersburg, MD 20878–1409
(301) 670–1377

American Industrial Hygiene Association
2700 Prosperity Avenue, Suite 250
Fairfax, VA 22031
(703) 849–8888

National Lead Information Center Clearinghouse
1–800–424–LEAD (Ask for the most current list of EPA-recognized laboratories for analyzing lead in paint, dust, or soil.)

National Institute for Occupational Safety and Health (NIOSH)
1–800–35–NIOSH

F. Training Providers

Risk assessors, inspector technicians, lead abatement supervisors, planners, and workers must all be trained by accredited training providers. When contracting for training services, potential trainees should always ask to see proof of accreditation. The State agency responsible for accreditation can be contacted for a list of training providers in any given area.

EPA has also established a national network of regional lead training centers that provide training services using a standardized EPA training curriculum. The organizations in this network are listed in Appendix5. Other groups may also provide the EPA training curriculum but may not be accredited.

On the national level, accredited training providers can be identified by contacting one of the following organizations:

The National Lead Abatement Council
P.O. Box 535
Olney, MD 20832
(301) 924–5490

The Environmental Information Association
1777 Northeast Expressway, Suite 150
Atlanta, GA 30329–2440
(404) 633–2622

A partial list of non-EPA network trainers can be found in Appendix 6.

V. List of Lead Periodicals and Other Publications

Information on lead-based paint hazard control products and technology and important developments is available from a variety of trade periodicals and other sources:

Alliance Alert
Alliance to End Childhood Lead Poisoning
227 Massachusetts Avenue NE., Suite 200
Washington, DC 20002

Deleading Magazine
P.O. Box 535
Olney, MD 20832

Journal of Protective Coatings and Linings
Steel Structures Painting Council
2100 Wharton Street, Suite 310
Pittsburgh, PA 15203

Lead Abatement Alert
Lee Publishing Company
P.O. Box 65121
Washington, DC 20035–5121

Lead-Based Paint Handbook
Jan Gooch, Ph.D.
Plenum Press
233 Spring Street
New York, NY 10013

LeadLetter
Leadtec Services, Inc.
8841 Orchard Tree Lane
Baltimore, MD 21286

Lead Poisoning Report
IAQ Publications
4520 East-West Highway, Suite 600
Bethesda, MD 20814

The Lead Letter
311 McClellan Avenue
Mount Vernon, NY 10553–2110

The Lead Line
Aulson Company
80 Foster Street
Peabody, MA 01960

Mealey's Lead Litigation Reports
P.O. Box 446
Wayne, PA 19087–0446

NIOSH Alert—"Preventing Lead Poisoning in Construction Workers," August 1991
Publications Dissemination, DSDTT
National Institute for Occupational Safety and Health
4676 Columbia Parkway
Cincinnati, OH 45226

"Protecting Workers and Their Communities from Lead Hazards: A Guide for Protective Work Practices and Effective Worker Training"
Society for Occupational & Environmental Health
6728 Old McLean Village Drive
McLean, VA 22101

"Working with Lead in the Construction Industry"
Occupational Safety and Health Administration
U.S. Department of Labor, OSHA Publications Office
200 Constitution Avenue NW., Room N3101
Washington, DC 20210

Chapter 3: Before You Begin—Planning To Control Lead Hazards

Planning To Control Lead Hazards: How To Do It

1. Determine the most appropriate long-term or short-term evaluation and control response to the lead hazards for a specific property. Select the most opportune time to conduct lead hazard evaluation and control (often during unit turnover, remodeling or renovation work, refinancing, or substantial maintenance activity). Determine if historic preservation requirements apply to the property.
2. Decide whether Federal, State, or local regulations require specific lead hazard evaluation or control activities.
3. Determine the potential for the property to contain lead hazards. If the dwelling was built before 1978 or if a child with an elevated blood lead level is present (see Glossary for technical definition), a building-related lead hazard may exist. If the dwelling was built after 1978 and no history of lead poisoning is evident, there is very little chance that a lead hazard exists and no further action is required.
4. Consider whether to acquire the services of a risk assessor and/or an inspector technician to perform an evaluation. For large multifamily projects, develop and issue a Request for Proposals (RFP) for inspections and/or risk assessments. If a property owner decides to implement lead hazard controls without an evaluation, all painted, varnished, or other coated surfaces should be assumed to have lead-based paint.
5. Conduct an evaluation (i.e., a risk assessment, paint inspection, or a combination of the two). For properties in good condition, a lead hazard screen risk assessment is recommended to determine if a full risk assessment is necessary (see Chapter 5).
6. If lead hazards are identified or assumed to exist, select specific lead hazard control methods for specific building components. Include waste considerations, management, resident and worker protection, and cost in determining the best method for the property. Determine the methods and the person(s) responsible for obtaining any necessary permits. Obtain a cost estimate from a certified contractor or risk assessor. Cost estimation considerations are outlined in this chapter.
7. Develop specifications for lead hazard control work (usually for large multifamily projects).
8. Conduct pilot projects and revise specifications if necessary (for large multifamily projects only).
9. Schedule other related construction work to coordinate with lead hazard control work.
10. Select a lead hazard control contractor (this may precede the pilot project). Ensure that the contractor has adequate bonding (if required) and insurance.
11. Correct preexisting problems or conditions before beginning lead hazard control work.
12. Determine person(s) responsible for monitoring work to ensure safety (supervisor, risk assessor/consultant, owner).
13. Select the independent, certified inspector technician or risk assessor responsible for conducting clearance testing. Certified risk assessors should conduct the clearance testing if a hazard evaluation was not performed before work began.
14. Conduct lead abatement or interim control work, including cleanup and clearance testing.
15. Determine if Federal regulations or local jurisdictions require issuance of certificates following clearance.
16. Arrange for ongoing monitoring by the owner or owner's representative and an appropriate reevaluation schedule by a certified professional (see Chapter 6).

Chapter 3: Before You Begin—Planning To Control Lead Hazards

This chapter is designed to help plan lead hazard control efforts. It describes the process of evaluation and control and suggests items to consider in estimating costs and ensuring quality. Included are (1) methods for determining whether risk assessments or inspections are appropriate; (2) the typical phases of lead hazard control projects (both interim control and abatement); and (3) the key issues to be addressed at each phase.

I. Concept and Purpose

The goal of lead hazard evaluation and control is to correct lead hazards in the safest and most cost-effective manner feasible. In most cases this will require the expertise of licensed or certified professionals. The choices usually include inspection followed by abatement, risk assessment followed by interim controls, and/or abatement or lead hazard control without a risk assessment or inspection. However, this simple concept may not be applicable to all cases. Sometimes a tailored combination approach is best. In some cases risk assessments will result in abatement if interim controls are not feasible or advisable. A combination of abatement and interim control methods is sometimes most feasible for a particular dwelling. See the Glossary and Chapter 1 for definitions of risk assessment, inspection, interim controls, and abatement.

If it is reasonable to assume that all surfaces to be treated contain lead-based paint, all horizontal surfaces have lead-contaminated dust, and all bare soil is contaminated, it may be cost effective to proceed directly to lead hazard control procedures without any preliminary inspection or risk assessment. If there is no evaluation, the control activities should be followed by a risk assessment to ensure that all risks have been appropriately controlled. In this case, all clearance testing must be done by a certified risk assessor. This option is discussed further in Section IV below.

If all paint is intact, dust and bare soil lead levels are well below applicable standards, and no other hazards are present, any lead-based painted surface can be managed until an opportune time for abatement occurs (such as a planned renovation or dwelling turnover).

II. Determining Whether a Short-Term or Long-Term Response Is Appropriate

Completely eliminating the hazards from the housing environment through risk assessment/inspection followed by abatement is an effective and safe approach to lead hazard control, provided that:

- All types of lead hazards are addressed, including lead-contaminated dust and soil.
- Workers and residents are not adversely affected during the work.
- The process is properly controlled so that new lead hazards are not created.
- Cleanup is adequate as determined by clearance testing.

The inspection/abatement approach has the advantage of being a one-time intervention that, if done properly, can produce permanent results. However, for many owners, abatement may be unnecessary or too expensive and technically demanding, at least in the short run.

Until permanent abatement is feasible for these owners, identifying lead hazards by risk assessment and treating them by using interim control methods (and perhaps abating a few key surfaces) is an effective, short-term alternative. The risk assessment/interim control approach has the advantage of treating the lead hazards to which children are likely to be exposed, while temporarily controlling and monitoring the lead-based paint on an ongoing basis.

Some owners may decide to adopt a continuous interim control approach, which will require ongoing monitoring of paint hazards. Unless regulated by the local jurisdiction or applicable Federal or State funding program, owners can select whatever strategy they wish, as long as certain prohibited paint removal practices are not used (see Chapter 11) and compliance with clearance standards is achieved. This provides substantial flexibility for different types of housing and ownership patterns, permits innovation, and still ensures that dwellings are lead-safe (see the Glossary for the definition of a "lead-safe dwelling").

To determine the measures that will be most effective and safe for a given property, certain planning steps are appropriate (see Table3.1). These steps are generally the same for all types of properties, but for smaller buildings and especially single-family homes, some of the steps may not be appropriate, as indicated by asterisks in Table 3.1.

Regulatory requirements may predetermine the lead hazard control strategy as well as when lead hazard identification efforts are required. In a few States, including Maryland and Massachusetts, inspection and abatement of certain lead-based paint hazards (defined by each State) are mandated, under some circumstances, for rental properties. In many States inspection and abatement (to varying standards) are required when a lead-poisoned child is identified. If the dwelling is associated with a Federal program, HUD regulations for that specific program should be consulted. (HUD regulations vary considerably from one program to the next.)

III. Review of Existing Conditions and Preliminary Determination of Lead Hazard Control Strategy

The choice of a strategy depends on the extent of the lead hazards that exist and the financial resources available to address them. In addition, before undertaking risk assessment or inspection, certain existing conditions at a property should be reviewed, since they may indicate which lead hazard control strategy is appropriate. The lack of historical evidence of lead poisoning in a particular area should not be considered conclusive when determining whether or not a population is at risk or whether a dwelling unit contains lead hazards. Although in many parts of the country there have historically been few reported cases of lead poisoning, it may be because very few children were tested regularly. With increased public awareness and more widespread blood lead testing, it is expected that many more children with lead poisoning will be identified. The following general issues should be reviewed:

- Condition of the property.
- Age of the property (including historic preservation requirements).
- Capital replacement plans for the property (or expected useful life).
- Ongoing management and maintenance issues.
- Existing occupants.
- Regulatory requirements.
- Financing resources.

Each of these considerations is described below.

A. Condition of the Property

The condition of painted building components should be a primary consideration in devising the overall lead hazard control strategy. If painted building components have deteriorated to the point where they are difficult to maintain, or if the dwelling unit is subject to recurring water infiltration or other water damage, neither interim controls nor abatement will be effective without a substantial restoration effort. Interim controls and some forms of abatement are likely to have very short lives in these situations.

B. Age of the Property

Age of the property can indicate the amount of lead-based paint likely to be present and the extent of the lead hazard control work that may be necessary. The majority of buildings built before 1978, and especially those built before 1960, contain some lead-based paint (HUD, 1990b). The older the dwelling, the higher the concentration of lead in the paint. For pre-1950 properties, it is reasonable to assume that lead-based paint is present on more than a few surfaces and that abatement of lead hazards will involve a significant amount of work. Table 3.2 demonstrates the relationship between age and prevalence of lead-based paint (HUD, 1990b). It is worth noting that there is tremendous variability in houses within each age group. Depending on local conditions, some pre-1950 dwellings may have no lead-based paint at all, while newer ones may have a considerable amount.

In most properties built between 1960 and 1978, it is reasonable to expect that fewer surfaces with lead-based paint are present. For

Table 3.1 Summary of Steps in Planning Lead Hazard Control Projects

1. Review of existing conditions/preliminary determination of lead hazard control strategy, including historic preservation requirements.
2. Evaluation of lead hazards.
3. Selection of specific lead hazard control methods.
4. Selection of resident protection and worksite preparation level.
5. Development of specifications.*
6. Initiation of pilot project.*
7. Scheduling of other related construction work.
8. Selection of lead hazard control contractors.
9. Correction of preexisting conditions that could impede lead hazard control work.
10. Monitoring the work and cleanup process.
11. Clearance (and certification if required by the local jurisdiction).
12. Arrangement of ongoing monitoring and reevaluation.

* Not necessarily required in single-family dwellings.

Table 3.2 Privately Owned Dwellings With Lead-Based Paint (by Age and Amount)

Construction Year	Total Occupied Units[1]	Percent With Lead-Based Paint[2]	Average Surface Area With Lead-Based Paint (≥1 mg/cm^2) on Interior and Exterior Surfaces[3] (square feet)
1960–1979	35,681,000	62%	466
1940–1959	20,476,000	80%	1,090
Before 1940	21,018,000	90%	1,996

Source: *Comprehensive and Workable Plan for the Abatement of Lead-Based Paint in Privately Owned Housing: A Report to Congress* (HUD, 1990b).

[1] Total units data are from the 1987 American Housing Survey.

[2] The approximate 95% confidence intervals for the estimated percentages are: 1960–79 and before 1940 = +/– 10%, 1940–59 = +/– 9%.

[3] Calculated from Tables 3–14 and 3–15 of the Comprehensive and Workable Plan. Average is calculated using only units with lead-based paint.

these properties, inspection (see Chapter 7) or a lead hazard screen risk assessment (see Chapter 5) is often most cost effective to determine whether lead-based paint or lead-based paint hazards are present. These newer properties still require hazard evaluation, since there is some evidence that significant levels of lead-based paint were sold up to at least 1971 (*New York Times*, 1971).

It is unusual but not impossible to find lead-based paint in houses built after 1978. For example, some health departments still periodically confiscate new residential paint containing illegal amounts of lead (Massachusetts, 1992). Since 1978 the Consumer Product Safety Commission has permitted no more than 600 µg/g (0.06 percent) of lead in residential paint. Thus, because the use of lead in paint had almost ceased by 1978 and because of the need to focus scarce resources, houses built after 1978 are not targeted for inspection or risk assessment, unless a child with lead poisoning is identified. In some dwellings, historic preservation requirements may apply (see Chapter 18).

C. Capital Replacement Plans (Expected Useful Dwelling Life)

Future plans for the building play an important role in deciding whether long-term or short-term approaches are best. If the building is expected to be demolished within 3 years, a substantial investment in the form of abatement makes little sense. In this case a risk assessment and interim controls are clearly best. Furthermore, if no children or pregnant women will be present inside the building, hazard control measures are only necessary to protect the environment and maintenance and demolition workers. If substantial comprehensive renovations are planned, it may be efficient, and often necessary (for safety reasons), to integrate lead abatement into the project. Before capital replacement projects are performed, all painted surfaces that will be disturbed should be inspected. It is probably cost effective to carry out a full lead-based paint inspection at this time to determine if additional work can take care of other lead-based paint at the same time. Inspection is especially important if the construction process will disturb painted surfaces and generate a substantial amount of dust. If lead-based paint is present in such a project, the renovation process should be designed to prevent leaded dust from being dispersed throughout the housing environment. If no lead-based paint is found, any construction work can proceed in the usual fashion. If replacement or enclosure of certain components is already planned, this work may accomplish abatement of those components. These components should be inspected to determine whether the project requires additional safety controls. For building components that can be readily removed or enclosed without generating significant amounts of leaded dust, the work can usually proceed safely with the addition of a few simple
controls.

If abatement of asbestos or other environmental hazards is planned, it may be cost effective to combine this work with lead abatement. Although there are some important differences, many requirements for containment and cleanup for both lead and asbestos abatement are similar (for example, use of high-efficiency particulate air (HEPA) vacuums and respirators). Therefore the same firm may be able to carry out both types of work, if certified to do both.

D. Management and Maintenance Issues

Abatement is a relatively permanent response to lead hazards; interim control is a repeated, temporary response. Both can produce lead-safe dwellings. Abatement normally requires an intensive effort at considerable inconvenience, but can usually be completed within a brief timeframe. To be consistently effective, interim controls require an ongoing effort as well as some inconvenience and expense at periodic intervals.

For example, painted surfaces must be examined regularly and kept in good condition. If significant dust and soil hazards were found as a result of risk assessment, dust and soil sampling may have to be repeated on a regular basis. If recontamination occurs after interim controls, cleanup and paint stabilization will have to be repeated.

The interim control option requires that control of lead hazards become a formal part of normal property management. Owners and managers may choose to focus resources on a one-time, permanent abatement solution unless they are willing and able to carry out such a management regimen. Others may decide that ongoing management is appropriate for them. Regardless of the option chosen, the dwelling unit must be made lead-safe.

E. Resident Population

Children under 6 years old are especially at risk for lead poisoning and are most likely to be impaired as a result of exposure (CDC, 1991b). Dwelling units where young children currently reside, or vacant units that may be occupied in the near future by a family with a young child should be given high priority for hazard control. Pregnant women also are at risk, so units with pregnant women are also high priority. Eventually, *all* older dwellings will require treatment, since one cannot predict with certainty which dwelling units will house children or pregnant women.

It is worth noting that owners who refuse to rent dwellings to families with young children or pregnant women may be in violation of the Federal Fair Housing Amendments Act of 1988.

F. Cost and Financing

The cost of lead hazard control varies enormously with the size and condition of the dwelling unit and the soil at the dwelling site, the treatments selected, local wage rates, the competitiveness of the market, and other factors.

In 1991 HUD estimated that more than half of all housing units with lead-based paint could be abated for less than $2,500 (HUD, 1991). These estimates did not include testing or relocation costs. Abating all hazards in older dwelling units with substantial deferred maintenance can be much more expensive. Owners should not assume the cost of abatement is prohibitive until proper inspection has been completed, lead hazard control options have been identified, and costs have been estimated by qualified abatement contractors. Variables that should be considered in constructing a reliable cost estimate are described in SectionVI of this chapter.

Although there are very little historical data on interim control costs, it should be assumed that, in the short run, interim control is far less expensive than abatement. In the long run, interim control may eventually exceed the cost of abatement due to ongoing maintenance, reevaluation, and cleanup.

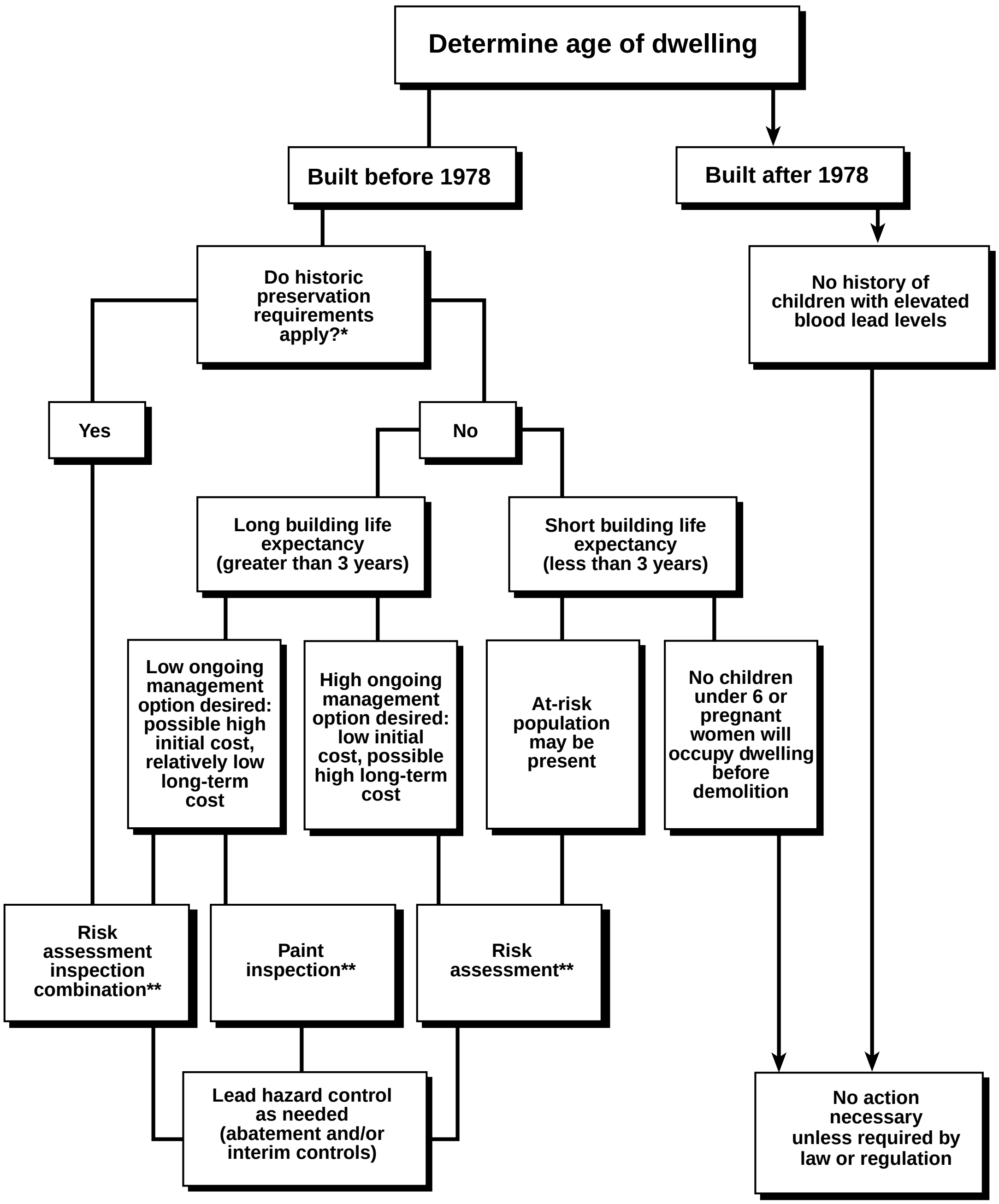
Some properties may be eligible for loans and grants under public programs usually administered by State or local housing and/or health departments. If private loans are to be used to finance the project, the properties and the lead hazard control project will probably need to meet the requirements for home improvement (generally only available for owner-occupied properties) or other equity-backed loans (first and second mortgages). Financing for these activities will be subject to the same loan underwriting requirements that apply to other types of building improvement financing. Such programs generally favor substantial capital improvements that can clearly be shown to increase the value of the property.

G. Preliminary Determination of Lead Hazard Control Strategy

After reviewing these issues, the next step is to decide on an overall lead hazard control strategy. For example, if an older building has multiple deteriorated surfaces, an at-risk resident population, and a need or plans for replacement of several key building components, a combined risk assessment/ inspection followed by abatement may be the most appropriate lead hazard control approach. For other buildings with surfaces in “maintainable” condition and no immediate need for replacement of building components, risk assessment followed by interim controls (if necessary) may be appropriate.

Figure 3.1 provides a summary flowchart to aid in the decisionmaking process.

Figure 3.1 Risk Assessment vs. Inspection: Decisionmaking Logic.



* Whenever it is determined that a child with an elevated blood level is living in the dwelling unit, a lead hazard investigation must be completed (see Chapter 16).

** This is only general guidance. Actual on-site conditions or regulatory requirements may dictate another choice of hazard evaluation method. A paint inspection by itself may not identify lead-based paint hazards. A risk assessment inspection combination is an option whenever a risk assessment or an inspection is indicated. A risk assessment screen is appropriate for buildings in good condition. Some jurisdictions may limit choices in some circumstances.

H. Prioritizing Lead Hazard Evaluation and Control Efforts

The factors outlined above should assist a property owner with multiple housing units in deciding where to focus initial attention. It may not be feasible for owners to have risk assessments or inspections performed simultaneously at all properties. As long as the owner plans to identify all lead hazards in all dwellings in a timely manner, prioritizing units may be acceptable. For example, risk assessment and lead hazard control during unit turnover eliminates the expense associated with resident relocation. Older properties should generally be evaluated first, since they are more likely to contain lead-based paint. Dwelling units housing or likely to house children should also receive priority attention.

Unless prescribed by Federal, State, or local law, decisions on prioritizing are the responsibility of the owner and will need to be made on a case-by-case basis. This flexibility should provide the foundation for keeping costs as low as possible. The prioritized schedule should be documented in a lead hazard control plan.

IV. Lead Hazard Evaluation—Inspection and Risk Assessment

The review of existing conditions will usually determine whether the property owner should arrange for an inspection to determine the location and concentration of lead in painted and varnished surfaces or a risk assessment to identify lead hazards. If the property owner has already decided to abate all lead-based paint, a certified inspector technician should be retained to help determine what surfaces need to be abated. If no decision between interim control or abatement has been made, a certified risk assessor should be retained to sample dust and soil and suggest options for controlling lead-based paint hazards.

A. Bypassing the Lead Hazard Evaluation Step

In some cases where local laws or regulations prescribe lead hazard control measures or where there is every likelihood that lead-based paint hazards are present, the property owner may decide to forego lead hazard evaluation and proceed directly to lead hazard control. In that event the property owner should assume that all painted and varnished surfaces contain lead. The clearance examination should include a determination of whether or not some lead hazards were overlooked, since the initial lead hazard evaluation was not performed. In this case the clearance examination needs to be conducted by a certified risk assessor, not an inspector technician. However, when it is likely that only some of the surfaces to be treated contain lead-based paint, an inspection or risk assessment may be more cost effective, since up-front evaluation enables the lead hazard control activities to be more focused (HES, 1993).

B. Risk Assessment Costs

Risk assessment costs per dwelling unit vary according to the type of housing being studied. The cost per dwelling unit is lower in large multifamily housing than in single-family or small multifamily housing because environmental sampling is not required for every dwelling in large projects (see Chapter 5). For example, for an apartment complex with 200 similar dwellings, only 20 dwellings would have to be entered and sampled for risk assessment purposes, provided that construction and painting histories are uniform throughout the complex. Costs vary depending on local market conditions and can be expected to decline as the profession matures.

In the public housing program, about 50 percent of the cost of a risk assessment is attributable to the cost of analyzing environmental samples; the balance consists of activities such as visual inspection, data collection, sample collection, and report writing (HES, 1993). If extensive paint chip or soil sampling is required due to the presence of a significant amount of paint in poor condition, the sampling costs will be higher. Since these conditions can only be determined in the field once the work starts, the risk assessor should provide a separate unit price for collection and analysis of additional samples.

C. Inspection Costs

The cost of inspection depends on the number of surfaces that must be tested, which in turn depends on the number of painted components. A typical 2-bedroom apartment or small house (5 to 7 rooms) has 40 to 80 painted interior components and 5 to 15 exterior components, all of which will need to be tested. A large single-family house may have far more surfaces to be tested, depending on the number of rooms, painted components in each room, exterior components to be tested, and surfaces that require confirmatory laboratory analysis of paint chips. A typical apartment unit or small-to-average single-family house can usually be tested in 2 to 3 hours by one person operating a single x-ray fluorescence (XRF) analyzer. An additional hour for report preparation is typically needed. Using the protocol in Chapter 7 and current XRF technology, it is not possible to inspect units for $35–$45, despite claims by some inspectors to the contrary. Owners are advised to examine closely the competence of inspectors submitting bids.

D. Key Elements in a Request For Proposals (RFP) for Risk Assessment and Inspection

Most public agencies are required to advertise publicly an RFP for consultant services, such as risk assessment and inspection, depending on the estimated value of the services. Although this is not a requirement for most private-sector solicitations, it is still advisable to draw up a list of the information that each proposer should provide and a list of factors by which different proposals can be competitively evaluated.

A formal RFP for a risk assessment or inspection should contain the general sections listed in Appendix 7.1. Such an elaborate proposal is not necessary in situations where agreements can be reached by private negotiation (for example, a risk assessment for a single-family home), but these elements should still be considered before a proposal is accepted.

E. Monitoring the Risk Assessment/Inspection Process

The owner should monitor the risk assessment or inspection to ensure that all dwelling units and surfaces to be tested are in fact examined. There have been reports of inspectors providing fictitious testing data or skipping surfaces or even entire dwelling units. One way for the owner to ensure that services are delivered properly is to inform the inspector that a third party will repeat some of the testing as a quality control check. Alternatively, the owner can conduct unannounced surveillance of the testing campaign or can accompany the inspector/risk assessor as the work proceeds (see Chapter 7 for a detailed quality control plan for paint testing).

F. Reviewing the Risk Assessment Report

The contents of a risk assessment report should closely follow the format described in Chapter5. The risk assessment report should include a section detailing the lead hazard control options (i.e., what the owner should do) for each of the lead hazards identified. For all lead hazard control methods except complete lead-based paint removal (via building component replacement or paint removal), a plan for monitoring and professional reevaluation should be described (see Chapter 6). Also the report should explain precautions needed to avoid creating additional lead hazards in the future.

G. Reviewing the Inspection Report

The inspection report should include documentation demonstrating that the testing work was done in conformance with the protocols in Chapter 7. The report should contain schematic floor plans for each unit or area indicating test locations, all raw measurement data, and the results after averaging and correction for substrate interference (if applicable). The report should document that an acceptable sampling scheme was followed. A table of confirmatory test results and a summary table that shows the percentage of each component testing positive, negative, and inconclusive (multifamily housing only) should be included. The deci-sionmaking rules for classifying all surfaces in a dwelling (as outlined in Chapter 7) should be explained and applied properly. Finally, the report should state which components contain lead-based paint and which do not, and should include any recommendations for further testing.

V. Considerations in Selecting Control Methods

This section summarizes factors that should be considered in the selection of lead hazard control methods. (Specific techniques and the advantages and disadvantages of each type of lead hazard control are described in Chapters 11, 12, and 13. Before implementing the control measures, whether they be abatement or interim controls, decisions must be made regarding protective measures, the degree of containment (to protect residents), worker protection, cleaning and clearance, and waste management.

A. Containment and Resident Protection

Resident protection is an essential component of all lead hazard control work conducted in occupied units. Containment is also required to prevent dispersal of lead into soil or nearby dwellings. These measures are implemented by selecting one of the Worksite Preparation Levels described in Chapter 8. The Worksite Preparation Level should be defined in the project specifications. If there are no specifications, the certified contractor can select the level. The contractor and the property owner share responsibility for correcting any breech in the containment system. In all circumstances residents must never be permitted to enter the work area while work is underway. In some cases lead hazard control work can take place if the residents leave for the day or do not enter the work area until cleanup and clearance have been completed.

B. Worker Protection

The Occupational Safety and Health Administration (OSHA) regulations require that workers be protected whenever they are exposed to airborne leaded dust above certain levels or are performing certain construction tasks (29CFR 1926.62). (Some types of maintenance workers are covered by 29 CFR 1910.1025.) At this time no lead hazard control technique is automatically exempt from worker protection requirements, including encapsulation and enclosure. However, it is possible for employers to show that some of the requirements are not applicable by generating objective data from jobs in similar housing using corresponding methods with the same workers. Unless monitoring is completed showing that airborne lead levels are well below OSHA exposure limits, workers should wear half-mask respirators fitted with the correct HEPA filter for leaded dust particles and protective clothing, exercise proper personal hygiene (preferably onsite showers), and undergo medical surveillance. These measures will also prevent workers from taking home leaded dust on their shoes and work clothing, where their own children could be exposed. Some of these protective measures may not be necessary for low-level interventions (wet cleaning, for example). The cost of meeting OSHA requirements must be taken into account in any lead hazard control effort. Chapter 9 provides further guidance on implementing the OSHA lead construction standard in the housing industry.

C. Cleanup and Clearance Requirements

The lead hazard control method selected will determine the extent of the cleanup required. For very low-lead, dust-generating jobs, careful wet cleaning alone may suffice. For most interim control and abatement jobs, a HEPA vacuum cleaning, followed by a wet wash, and final cleaning with the HEPA vacuum, is the best way of meeting clearance standards. For jobs generating more leaded dust, one or more HEPA/wet wash/HEPA cycles may be required (see Chapter14).

At the end of the job, a clearance examination is conducted to document that the area is safe to be reoccupied, all work was completed, and cleaning was adequate. Chapter 15 explains clearance requirements.

D. Waste Disposal

The cost of waste disposal and waste testing should be considered when deciding on a lead hazard control strategy. Waste characterization must be done before shipping leaded debris to disposal facilities. If waste is found to be hazardous, its handling, transport, and disposal are subject to strict regulation (see Chapter 10).

The cost of hazardous waste disposal may be a key factor in selecting abatement methods, particularly because it can significantly affect the project budget. Therefore, testing to characterize wastes should be performed as early as possible in the planning process. Additionally, a plan for segregating hazardous and nonhazardous waste is needed to avoid labeling all waste hazardous. Also, contractors must know if waste is hazardous in order to submit accurate bids; otherwise, they may estimate costs on differing bases, making it difficult to compare bids.

If the project will generate hazardous wastes, waste minimization should be investigated. Hazardous waste costs are dependent on the volume and sometimes the weight of the waste deposited in a landfill. Costs may be significantly reduced by minimization and segregation of wastes into different categories.

E. Extent of Concurrent Work

Lead hazard control measures will be effective only if components and substrates are structurally sound and in reasonably good condition. Structural deficiencies and any possible sources of water infiltration must also be addressed before lead hazard control activities are undertaken. Cost estimates should clearly reflect these additional requirements.

When the work begins, the contractor may need extensive access to the units, common areas, and worksite. Corridors, stairs, elevators, streets, walkways, and site spaces may have to be used for lead hazard control activities. The existing uses of these spaces may have to be suspended until the work is done. Fire escape routes and exits must never be blocked, however, unless alternative routes are approved by local fire authorities.

Mechanical and electrical fixtures may have to be removed before lead hazard control work can be accomplished. For example, if exterior siding is being replaced, light fixtures, electrical power outlets, cable TV conduits, and telephone and water services may impede the work. If interior walls are being abated, electrical fixtures and radiators may have to be removed.

VI. Considerations in Cost Estimating for Abatement

The price for a lead hazard control job will depend on the:

- Hazard control methods/strategies.
- Building components being treated.
- Extent of the work.
- Location of the job.
- Individual circumstances of the job.

A. Type of Dwelling Unit

Overall lead hazard control cost depends on the type(s) of units being worked on. Multifamily dwelling units are the least expensive because their size is usually limited and the work is highly repetitive. The cost is much lower than for treatment of a detached single-family house, unless common areas, like stairs and hallways, are included.

A common two-story rowhouse is relatively inexpensive to treat because there are no side windows (except in end units). The price will increase if the rowhouse is three stories, since the third floor adds a flight of stairs and two or more additional rooms. Some turn-of-the-century rowhouses near the urban centers of older cities are quite sizable, particularly in terms of ceiling height and property depth, and have elaborate moldings; this will potentially increase the cost of the treatment.

Semidetached dwellings, such as duplexes and triplexes, include a bank of windows going down one side of the home and are comparable to an end-unit rowhouse. Overall, this type of residence has more square footage than the standard rowhouse and treatment price will rise accordingly.

Generally, single, freestanding dwellings are the most expensive to treat. Windows are on all four sides and attics, basements, garages, and elevated porches (both front and back) are common. If the exterior is painted, the lead hazard control cost will be relatively high.

These general principles have important limitations. All homes are unique and abatement requirements are specific to the particular dwelling.

B. Number of Building Components To Be Treated

The number of components being treated will directly affect the cost. Older houses generally contain a greater number of components for two reasons. First, houses with lead-based paint that were built between 1960 and 1980 contain an average of only 466 square feet of lead-based paint, while those built before 1940 contain an average of nearly 2,000 square feet (HUD, 1990b) (see Table 3.2). Second, older homes also have more decorative components, such as crown moldings, chair rails, wainscoting, and carved fireplace mantels. In addition, older homes typically contain more coats of paint, rendering the paint on components more difficult to remove.

C. Types of Items

The types and ornateness of items to be treated will influence costs. For example, it is expensive to treat flights of stairs with spindles, newel posts, handrails, stringers, and skirt boards. Painted kitchen cabinets are also costly to treat. Homes with radiators are more expensive to treat than homes with hot-air registers that can be replaced inexpensively.

A significant portion of the total cost of treatment (perhaps as much as one-third) will be devoted to enclosed porches with window and screen frames; wood panels with framing under the windows; wide porch pillars; painted porch steps and floors; porch ceilings and support beams; the cornice, soffit, and facia; fat "vase"-styled spindles; wide upper and lower rails; and the exterior side of the front living room windows within the porch enclosure.

Generally, the more ornate the components and the more difficult they are to work with, the higher the cost of the job.

For historic properties lead hazard control is difficult because acceptable methods can be restricted. Generally, replacement of original components is not desirable, nor is their enclosure or encapsulation, since the detail and the integrity of the trim usually must be preserved. Some strippers may damage plaster and soft woods, and the use of heat guns in a historic dwelling can create fire hazards. Methods must be specifically tailored to the unique circumstances of the individual situation. Typically, restrictions are stringent and costs are correspondingly high for these properties (see Chapter18).

D. Wage Rates

As a general rule, labor accounts for two-thirds of the direct field cost in lead hazard control work. Therefore, labor-intensive treatments are generally more expensive.

E. Resident Status

If the lead hazard control job, including clearance, is to be performed so that the resident can return to the dwelling unit each night, or is restricted from certain work areas in progress, then the job will be substantially more complicated than one performed on a vacant dwelling. For example, a bathroom must be kept available for the residents.

Should the residents move but leave their belongings in the dwelling (to be moved from room to room or covered to prevent dust contamination), the job will also be substantially more expensive than work performed in a vacant dwelling, for three reasons. First, continuously moving furniture and personal effects is labor-intensive. Second, liability for breakage, which includes appliances and electronics, must be considered. Third, moving furniture back into a room may reduce the likelihood of readily achieving the very low leaded dust levels necessary for clearance when the entire house is completed. For all these reasons, it is preferable to undertake major control projects in vacant units whenever possible.

F. Security

Properties in the care, custody, and control of contractors may be the contractors' contractual responsibility. When vandalism or theft is a valid concern, the cost of the job can increase.

G. Utilities

The absence of utilities (heat, electricity, and water) necessary to perform certain lead hazard control activities should be factored into the cost of the hazard control. Dwellings that have been vacant for a long period of time can present special problems. In order for paint-removing chemicals to work, encapsulants to cure, and adhesives to dry, the property must have heat in cold weather. If home heating units are not functioning or are missing, then either expensive repairs need to be performed or potentially costly alternatives considered.

Electricity is required for the operation of power tools, HEPA vacuums, and heat guns. Restoring wiring or providing new electrical service to the property is expensive. Using portable generators is often insufficient and inefficient and presents a capital expense and maintenance cost.

Water is required for worker cleanup and for achieving compliance with clearance standards. It would be inconvenient and expensive to transport large quantities of water to and from the property. Water may have to be hauled away if waste systems are not functioning because it cannot be poured into the ground. Discharge must always be coordinated with local water treatment authorities.

H. Clearance

As a job is completed, clearance from a certified risk assessor or certified inspector is always appropriate. If no preliminary risk assessment was performed, the final clearance should only be performed by a certified risk assessor, since certified inspectors are not trained to identify hazards. Downtime caused by delayed clearance testing can be costly; proper scheduling is essential.

I. Site Access

To contain costs, contractors should ensure, prior to the start of the job, that workers have access to elevators in high-rise buildings. Similarly, in a housing development, the contractor's trucks should have close access to the dwelling units treated.

J. Job Design

Lead hazard control in large multifamily buildings must be carefully planned to permit efficient phasing of the work. Initially, the owner should plan to set aside available dwelling units for lead hazard control during vacancy turnover. It is likely that the first wave of work will be scattered throughout a housing development or various floors of a multifamily building. Thereafter, these abated vacant units should be filled with residents from a single floor or housing block. It is critical that family size and housing size be matched. The job should then progress in a linear path, from floor to floor and block to block. The residents thereby retain the same neighbors and are not relocated to new areas that affect transportation, merchant relationships, day-care facilities, and school access.

The job can then be executed in a more controlled and economical way that saves money and consolidates workers in a given area. Working floor by floor in multifamily housing also mitigates residents' concerns and logistics over worker contamination of common areas.

K. Hazardous Waste

Costs associated with waste disposal can be substantial. See Section V of this chapter for further details.

L. Other Costs

The following factors can also affect the cost of performing a lead hazard control job:

- Additional worker training to meet OSHA requirements.
- Poorly defined terms and work items, and illogical work sequencing through the dwelling, resulting in missed items and abatement of incorrect items.
- Delays in resident departure.
- Dwelling insufficiently cleared of trash and belongings.
- Weak floors, stairs, or other structural components.
- Delayed fumigation (if required).
- Inexperience.

VII. Specifications

The property owner should consider whether a detailed set of specifications is needed. For most single-family homes, a detailed set of specifications may not be appropriate. However, for large multifamily housing projects, carefully prepared specifications can help prevent confusion in bidding and job completion. It is beyond the scope of these *Guidelines* to provide a model set of specifications that can be tailored to specific properties. However, an example of a project specification is provided in Appendix 7.3. (This should be modified substantially for each individual job.) A model specification may also be available in the future from the National Institute for Building Sciences.

VIII. Pilot Projects

The methods of abatement and interim control in these *Guidelines* have been found to be generally safe and effective, but to date some of them have not been tested repetitively in a wide variety of housing situations. Therefore, it is advisable to test the safety and effectiveness of the methods and controls selected "onsite." Pilot projects can be used to answer a variety of questions, such as whether hazardous waste will be involved, encapsulants will be effective, paint removers will actually work, and excessive levels of dust will be generated. Pilot projects are most appropriate when a large-scale multifamily project is being considered and whenever there is uncertainty about the safety and effectiveness of a particular lead hazard control process.

In pilot projects a representative portion of the total project is carried out and carefully evaluated. The pilot project work should be performed as closely as possible to the way the larger project will be performed, including carrying out specific lead hazard control work, scheduling activities, and integrating other work. This type of pilot study should be evaluated by a risk assessor along with environmental sampling to document that the work is being adequately controlled. Pilot projects should be performed in vacant units whenever possible.

IX. Coordination of Lead Abatement With Other Renovation Work

Lead hazard control work should be coordinated with other renovation work performed as part of the same project (see Chapter 4). For abatement work it is generally preferable, and sometimes necessary, to complete the abatement work *before* all other renovation work. This may permit most of the construction work to be done in a traditional way without worker protection. For example, it would be necessary to abate certain lead-based painted surfaces in a kitchen or bath before attaching new fixtures or cabinets. This approach simplifies coordination of the subsequent construction work, since renovations are not started until the abatement is complete.

However, for some projects it may be difficult to separate lead hazard control and renovation. In such cases the role of the abatement contractor may have to be expanded to include general carpentry and other construction activities. Alternatively, the work of certain trades may have to be done under abatement conditions. For example, to remove and replace a window and attached trim covered with lead-based paint, an abatement worker with carpentry skills is valuable. Similarly, in a situation where there is lead-based paint on interior walls and ceilings, it may be more efficient for an electrician to work under abatement controls rather than have an abatement contractor remove paint from walls and ceilings.

X. Insurance

There are three types of insurance that owners, consultants, and contractors should consider acquiring:

- General liability insurance (all parties).
- Pollution liability insurance (all parties).
- Errors and omissions (E&O) insurance (for consultants).

General liability insurance and E&O insurance are widely available in the commercial insurance market; however, pollution liability insurance is not. Standard policy forms almost always contain a strict pollution exclusion clause and therefore do not cover lead-based paint abatement activities.

Each of the parties involved in the project should discuss adding pollution liability coverage with their general liability or E&O carrier. Some insurance companies do offer specialty policies that insure lead abatement activities under limited terms and conditions.

Unfortunately, insurance and bonding for lead abatement activities are not widely available in the general insurance market at this time. Further, the few insurance policies that are being offered vary greatly in terms of cost and quality of coverage provided.

For these reasons, if the building owner, contractor, risk assessor, inspector technician, or planner decides to acquire insurance, sample copies of all insurance policies should be obtained beforehand to determine if the coverage will apply to the unique exposures in lead hazard control work. On large projects a professional insurance broker knowledgeable about such coverage should be consulted to review the policy forms and evaluate the financial strength and viability of the insurers providing the coverage. The insurance should be occurrence-based, not claims-based.

The certified contractor and the risk assessor, inspector technician, or planner who elects to purchase insurance should maintain applicable policies in force for the entire term of the project, from bid acceptance to final completion of the work. They should also ensure compliance with clearance criteria and the removal of all equipment, supplies, and employees. Policies should not be canceled for any reason without written notice of at least 30 days to the building owner. Ideally all parties should submit Certificates of Insurance to the building owner at least 10 days before beginning operations or at any preconstruction meeting, whichever is sooner.

A. Commercial General Liability (CGL)

CGL insurance is readily available at reasonable cost. The policy should be written on an “occurrence” basis, and include premises and operations liability, contractual liability, independent contractors liability, and products and completed operations liability. If available at a reasonable cost, the policy should be specifically endorsed and/or written to include coverage for lead abatement operations and eliminate or modify the “pollution exclusion” clause so that it will not exclude lead hazards, exposures, poisonings, or claims. Limits of liability of $1,000,000 per occurrence with a $2,000,000 policy aggregate, for bodily injury and property damage, are recommended. The building owner should also be named as an “additional insured” on all such policies.

Occurrence policies require that there be bodily injury or property damage caused by an accident during the policy period, including continuous or repeated exposure to harmful conditions. There is no restriction on when a resulting claim or suit must be made or brought against the insured, as there is in a “claims-made” policy.

B. Professional Liability Errors and Omissions (E&O)

In addition to CGL insurance, the risk assessor, inspector technician, and/or planner should consider carrying E&O insurance coverage if it is available at reasonable cost. The policy will typically be written on a "claims-made" basis and cover professional services rendered in connection with risk assessments, inspections, environmental sampling, project supervision and monitoring, and specification writing. Again the policy should eliminate or modify the "pollution exclusion" clause so that it will not preclude coverage for acts, errors, or omissions that result in lead hazards, exposures, poisonings, or claims. Limits of liability of $1,000,000 per claim with a $2,000,000 policy aggregate are appropriate.

"Claims-made" policies require that either bodily injury or property damage be caused by an "occurrence" that occurs during the policy period *and* results in a claim or suit first made against the insured and reported to the insurer during the policy period. Virtually all E&O policies available today are written on a "claims-made" basis; "occurrence" coverage is not an option at this time.

C. Bonding

In addition to insurance, performance bonding may be required for some large projects.

XI. Project Completion

No interim control or abatement project is complete until compliance with clearance standards has been achieved and a final report prepared.

A. Clearance

The work area cannot be released to residents until a visual evaluation and dust sampling have been completed. If these tests show that all work was performed satisfactorily and leaded dust is not present above clearance standards, then the area can be considered to be safe for residents. If work was not completed or if there is an excessive amount of leaded dust remaining, additional work and cleanup are required until final clearance is achieved (see Chapter 15 for more detailed information on the clearance process).

B. Final Report

A final report should be prepared by the professional who is conducting the clearance examination, to document the work and any ongoing monitoring and professional reevaluation that may be required in the future by the owner. If applicable, the date for the next reevaluation by a certified professional should appear in the report. EPA regulations may require final reports in some situations. The report will become an important document that should be transferred from one owner to the next as part of the disclosure requirements in Title X. Some jurisdictions may also require that certificates be provided to owners as proof of completion of lead hazard control work; these will also become part of the disclosure record. Owners and clearance examiners are responsible for maintaining such records.

Chapter 4: Lead-Based Paint and Housing Renovation

Chapter 4: Lead-Based Paint and Housing Renovation

I. Introduction

This chapter provides general information on the hazards of lead-based paint in various kinds of housing renovation work, including demolition, remodeling, repainting, rehabilitation, weatherization, and other forms of home improvement. If these activities are performed in older dwellings where lead-based paint is sanded, scraped, or otherwise disturbed, workers and residents may become lead poisoned if protective measures and special cleanup procedures are not used. Occupational Safety and Health Administration (OSHA) regulations require certain procedures for any paint that contains lead, even if it is below the HUD standard of 1 mg/cm^2 or 5,000 µg/g(0.5%). Clearance testing should be performed whenever a job creates leaded dust.

The Environmental Protection Agency (EPA) is currently studying the extent of lead hazards produced during this kind of work and will issue detailed guidelines on how to do renovation work involving lead-based paint safely. Starting in October 1995, Title X requires all renovation contractors to provide an EPA pamphlet to owners before beginning work in older dwellings. The pamphlet will describe the hazards of lead poisoning that could be caused by renovation work. Title X also sets certain lead-based paint hazard control requirements for housing rehabilitation assisted by the Federal Government. Future HUD regulations will provide details.

Additionally, some aspects of housing renovation work are regulated by OSHA, which recently issued a new rule covering lead in the construction industry. If the work includes manual demolition, scraping, sanding, and the use of heat guns, needle guns, and power sanders on surfaces that are coated with lead-based paint, there are worker protection requirements involving air monitoring, respirators, medical surveillance, training, and other protective measures. Further information on the OSHA standard can be found in Chapter 9.

A. Evidence of Lead Poisoning Caused by Renovation

There is substantial evidence that uncontrolled housing renovation work can cause lead poisoning. One study found that refinishing activity performed in dwellings with lead-based paint was associated with an average 69-percent increase in the blood lead level of the 249 infants living there (Rabinowitz, 1985a). Another study of 370 recently lead-poisoned children found a statistically significant association between household renovation activity and elevated blood lead level (EBL) ($p<0.0001$)[1] (Shannon, 1992). Other researchers have also reported cases where renovation activity has resulted in EBLs (Fischbein, 1981; Marino, 1990). The Marino case report (named after the physician who treated the family) is summarized in Figure 4.1.

II. Lead-Based Paint Hazards in Housing Renovation

A. Similarities Between Lead Hazard Control Work and Housing Renovation

Table 4.1 shows the similarity between lead hazard control work and renovation activity. Depending on the intent of the repair work, some of the same activities could be considered to be either lead hazard control work or renovation work. Because of these similarities, HUD recommends that all renovation workers and contractors become knowledgeable about how to conduct their work safely by reviewing the controlled work practices described throughout these *Guidelines*.

[1] A p value of less than 0.0001 means that there was less than 1 chance in 10,000 that the association observed was due to chance.

Figure 4.1 A Case Report: Renovation and Lead Poisoning.

The Marino case report (Marino, 1990) is an example of how uncontrolled renovation work can cause lead poisoning in both adults and children. The dwelling involved was a 2-story, 19th century Victorian farmhouse with 10 rooms. Most of the wooden floors, moldings, walls, ceilings, and door frames had been painted with lead-based paint.

The renovation work included restoration of surfaces by removing the paint down to the bare surface on floors and woodwork and recoating with new varnish. Ceilings were repaired, and wallpaper and paint were removed from a number of walls. Two workers used rotary power sanders, hand sanders, scrapers, torches, heat guns, and chemical paint strippers. The family left the house during most of the renovation work, but returned after it was only partially completed. There was dust throughout the dwelling.

After one of the family's dogs started to have seizures, a veterinarian determined that the dog was lead poisoned. The mother and two children were subsequently tested. The children had blood lead levels of 104 µg/dL and 67 µg/dL, which is 5 to 10 times above the level of concern established by the Centers for Disease Control and Prevention (CDC) (10 µg/dL). The mother had a blood lead level of 56 µg/dL. All three were admitted to a local hospital where they were treated for severe lead poisoning. The mother was 8 weeks pregnant and opted for a therapeutic abortion. A babysitter who had two children of her own sometimes cared for all four children in the home. The babysitter's two children were also tested and found to have blood lead levels of 80 µg/dL and 68 µg/dL. These two children were also hospitalized and treated for severe lead poisoning.

During the 1980s, at least $100 billion was spent on residential repairs and improvements. When working on houses that were constructed prior to 1978 (and especially before 1960), it is very likely that normal renovation and remodeling practices will expose surfaces that are covered with lead-based paint. Table 3.2 in Chapter 3 shows that the older the dwelling, the more lead-based paint is likely to be present.

B. Leaded Dust

It does not take much leaded dust to create a hazard. The use of palm sanders, belt sanders, and sandpaper can increase the amount of hazardous leaded dust by a great deal. Almost any activity that involves disturbing a lead-containing surface will temporarily increase the amount of microscopic leaded dust in the surrounding environment.

To understand how easily leaded dust hazards can be created from jobs disturbing lead-based paint, consider the following example. Suppose renovation work is done on only 1 square foot of painted surface and all the paint inside that square foot is turned into dust by sanding or some other work. If the paint has 1 mg/cm^2 of lead in it (the lowest level covered by HUD regulation) and if the dust is spread out over a 100-square-foot area, there will be about 9,300 µg/ft^2 of leaded dust present, which is nearly 100 times greater than the allowable level. HUD does not permit more than 100 µg/ft^2 of leaded dust to be left on floors following lead hazard control work. In short, dust-generating work performed on even a small area can cause a serious problem if not controlled and cleaned up. Of course working on a small area requires only modest cleaning and control measures, as described in Chapters 8 and 11.

C. Fumes

Whenever lead-based paint is heated above 1,100 °F, some of it may vaporize and later settle on the surrounding walls and floors. These small particles (fumes) are extremely dangerous because they can be inhaled by the lungs and rapidly absorbed into the body. These fumes are present whenever high-temperature heat guns or open flames heat the paint film excessively. Lead fumes can also be a problem when debris coated with lead-based paint is burned or metal coated with lead-based paint is welded.

Table 4.1 Similarities Between Lead Hazard Control and Renovation

Renovation Technique	Lead Hazard Control Technique
Repainting	Paint film stabilization
Window and door repair	Friction and impact surface treatments
Landscaping	Soil treatment
Installation of new building components (e.g., cabinet replacement)	Building component replacement
Paint stripping	Onsite paint removal
New wall installation	Enclosure

D. Paint Chips

Metal brushing, dry scraping, or water blasting any lead-containing surface creates many poisonous chips that will contaminate the ground, where they are accessible to children.

E. Exposed Surfaces

Surfaces that have had all lead-based paint removed may still have leaded particles trapped in the pores of the wood. While these surfaces are drying out and being prepared for recoating, they can cause lead poisoning if touched, mouthed, or chewed by small children. Recoating should always be completed before children are allowed back into the area.

F. Soil

For many years automobile gasoline contained lead that was deposited onto soil. Also, paint chips from previous paint-scraping jobs, and normal weathering of paint, may contaminate the top few inches of soil around older dwellings. Excavation, landscaping, concrete flatwork, and regrading that disturbs lead-contaminated soil into the dwelling may also cause lead poisoning by increasing the accessibility of the soil to children and by making the soil more easily tracked into the dwelling.

III. Combining Renovation and Abatement

While renovation work can pose certain dangers, it also provides the most cost-effective opportunity to permanently address lead-based paint hazards. Combining lead-based paint abatement with renovation work will result in substantial savings when compared to the cost of conducting each activity independently. HUD's public housing program has been combining lead-based paint abatement with housing renovation for several years with considerable success and cost savings. As a result a significant number of public housing units have been fully abated and a number of renovation contractors now possess the special skills required to perform lead-based paint abatement.

The best way of combining abatement and renovation is to determine which parts of the job will disturb lead-based paint or produce contaminated dust. The work that can create leaded dust hazards is best performed by a contractor certified in lead-based paint abatement (who may or may not also be the renovation contractor). The remainder of the job can be performed in the traditional fashion. In many cases this means that the abatement phase of the work will be completed first during the initial demolition work. In other cases a more complicated phasing process is necessary where abatement activities alternate with traditional construction work.

Window replacement is an example of renovation work that can also achieve abatement at the same time. A common finding of risk assessments is that old windows have deteriorated lead-based paint and very high levels of leaded dust on the window trough. A certified abatement contractor is best suited to prepare the work area for dust containment, remove the old window, dispose of it properly, and conduct cleaning. The new window can be installed in the traditional fashion without worker protection, as long as no other surfaces with lead-based paint will need to be disturbed during installation.

All cuts or penetrations into surfaces with lead-based paint that are needed to complete the job should be identified ahead of time so that they will be performed by the appropriate contractor (if multiple contractors are used) and so that cleanup, worker protection, and containment are employed at the appropriate times. For example, if new plumbing will require cutting into an existing wall containing lead-based paint, the abatement contractor should do the cutting and cleaning. Alternatively, the plumber can become certified as an abatement contractor and specialize in plumbing work on leaded surfaces. Of course, work that disturbs only a small amount of lead-based paint does not necessarily require a specialized, certified contractor. Nevertheless, the precautions recommended in these *Guidelines* should always be observed.

Separate contractors are not necessarily required when combining renovation and abatement work. All work can be completed by a single contractor, but only if the renovation contractor is also certified to conduct lead-based paint abatement. In many respects the ideal abatement/renovation project is performed by a contractor with good construction skills *and* abatement skills. Chapter 3 contains additional information on how to plan lead-based paint abatement projects.

IV. Safe Older Home Renovation Procedures

The information in these *Guidelines* can be used to ensure that renovation work does not cause lead poisoning in either children or adults or create lead hazards. There are certain basic precautions that should become part of the standard operating procedure of any renovation or remodeling project.

If lead-based paint or contaminated dust or soil is present, there are five basic precautions that should be taken:

- Resident protection (see Chapter 8).
- Adherence to OSHA regulations (see Chapter 9).
- Proper management of waste (see Chapter 10).
- Final cleaning techniques (see Chapter14).
- Final clearance (see Chapter 15).

A. Testing

Testing can be done for paint, dust, and soil to determine if it is contaminated with lead. The tests can define the building components that can be handled in a traditional way and the building components that must be treated with extra care. The best field testing method for lead in paint usually involves a portable x-ray fluorescence (XRF) lead paint analyzer backed up by laboratory analysis of paint chips, especially if many surfaces need to be tested. When properly used (see Chapter 7) this method has an adequate detection limit and an acceptable rate of false positives and negatives, and is relatively easy to use at a modest cost per test.

Dust testing shows how much leaded surface dust is on various horizontal building components. Usually the floors and the interior window sill and exterior window troughs will be tested as part of a risk assessment (see Chapter 5) and as part of clearance to determine if cleaning was adequate (see Chapters 14 and 15).

There is insufficient evidence to fully endorse the use of chemical spot-test kits at this time. Research efforts on these kits indicate that they may hold promise for the future. The National Lead Information Center should be contacted to determine the current status of the kits. If for some reason, XRF or laboratory paint-chip testing cannot be performed, the chemical spot-test kits should be used. Because there is some evidence that these kits erroneously report the presence of lead, they are not recommended by HUD at this time.

B. Occupant Protection

1. Education

Before starting any renovation job that is likely to disturb suspected lead-containing surfaces, the owner and/or resident should be informed of the dangers of lead-based paint—its dust, chips, and the increased exposure that most construction work will generate. A brochure about this topic may be obtained by calling the National Lead Information Center (1–800–LEAD–FYI). Residents who are not educated about the dangers of lead poisoning may compromise the containment measures and revisit the home unexpectedly or allow their children to play in the worksite. Owners and residents who are educated about the potential dangers will become aware of the special protection and cleaning procedures that all renovation contractors and subcontractors should now include in their general requirements when dealing with lead-based paint.

2. Containment

Rooms or areas where surfaces suspected of containing lead are being penetrated, removed, or prepared should be isolated from the other sections of the dwelling that will not be cleaned or renovated. This is usually done with sheets of 6-mil plastic, masking tape, and preformed or field-built containments. Only adequately protected individuals should be allowed to enter the contained area before it has been cleaned.

Exterior containment involves covering the soil or pavement around the building to a distance of 10 to 20 feet (possibly less in some situations). The soil must be covered in order to capture dust and chips and to prevent the soil around the home from becoming more contaminated with lead. See Chapter8 for a description of various worksite preparation practices.

3. Relocation

One of the safest ways to prevent lead poisoning is relocation of the residents and their "portable" belongings. With all of the small possessions out of the dwelling, there is relatively little to clean prior to reoccupancy. Occupants should not return to the work area until cleanup and final painting or finishing have been completed.

C. Cleaning Techniques

It is absolutely essential to clean the work area and any adjacent contaminated areas so that leaded dust levels are acceptable. All renovation contractors doing work on surfaces with lead-based paint must do more than simply clean up any visible dust. There are also small dust particles that cannot be seen by the naked eye. Cleaning should be done by using vacuums equipped with high-efficiency particulate air (HEPA) filters. HEPA filters trap very small particles from the vacuum exhaust so they do not recontaminate the work area or cause excessive exposures to workers. OSHA requires vacuums to have HEPA filters when working with lead. Ordinary vacuums release a cloud of small dust particles that cannot be seen with the naked eye.

To be most effective, HEPA vacuums should be used in combination with lead-specific detergents, high-phosphate detergents, or other suitable wet cleaning agents. The cleaning process starts with a HEPA vacuuming, followed by a wet wash, and a final HEPA vacuuming (see Chapter 14 for more details). If clearance can be established using only wet cleaning, the HEPA vacuuming step may not be needed. Carpeting and other dust traps may also have to be cleaned, discarded, or replaced before the family can reoccupy the dwelling. Renovation contractors working for owners who do not allow or wish to pay for this extensive cleaning should make it clear (in writing) that the contractor cannot be held responsible for lead contamination or lead poisoning.

D. Clearance Testing

Clearance testing should be completed after any renovation job that disturbs lead-based paint or creates leaded dust to ensure that the dwelling is safe for occupancy (see Chapter15).

E. Waste Disposal

For some types of renovation work involving lead-based paint, the waste will have to be sorted into various categories (see Chapter 10).

Some of this waste may need to be tested to determine whether it is hazardous. Even if the waste is "nonhazardous," lead-containing construction debris is still potentially dangerous and should not be placed directly on the ground. Debris piles should be placed on two layers of 6-mil plastic. The debris should be covered and clearly identified as containing lead. If the waste must be left onsite overnight, it must be stored in a secure area inaccessible to children or scavengers. Chapter 10 contains more specific information on waste disposal requirements.

For rolloff containers being used during extensive demolition jobs, debris should be handled in ways that minimize dust generation. Drop chutes cause too much dust and should not be used for lead-based paint construction debris unless proper precautions are taken to control dust. Loose plaster and dust should be thoroughly wetted down and/or covered prior to open transportation to the container.

V. Prohibited Activities

Many traditional methods of preparing a painted surface for repainting, refinishing, or restaining are prohibited if the old paint contains lead, since these methods are known to poison both children and workers. Chapters 11 and 12 discuss safe ways of removing lead-based paint. Prohibited methods of paint removal include:

- Open-flame burning or torching.
- Machine sanding or grinding without a HEPA vacuum exhaust tool.
- Uncontained hydroblasting or high-pressure washing.
- Abrasive blasting or sandblasting without a HEPA vacuum exhaust tool.
- Heat guns operating above 1,100 °F.

Dry scraping (except for limited areas) and methylene chloride paint strippers are also not recommended.

A. Flame Treatment

The use of open torches, infrared scorchers, electric irons, or high-temperature heat guns are all prohibited when the surface has a lead content equal to or greater than 1 mg/cm^2 or 5,000 μg/g (0.5 percent). Traditionally, these methods are used to remove a number of layers of paint prior to repainting; however, they release very large amounts of lead fume, which can poison workers and be very difficult to clean up. They should be avoided even if the lead concentration is below the HUD standards.

B. Dry Sanding

Ordinary circular, reciprocating, belt, and palm sanding of lead-containing surfaces generates a great deal of dust. These methods should be done on a wet surface or by using a HEPA vacuum exhaust tool (see Chapter 12).

C. Dry Scraping

Dry scraping was the traditional method of surface preparation. Dry scraping has been replaced by wet scraping for work on lead-based paint surfaces. Wet scraping should not be done near electrical circuits, even if they have been de-energized.

D. Abrasive Blasting

All forms of blasting are prohibited on lead-containing surfaces unless a HEPA-filtered local exhaust tool is used (see Chapter 12).

E. Power Washing

High-pressure washing is often used prior to starting an exterior paint job. However, uncontainable power washing or water blasting on lead-based painted surfaces is a prohibited practice. The alternative practice involves exterior containment, collection of all water, filtration of the water, and proper disposal of the filter and debris.

F. Welding on Painted Surfaces

Welding on surfaces coated with lead-based paint is prohibited by OSHA regulations. The high temperatures will produce leaded fumes and high exposures.

VI. General Guidance for Selected Renovation Activities

Certain activities are very likely to generate hazardous leaded dust and chips during renovation activities. Table 4.2 provides a summary of measures for protecting residents, providing containment, selecting safer alternate methods, and conducting cleanup for a few types of renovation.

Table 4.2 Selected Renovation Jobs and Work Practices

	Containment (see Chapter 8)	**Relocation** (see Chapter 8)	**Recommended Practices** (see Chapters 11 and 12)	**Cleanup** (see Chapter 14)
Demolition	Use plastic sheeting to prevent airborne dust migration. Interior Worksite Prep. Level 4; Exterior Worksite Prep. Level 3	No residents in dwelling during any work.	Wet surfaces, use covered containers to move debris; best subcontracted to abatement contractor, or a demolition contractor certified for abatement.	HEPA vacuum, wet mop, and HEPA vacuum.
Repainting	Floors and ground covered with 6-mil plastic. Interior Worksite Prep. Level 4; Exterior Worksite Prep. Level 3	No entry into work area during interior work.	Wet scrape, wet sanding, HEPA-filtered vacuum power tools.	Daily cleanup with HEPA vacuum, wet wash, HEPA vacuum.
Floor Sanding	Full containment of rooms, negative air recommended if leaded dust hazard identified.	No entry into work area during work.	Sanding lead-containing floors should be completed by abatement contractor, or other contractor certified for abatement.	HEPA vacuum of entire house may be needed.
Plaster Repairs	Localized containment for walls, entire room for ceiling. Usually Interior Worksite Prep. Level 1 or 2 for small jobs	No entry into work area.	Wet prior to removing.	HEPA final cleanup.
Window Replacement	Localized containment around each opening. See Table 8.3.	No occupancy during removal and initial cleaning and sealing.	Seal interior with plastic. Remove window from exterior if possible.	HEPA vacuum all areas with replaced windows.
Carpet Removal	Do dust sampling to determine contamination level. Usually Interior Worksite Prep. Level 3 or 4.	No occupancy during removal and initial cleaning.	Carefully remove and package carpet and pad in 6-mil plastic with taped seams. Wet down carpet before removal or disturbance.	HEPA vacuum floor after carpet bagged and prior to removal.

Chapter 5: Risk Assessment

Lead-Based Paint Risk Assessment: How To Do It

1. The owner or occupant contacts a risk assessor.

2. The risk assessor determines if the owner is requesting a risk assessment, an inspection, or a combination of the two. The owner and the assessor reach an agreement on costs and scope of effort. If a child with an elevated blood lead level is being investigated, use the protocol in Chapter 16 and/or coordinate with the local health agency. If the dwelling unit was built after 1978 (or if *all* lead-based paint has been removed and clearance has been established), a risk assessment is not needed. If the dwelling is in good condition (as defined by Form 5.1 in this chapter), a lead hazard screen risk assessment may be conducted to determine if a full risk assessment is needed. If a previous risk assessment has been conducted, determine if the owner is requesting a reevaluation. In all other cases, conduct a full risk assessment, a paint inspection, or a combination of the two.

3. The owner submits information on the type and condition of the buildings to the assessor on standard forms (or the risk assessor completes forms by phone interview).

4. Conduct environmental sampling and visual assessments in *each* dwelling if assessing owner-occupied, single-family houses; fewer than five rental units; or multiple rental units where the units are not similar. If there are five or more similar dwellings, select a few targeted dwellings using the criteria in this chapter (see Table 5.6).

5. Perform a visual assessment of the building and paint condition, using the standard forms and protocols in this chapter, and select sampling locations based on use patterns and visual observations.

6. Conduct dust sampling. Dust samples are typically collected in the entryway, common spaces, the kitchen, the living room, and a child's bedroom and playroom. Collect samples from floors, interior window sills (stools), window troughs, (window wells) and other surfaces suspected of contamination. One floor sample and one window trough or sill sample should be collected in each main room or area.

7. Conduct soil sampling. Soil samples are collected from bare spots in the play area, near the building foundation (drip line), in gardens, and perhaps the yard. If the total surface areas of bare spots is less than 1 square yard (9 sq. ft.)for each property, a lead-based paint hazard does not exist and soil samples are not necessary. Bare soil in a play area should always be sampled.

8. Conduct deteriorated paint sampling by collecting all layers of paint (not just the peeling layers) and submit the samples to a laboratory recognized by the U.S. Environmental Protection Agency (EPA) National Lead Laboratory Accreditation Program (NLLAP). Alternatively, deteriorated paint can be measured by portable x-ray fluorescence (XRF) if the deteriorated paint has a large enough uniform surface with all layers present. Destructive paint-chip sampling must always be done *after* dust sampling to prevent cross-contamination.

9. At the owner's request, collect water samples to evaluate lead exposures that can be corrected by the owner (leaded service lines, fixtures). Water sampling is not recommended for routine risk assessments of lead-based paint hazards, since EPA has another program in this area. If a lead-contaminated water problem exists beyond the owner's service line, the local water authority should be notified. Air samples are not recommended for routine lead-based paint risk assessments.

10. Interpret the laboratory results.
11. Integrate the laboratory results with the visual assessment results and other maintenance and management data to determine the presence or absence of lead-based paint hazards, as defined under applicable statutes or regulations.
12. Discuss the various safe and effective lead hazard control options for specific lead hazards with the owner and determine the most feasible and effective options for the specific situation.
13. Prepare a report listing any hazards identified and acceptable control measures, including interim control and abatement options. Provide rough cost estimates of specific alternatives by building component, including the costs of reevaluation (if applicable). Inform the owner how to obtain educational materials from EPA, the Occupational Safety and Health Administration (OSHA), and the local childhood lead-poisoning prevention program and provide copies of these materials if possible. The report should also indicate which control method the owner has chosen to implement (if known).
14. After lead hazard control work has been completed, and clearance established, provide any statements of compliance or other documentation required by Federal, State, or local regulation.

Chapter 5: Risk Assessment

I. Introduction

Two broad types of evaluations can be performed to identify hazardous levels of lead in and around residential dwellings: risk assessments and paint inspections. While most of this chapter is devoted to risk assessment protocols, this section offers owners, planners, and risk assessors guidance on choosing the most appropriate evaluation method for specific housing situations. (See Chapter 3 for further information on this issue.)

A. Evaluation Options

Except where regulations specifically require a risk assessment or a paint inspection, there are no simple rules for choosing an evaluation method. Figure 5.1 provides a decision tree to help determine whether a risk assessment or a paint inspection is most appropriate. This section offers a quick overview of the options, so that owners will be able to make more informed decisions about the best method for them.

Risk assessments and paint inspections are two strategies for identifying lead-based paint hazards in housing *before* they actually cause lead poisoning in a child. Preventing lead hazards in housing is cost effective for all property owners, especially in light of the substantial medical, legal, and relocation expenses associated with the care of a child with an elevated blood lead level.

A property owner has a choice of the following evaluation options:

- Lead hazard screen risk assessment (for properties in good condition).
- Risk assessment.
- Paint inspection.
- Combination risk assessment/paint inspection.
- No hazard evaluation (proceed directly to hazard control).
- Investigation of a house having a child with an elevated blood lead level.

1. Bypassing Risk Assessments

These *Guidelines* generally discourage owners from skipping the preliminary evaluation process. Table 5.1 shows that for most building components, there is a significant chance that lead-based paint will not be present, especially in housing built after 1960, when lead-based paint began to be used less frequently. However, in cases where the owner thinks that deteriorated lead-based paint is present (e.g., on exterior walls constructed before 1940), the owner can correct the suspected hazard using the hazard control methods described elsewhere in these *Guidelines* without conducting an initial risk assessment (such corrections should be conducted by trained personnel only). It is important to note that bypassing the evaluation process can result in both the expensive correction of nonexistent hazards, and, even worse, the failure to correct undetected problems. If owners bypass the initial risk assessment, all painted surfaces must be assumed to contain lead-based paint, and all worker and resident protection measures and reevaluation schedules must be followed accordingly. All dust and soil should also be assumed to be contaminated. The clearance process for such a dwelling should include a followup risk assessment to determine whether all lead hazards were addressed. The followup risk assessment should be done by a certified risk assessor. On the other hand, the clearance process for a dwelling that has had a preliminary risk assessment need not include a followup risk assessment after hazard correction. In this case, a clearance examination can be conducted by a certified inspector technician. Additional details on the clearance process are provided in Chapter 15.

2. Risk Assessments

Risk assessments determine the presence or absence of lead-based paint hazards and suggest appropriate hazard control measures. They can be performed only by certified risk assessors who should use the standard forms provided at the end of this chapter or equivalent forms. To provide the necessary guidance, a risk assessment must cover the following:

- Identification of the existence, nature, severity, source, and location of lead-based paint hazards (or documentation that no such hazards have been identified).
- Presentation of the various options for controlling lead hazards in the event that hazards are found, including interim controls, abatement measures, and any recommended changes to the management and maintenance systems.

In some cases, the risk assessor will provide recommendations beyond the basic lead hazard control options. For example, if lead-based paint will remain in a dwelling after present hazards are corrected, the risk assessor will provide information to the owner on how to keep that paint in a nonhazardous condition.

Table 5.1 Percentage of All Paint That Is Lead-Based, by Year and Component Type

Component Category	Interior	Exterior
Walls/Ceiling/Floor		
1960–1979	5	28
1940–1959	15	45
Before 1940	11	80
Metal Components[1]		
1960–1979	2	4
1940–1959	6	8
Before 1940	3	13
Nonmetal Components[2]		
1960–1979	4	15
1940–1959	9	39
Before 1940	47	78
Shelves/Others[3]		
1960–1979	0	—
1940–1959	7	—
Before 1940	68	—
Porches/Others[4]		
1960–1979	—	2
1940–1959	—	19
Before 1940	—	13

[1] Includes metal trim, window sills, molding, air/heat vents, radiators, soffit and fascia, columns, and railings.

[2] Includes nonmetal trim, window sills, molding, doors, air/heat vents, soffit and fascia, columns, and railings.

[3] Includes shelves, cabinets, fireplace, and closets of both metal and nonmetal.

[4] Includes porches, balconies, and stairs of both metal and nonmetal.

Source: HUD 1990b. These data are from a limited national survey and may not reflect the presence of lead in paint in a given dwelling or jurisdiction.

Risk assessments do not simply identify lead-based paint, but lead-based paint *hazards*. Risk assessments go beyond simply assessing the condition of paint, and take into account both resident and owner use patterns and management and maintenance practices that will affect that paint. Risk assessments also identify other potential sources of lead hazards, such as dust and soil. By considering all hazards and examining resident and owner practices, a risk assessor determines appropriate ways to control hazards and to modify management practices so that the chance of hazards recurring is reduced.

3. Lead Hazard Screen Risk Assessments

In dwellings in relatively good condition where the probability of finding lead-based paint hazards is low, a full risk assessment may be unnecessary. To avoid the costs of a full risk assessment, a lead hazard screen risk assessment may be conducted. A screen risk assessment employs more limited sampling and more sensitive hazard identification criteria. The protocol for lead hazard screen risk assessments is described later in this chapter. If a screen indicates that lead hazards may be present, the owner should have a full risk assessment performed.

Because lead hazard screen risk assessments employ more stringent evaluation criteria to act as a "negative screen," they are only cost-effective for dwellings in good condition. Lead hazard screen risk assessments should not be used in buildings in poor condition, since a full risk assessment will usually be needed. This is especially true of structures built before 1960. A suggested decisionmaking process to determine whether the lead hazard screen risk assessment option is appropriate is outlined in Figure 5.1.

4. Paint Inspections

Lead-based paint inspections (covered in Chapter 7) can be performed by either a certified inspector technician or a certified risk assessor. Inspections measure the concentration of lead in paint on a surface-by-surface basis. Inspection results enable the owner to manage *all* lead-based paint, since the exact locations of the lead-based paint have been identified.

Figure 5.1 Lead Hazard Screen Decision Logic.

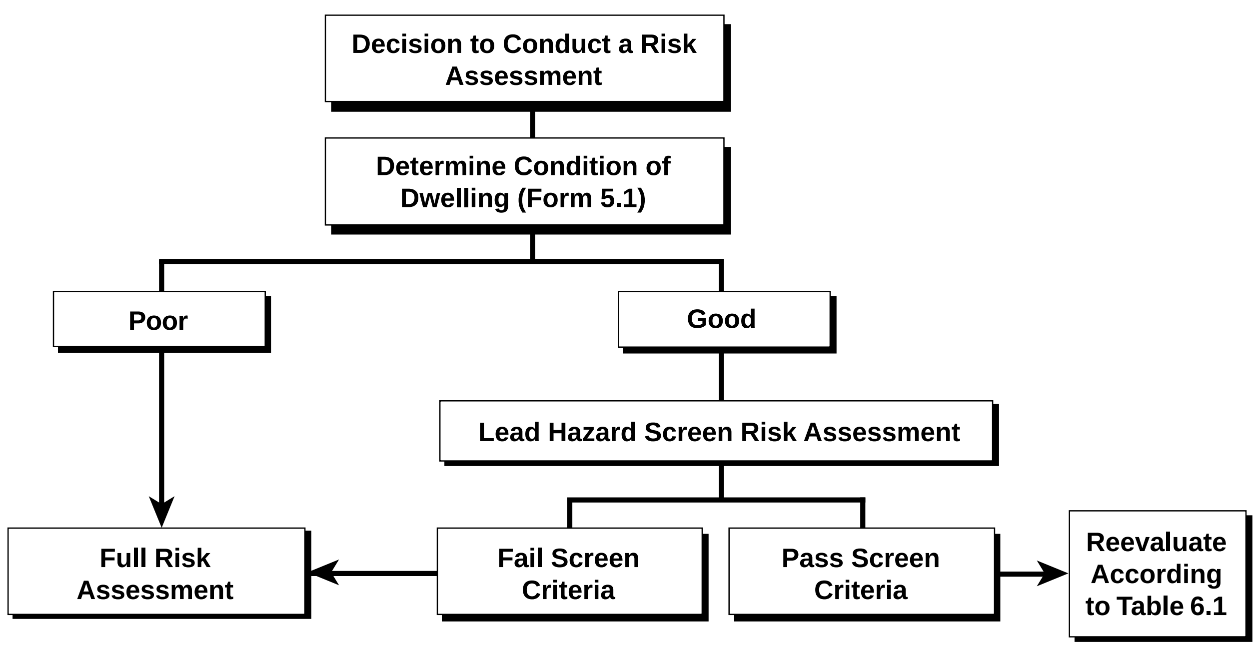


Table 5.2 Comparison of Risk Assessment and Paint Inspection

Analysis, Content, or Use	Risk Assessment	Paint Inspections
Paint	Deteriorated paint *only*	Surface-by-surface
Dust	Yes	Optional
Soil	Yes*	Optional
Water	Optional	Optional
Air	No	No
Maintenance status	Optional	No
Management plan	Optional	No
Status of any current child lead poisoning cases	If information is available	If information is available
Review of previous paint testing	Yes	Yes
Typical applications	1. Interim controls 2. Building nearing the end of expected life 3. Sale of property/turnover 4. Insurance (documentation of lead-safe status)	1. Abatement 2. Renovation work 3. Weatherization 4. Sale of property/turnover 5. Remodeling/Repainting
Final report	Lead hazard control plan or certification of lead-based paint compliance	Lead concentrations for each surface tested

* If local experience indicates that soil lead levels are all very low, repeated soil sampling is not necessary.

However, an inspection usually identifies only the presence of lead-based paint, and does not determine whether the paint presents an immediate hazard. The collection of dust and soil samples is also not part of a routine paint inspection. Thus, if a risk assessment is not performed along with the paint inspection, a full determination of the location and nature of all lead-based paint hazards (as defined in Title X) cannot be made.

Without data about hazards, an inspector technician cannot be expected to offer any guidance on lead hazard control, including appropriate lead hazard control measures. An inspector technician does not necessarily have the training to identify all hazard control options, while a risk assessor does.

Nevertheless, a paint inspection is the preferred evaluation method when an owner has decided to abate all lead-based paint or when the prevalence of lead-based paint is low. Because abatement activities can be costly, it is usually cost effective to complete a paint inspection before using resources to abate assumed hazards. Inspections are also appropriate when extensive renovation that is about to occur will disturb painted surfaces.

5. Combination Risk Assessments and Paint Inspections

It is sometimes advisable to conduct *both* a paint inspection and a risk assessment. By combining measurements of dust and soil with surface-by-surface paint analysis, and by collecting maintenance and management data, lead-based paint hazards can be identified and addressed in a comprehensive fashion, employing the best mix of interim control and abatement strategies. If a paint inspection has been completed before the start of a risk assessment, the risk assessor will often be able to reduce the time spent on the assessment, yet offer much more comprehensive advice. However, risk assessors should ensure that the paint inspection was conducted properly before relying on its results. The evaluation of previously conducted paint testing is discussed later in this chapter.

B. The Risk Assessment Process

Whether hired by the owner or employed by the public sector, the risk assessor is an independent, trained professional certified by the State (or EPA) as being capable of objectively analyzing lead-based paint hazards. Risk assessors may also be licensed by local jurisdictions. Property owners may choose to have a member of their management staff trained and certified to aid in the decisionmaking process, but such an assessor may not be perceived as being able to provide an unbiased evaluation of the property. Therefore, the owner may want to consider contracting with an independent, certified risk assessor to minimize the perception of bias (which would be especially important in the event of litigation). In those States without a certification program, owners should use trained risk assessors, preferably certified in another State. The risk assessor (or risk assessment firm) should not perform the actual lead hazard control work, since this would create a conflict of interest by providing an incentive to identify nonexistent lead hazards or to suggest controls that are not necessary or cost effective.

The risk assessment process begins with the collection of information about the property from the owner. In single-family, owner-occupied dwellings, this information includes resident use patterns, such as where the child's principal play area is located. In rental dwellings, the information provides details about management and maintenance practices and the occupancy status of buildings. The risk assessor will use this information to make decisions about the location of the limited environmental sampling within the dwelling. If the risk assessment involves the evaluation of five or more similar dwellings, the risk assessor will select a limited number for sampling using specific criteria. The risk assessment entails both a visual assessment of the targeted dwelling and collection of environmental samples. The environmental samples (including deteriorated paint, surface dust, and soil) are then sent to a laboratory for analysis.

When the lab results are received, the risk assessor reviews all data, including visual assessment results, environmental sampling results, and management and maintenance information. The assessor then drafts a report identifying lead-based paint hazards and acceptable lead hazard control options, including a spectrum of treatments ranging from interim controls to full abatement of all identified lead hazards. The report includes rough cost estimates for each option, both in the short term and the long term. The control options identified take into account the condition of the property, and the location and severity of lead-based paint hazards, based on criteria established in these *Guidelines* and Federal or other regulations. The property owner must decide which hazard control option is most appropriate for the dwellings, and develop a plan to implement that option. To the extent possible, risk assessors should provide a range of options for all cases. EPA has also published information about the risk assessment process in owner-occupied, single-family dwellings (EPA, 1994b).

The risk assessment protocols contained in this chapter are based in part on procedures used in public housing (HES, 1991; HUD, 1992) and private housing (Rhode Island, 1993; EPA, 1994b). These protocols represent the *minimum* recommended procedures for conducting risk assessments, and attempt to strike a balance between the need to have enough data to make informed decisions and the need to contain costs. More elaborate and extensive investigations may be conducted in certain situations (e.g., responding to parents' concerns about lead poisoning).

C. Limitations of This Risk Assessment Protocol

1. Risk Assessments of Dwellings Housing Children With Elevated Blood Lead Levels

The risk assessment protocol contained in this chapter is not appropriate for an investigation of a dwelling presently housing a child with an elevated blood lead level. In these cases, a more comprehensive investigation of all sources of lead is necessary (see Chapter 16), because it is possible that the exposure is unrelated to the residence (e.g., glazed pottery or leaded toys), or another dwelling is the source of the poisoning. For more information about investigations involving children with elevated blood lead levels, consult the local childhood lead poisoning prevention program, and the local heath department, and review the protocols and recommendations issued by the Centers for Disease Control and Prevention (CDC), which are currently being revised.

2. Public Housing Risk Assessments

The protocols described in this chapter are not meant to replace the public housing protocol, which is designed to meet the more complex management and maintenance needs of public housing authorities.

3. Assessment of Less Common Sources of Lead Exposure

In order to evaluate the largest number of dwellings in the shortest period of time, these *Guidelines* do not recommend assessing *all* potential sources of lead at each property. Instead, these *Guidelines* recommend assessing the *most likely* sources of lead hazards that are within the control of the property owner. Private risk assessors have an obligation only to investigate those lead exposures that are directly related to the residence, although other obvious sources should be identified. For example, if it is known that the use of folk remedies containing lead is widespread in a given neighborhood, risk assessors should not try to analyze these remedies, but should identify the potential source in their final report and notify the local health authority about their concerns. EPA has published information on additional sources of lead and how they should be addressed (EPA, 1994b).

Air sampling is not recommended for routine risk assessments of housing. The levels of airborne lead in a residence are expected to be low unless there is an identifiable lead air emission source nearby. If a source is identified, it should be noted in the final report, but the responsibility for action rests with public agencies.

Water sampling is also optional for routine risk assessments. If a property owner is concerned about plumbing within the building and specifically requests water testing, the risk assessor should have the water analyzed or refer the owner to the local water authority, which may conduct such tests at no charge. Information on municipal water quality can be obtained from the EPA Drinking Water Hotline (1–800–426–4791). In communities where water contamination appears to be especially prevalent, EPA requires public water suppliers to evaluate and correct the problem.

Computer exposure or risk assessment models (EPA, 1989; Cohen, 1993) that integrate various exposure sources and pathways are not recommended for routine residential risk assessments for three reasons: they were developed for large populations, sampling of all sources in millions of dwellings is not feasible, and there is little agreement within the scientific community on which model best characterizes risk at this time.

II. Onsite Data Collection Procedures

The onsite phase of the risk assessment involves a visual inspection of the dwellings or common areas being evaluated, and a collection of a limited number of paint, dust, and soil samples. Standard field sampling forms for onsite field testing are provided at the end of this chapter.

A. Visual Assessment

The visual assessment is conducted to locate potential lead-based paint hazards and evaluate the magnitude of the hazard. If a paint inspection has already been conducted, the assessor should focus on the painted surfaces that are known to contain lead-based paint and the dust reservoirs around them. The risk assessor should review all previously conducted inspections to determine if the findings are reliable (see p. 5–21 and Chapter 7). In dwellings where no inspection has been conducted, any painted surface that has not been replaced after 1977 must be assumed to contain lead-based paint. The assessment should also review the overall condition of the building.

The visual assessment should identify:

- Deteriorating painted surfaces.
- Areas of visible dust accumulation.
- Areas of bare soil.
- Painted surfaces that are impact points or subject to friction.
- Painted surfaces on which a child may have chewed.

Information from the visual assessment should be used to:

- Determine where environmental samples will be collected.
- Define in a preliminary way the extent of the lead hazard control efforts needed.
- Predict the efficacy of the various hazard control options given current maintenance practices.
- Determine housing conditions (such as water leaks) that, if not corrected, could lead to rapid paint deterioration.

1. Condition of Painted Surfaces

Every risk assessment should include an evaluation of the condition of painted surfaces. The risk assessor should observe the extent of any paint deterioration by rating the paint condition as "intact," "fair," or "poor." An attempt should be made to determine whether the deterioration is due to a moisture problem or some other existing building deficiency. The type of deterioration (i.e., blistering, flaking, etc.) may yield information about necessary hazard control treatments. For example, if the type of deterioration is commonly caused by moisture in the substrate, the moisture problem will need to be addressed before the paint can be stabilized. Poor surfaces are considered to be a hazard and should be corrected. Fair surfaces should be repaired, but are not yet considered to be a hazard; if not repaired, they should be monitored frequently. Intact surfaces should be monitored to ensure that they remain in a nonhazardous condition.

An example of the building components to be rated can be found in Forms 5.2 and 5.7 at the end of this chapter. If the paint on certain components is *known* not to contain lead above the regulatory limit, its condition need not be evaluated, although all deteriorated paint should be repaired since it may contain lower levels of lead.

While risk assessors should use their own professional judgment when evaluating the condition of painted surfaces, they should generally follow the guidelines and use the standardized definitions for intact, fair, and poor paint conditions provided in Table 5.3. The size of the area of deteriorated paint need not be measured but simply estimated.

The evaluation of paint conditions is critical to the lead hazard control decisionmaking process; therefore, risk assessors have found it helpful to have owners or maintenance personnel also rate the paint conditions in multifamily situations. Although most dwellings exhibit some minor degree of paint deterioration, it is common for building owners to rate the condition of their paint more highly than a trained, objective professional (HES, 1993). By discussing

Table 5.3 Categories of Paint Film Quality

	Total Area of Deteriorated Paint on Each Component		
Type of Building Component[1]	**Intact**	**Fair**[2]	**Poor**[3]
Exterior components with large surface areas.	Entire surface is intact.	Less than or equal to 10 square feet.	More than 10 square feet.
Interior components with large surface areas (walls, ceilings, floors, doors).	Entire surface is intact.	Less than or equal to 2 square feet.	More than 2 square feet.
Interior and exterior components with small surface areas (window sills, baseboards, soffits, trim).	Entire surface is intact.	Less than or equal to 10 percent of the total surface area of the component.	More than 10 percent of the total surface area of the component.

[1] Building component in this table refers to each *individual* component or side of building, *not* the combined surface area of all similar components in a room (e.g., a wall with 1 square foot of deteriorated paint is in "fair" condition, even if the other three walls in a room are intact).

[2] Surfaces in "fair" condition should be repaired and/or monitored, but are not considered to be "lead-based paint hazards" as defined in Title X.

[3] Surfaces in "poor" condition are considered to be "lead-based paint hazards" as defined in Title X and should be addressed through abatement or interim controls.

how to assess deteriorated paint, risk assessors have helped owners to be more vigilant when working on surfaces with potential lead-based paint hazards. While this exercise is not recommended for all assessments, it may be a valuable educational tool for some owners. Use Form 5.2 or 5.7 for recording the condition of paint.

Figures 5.2a through 5.2g illustrate seven different paint conditions that can be grouped into three general categories: surface deterioration, bulk deterioration, and layered deterioration (NDPA, 1990). While it is not necessary to record the type of paint deterioration, different types of paint deterioration will require different hazard control solutions. For example, if paint is "alligatoring" on a surface and the cause appears to be too many layers of paint, a risk assessor should recommend component replacement or paint removal before paint film stabilization. Applying additional layers of new paint to an alligatored paint film will be ineffective. Definitions and causes of paint deterioration are as follows:

Surface Deterioration.

Chalking—A formation of a fine powder on the surface of a paint film, usually caused by a failure to adequately prime or seal a porous surface, overthinning of paint, or exposure to sunlight, causing breakdown of the paint binder and release of pigment. Almost all exterior oil paints are designed to eventually chalk in order to wash dirt away in the rain and provide a good surface for repainting. The chalk may contain high levels of lead.

Mildew—A formation of microbial growth usually caused by excessive moisture. If unchecked, mildew formation can lead to extensive paint film failure. Mildew should be removed as a preventive measure to decrease the chance of paint film deterioration.

Worn Paint Due to Friction or Impact—Paint that is worn or chipped due to friction or mechanical damage is also considered deteriorated. Worn paint is often due to improperly hung doors, sticky window sashes, etc. The building component should be repaired so that it operates smoothly before it is recoated.

Bulk Deterioration.

Checking—A pattern of short, narrow breaks in the top layer of paint that is usually caused by a loss of elasticity. Plywood substrates can often cause checking. The deteriorated paint should be removed if a new coating is to be applied.

Cracking and Flaking—An advanced form of checking that usually occurs on surfaces with multiple layers of paint and includes breaks in the film that extend to the base substrate. The cracks usually form parallel to the grain of the wood. The damaged coating should be removed if a new coating is to be applied.

Alligatoring—Reptilian scale patterns on dried paint films that are often caused by the inability of the topcoat to bond smoothly to a glossy coat underneath. The old paint should be completely removed and the surface should be primed and repainted. Alligatoring is usually associated with paint films that are too thick, or the application of a brittle coating over a more flexible one. In some cases it may be necessary to remove all of the paint before recoating, since the existing paint film is already too thick. Enclosure or component replacement will probably be the most effective and safe hazard control methods in this circumstance.

Layered Deterioration.

Blistering—The formation of bubbles in the paint film caused by either heat or moisture. The risk assessor should break open one of the bubbles; if bare substrate shows, then the likely cause is moisture. However, if another layer of paint shows instead of substrate, heat probably caused the blister (not moisture). The risk assessor should endeavor to locate the moisture source if moisture is suspected. Control of the moisture source will lengthen the effective lifespan of many forms of lead-based paint hazard control, especially paint film stabilization.

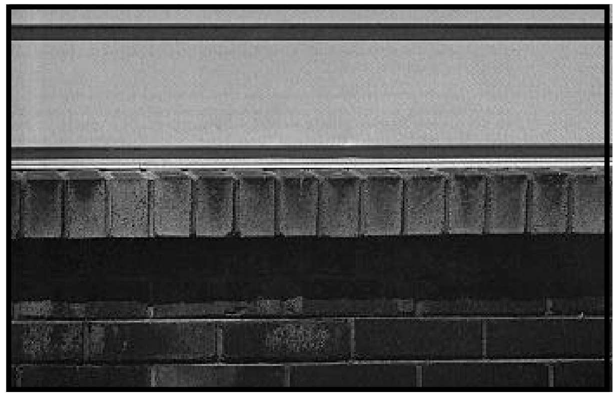


Figure 5.2a Forms of Paint Deterioration: Chalking.

Courtesy: National Decorating Products Association

Figure 5.2b Forms of Paint Deterioration: Scaling, Cornflaking, and Peeling.

Courtesy: National Decorating Products Association

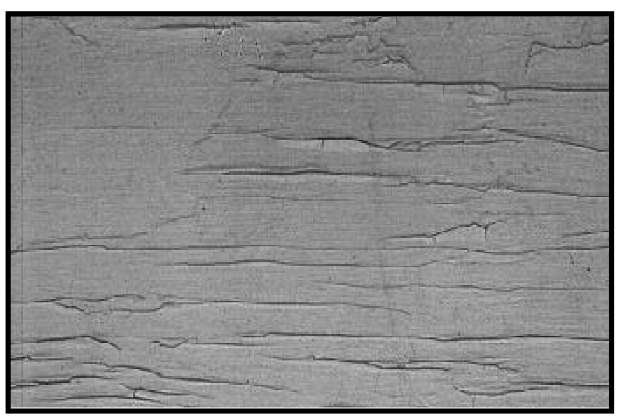


Figure 5.2c Forms of Paint Deterioration: Checking.

Courtesy: National Decorating Products Association

Figure 5.2d Forms of Paint Deterioration: Alligatoring.

Courtesy: National Decorating Products Association

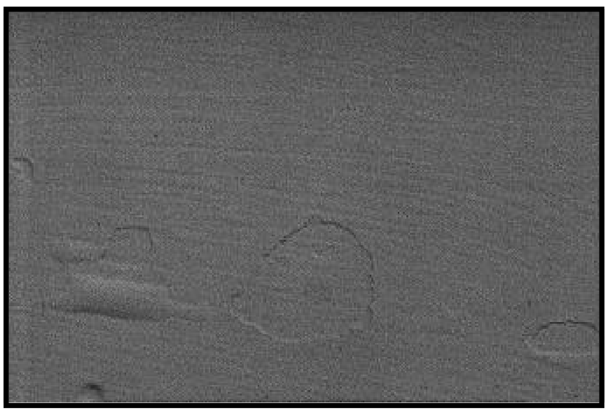


Figure 5.2e Forms of Paint Deterioration: Blistering.

Courtesy: National Decorating Products Association

Scaling or Flaking (peeling)—A form of paint separation often found in those exterior areas of the building susceptible to condensation, such as under eaves. Salt deposits drawn to the paint film surface can cause scaling. The deteriorated paint should be removed, and the salts should be washed off if the surface is to be recoated. Enclosure may be the most effective and safe hazard control method for this type of deterioration.

Peeling From Metal—A form of paint separation usually caused by improper priming of bare, galvanized metal, or by rusting (often seen on garage doors). The loose paint should be removed by wet scraping and the metal should be primed with a galvanizing primer or other primer made for metal before paint film stabilization. Industrial paints containing lead should not be used to prime metal surfaces. Component replacement and enclosure are likely to be most effective.

Peeling From Exterior Wood—A type of paint deterioration usually resulting from wet wood swelling under paint, causing the paint film to loosen, crack, and dislodge. The water may be present because of either moisture passing through the substrate from the interior (poor ventilation) or exterior sources of moisture penetrating the paint film. The risk assessor should recommend that the cause of the moisture problem be discovered and addressed before attempting paint film stabilization or any form of recoating.

Peeling From Plaster Walls—Peeling from plaster walls could be the result of insufficient wet troweling of the white coat when the plaster was applied, causing chalking of the surface. Both the use of glue size, which absorbs water, and use of a primer with poor alkali resistance can also cause deterioration.

Peeling From Masonry Surfaces—Peeling from masonry surfaces is often caused by the alkaline condition of the surface. A coating system that is appropriate for alkaline surfaces should be used.

2. Condition of Building

During the evaluation of painted surfaces, overall building conditions should also be determined. The condition of the building can offer insights into where future lead-based paint hazards may occur and whether certain hazard control options are likely to be successful. A leaking roof should be noted since it could cause paint deterioration in the near future. A poorly maintained building may indicate that an owner is unlikely to sustain interim controls.

The recommended method of evaluating the overall condition of the building is to rate the building using the Building Condition Form (Form 5.1). If the condition of the building is rated poor, a lead hazard screen is not an option. Risk assessors are responsible for informing owners of the frequency and duration that a dwelling should be reevaluated following lead hazard control treatments. Procedures to develop a site-specific Reevaluation Schedule are discussed in Chapter6.

3. Condition of Friction and Impact Surfaces

Deterioration on friction and impact surfaces should be determined by operating several of the windows and doors that are used most frequently (if known). Windows that do not operate smoothly and doors that bind or otherwise contact the frame improperly are indications of a potential source of leaded dust. Operating three or four windows and three or four doors is usually adequate; it is not necessary to operate all windows and doors in the dwelling. For risk assessment purposes, it is not necessary to analyze the paint for lead content on these surfaces unless it is deteriorating.

4. Chewed Surfaces

Surfaces with teeth marks are considered hazards if the paint is lead based.

5. Common Areas

Paint and building conditions should be evaluated in all common areas accessible to children.

B. Dust Sampling

1. General Guidance and Definitions

These *Guidelines* provide advice on deciding which rooms to sample and which components to sample within rooms. However, only general guidance can be offered on exactly *where* samples should be collected. The exact spot to be sampled should be chosen based on the risk assessor's visual observations and the results of any resident interviews and use patterns (if available). Of course, no interviews or observation of use patterns can be done in vacant units. Generally, floor dust samples should be collected from areas that are likely to be contacted by young children, such as play areas within rooms, high-traffic walkways, room midpoints, or areas immediately underneath windows. Window dust samples in a given room should be collected from the window that is most frequently operated or most frequently contacted by children, if known. For example, if toys are located on one window sill but not the other, the one with the toys should be sampled. Conversely, the window trough of windows that are difficult to open and are infrequently operated should *not* be sampled, since contact by children is unlikely.

Figure 5.2f Forms of Paint Deterioration: Cracking, Peeling,and Blistering.

Courtesy: National Decorating Products Association

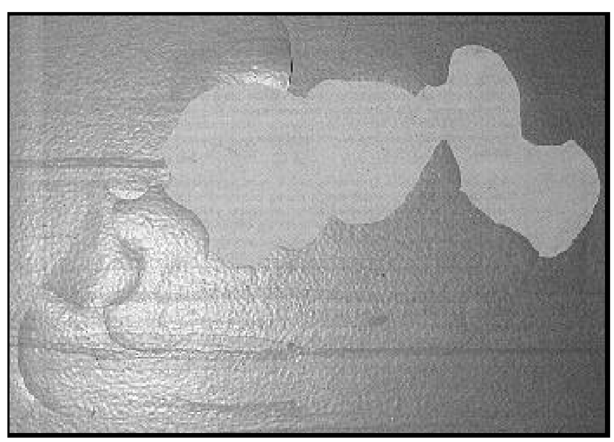


Figure 5.2g Forms of Paint Deterioration: Cracking and Peeling on Plaster.

Courtesy: National Decorating Products Association

Figure 5.3a shows where wipe samples should be collected from window assemblies. Samples should be collected from interior window sills (also known as stools or ledges), which are shown as Area C in Figure 5.3a. Samples should also be collected from window troughs (Area A or Areas A and B), formerly known as window wells (or exterior sills). It should be noted that the entire exterior sill is not sampled.

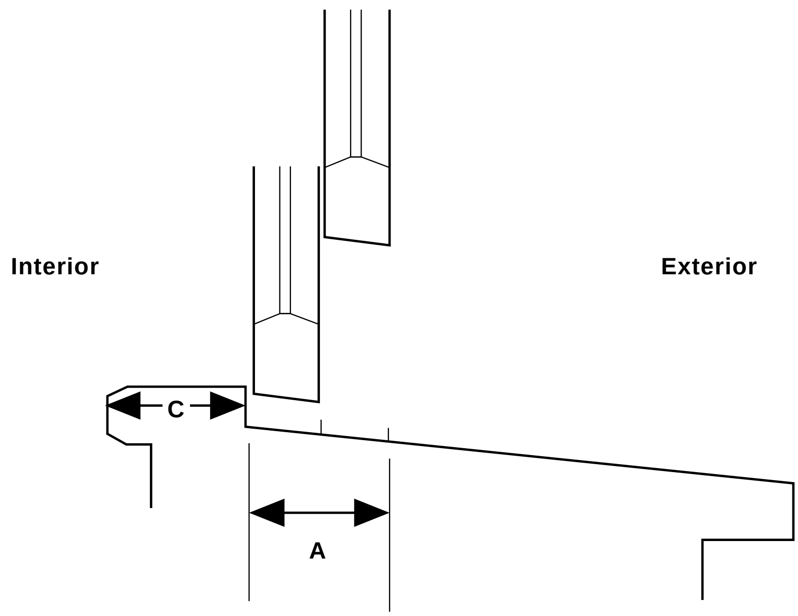
- Interior window sills—The portion of the horizontal window ledge that protrudes into the interior of the room, adjacent to the window sash when closed; technically called the window "stool."
- Window trough—The portion of the horizontal window sill that receives both the upper and lower window sashes when they are lowered, often located between the storm window and the interior window sash; sometimes called the window well. If there is no storm window, the window trough consists of the portion of the horizontal window trim that contacts the sashes when they are closed (i.e., not the entire exterior sill). See Figure 5.3 for an illustration of the window surfaces from which dust samples should be collected.

The risk assessor can conduct either composite or single-surface dust sampling. In composite sampling, samples are collected from common components in different rooms and analyzed as one. Composite sampling often reduces the total number of samples analyzed, thus lowering the cost, but offers only limited information about individual rooms. Single-surface sampling involves collecting and analyzing samples from individual components. Single-surface sampling incurs higher analytical costs, but provides specific information that may help focus hazard control efforts on particular surfaces and make hazard control more cost effective by limiting its scope to specific rooms.

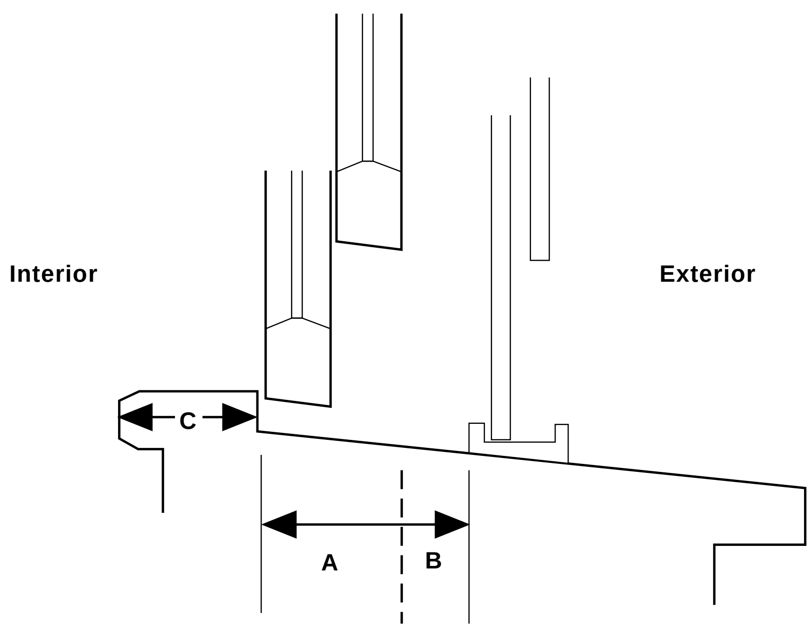
Dust samples can be collected using either a wet wipe or a special vacuum. The complete field sampling and analytical protocol for wipe sampling is contained in Appendixes 13 and 14. At this time, HUD is able to offer guidance on interpreting the results of wipe sampling only, because there is no recommended standard for vacuum sampling. While vacuum sampling may be used, it is up to the user to interpret the results. The results of wipe sampling and vacuum sampling are *not* interchangeable or equivalent. Further information on dust sampling will be available from EPA when health-based leaded dust standards are promulgated. The following considerations should be observed when collecting dust samples:

- Wipe sampling is the preferred method of dust collection because it is simple, inexpensive, and has been used successfully for a number of years in several States and in the public housing program. Recent research has indicated that wipe-sampling results correlate well with blood lead levels in children (Lanphear, 1994; Farfel, 1992). Currently, researchers are examining the efficacy of vacuum sampling, and HUD and EPA will provide further guidance on interpreting vacuum-sampling results pending further research.
- Whenever possible, dust samples from floors should be collected from hard surfaces. Wipe samples can be collected from the surface of carpets; however, carpet sampling is more ambiguous because of the variability among carpet styles.
- Only certain brands of wipes should be used, unless equivalence can be demonstrated through a blind dust-spike sample analysis (see Appendix 13.1).
- Whatman™ filters and thick diaper wipes should not be used. (Whatman™ filters are not sufficiently durable for use in the field, and many thick diaper wipes cannot be digested in routine lab analysis.)
- Unmarked spiked wipe samples should be submitted for analysis with regular field samples in order to ascertain the efficiency of the laboratory digestion procedure. See Section IV of this chapter and Appendix 14.3 for more information on spiking wipe-sample media with leaded dust.

Figure 5.3a Window Locations for Dust Sampling.



1. Sectional view of window (with no storm window) showing window trough area, A, to be tested. Trough is the surface where both window sashes can touch the sill when lowered. The interior window sill (stool) is shown as area C. Interior window sills and window troughs should be sampled separately.



2. Sectional view of window (including storm window) showing window trough area, A and B, to be tested. Trough extends out to storm window frame. The interior window sill (stool) is shown as area C. Interior window sills and window troughs should be sampled separately.

Figure 5.3b Deteriorated Window Troughs Often Contain High Levels of Lead-Contaminated Dust.

- Hard containers (not plastic bags) should be used to transport wipe samples from the sampling site to the lab, since the container will be rinsed quantitatively to recover all lead on the sample.
- Hard containers should be triple-rinsed in the laboratory to ensure quantitative transfer.
- Wipes should always be moist; if the wipes have dried out (e.g., from an open lid), they should not be used.

2. Composite Dust Sampling

If composite sampling is used, a minimum of three separate composite dust samples should be collected. A fourth composite sample would be needed if wall-to-wall carpets are present. The composite samples should be collected from floors, interior window sills, and window troughs.

Risk assessors should follow the composite sampling protocol found in Appendix 13.1. The following rules should be observed when conducting composite dust wipe sampling:

- Separate composite samples are required from carpeted and hard surfaces (e.g., a single composite sample should not be collected from both carpeted and bare floors).
- Separate composite samples are required from each different component sampled (e.g., a single composite sample should not be collected from both floors and interior window sills).
- Separate composite samples are required for each dwelling.
- Floor surface areas sampled in each room should be approximately the same size (1ft ^{2} or 929cm ^{2}). Window trough and interior window sill sampling sizes are dependent on window characteristics, but should be as similar as possible from room to room (e.g., the surface sampling area should not be skewed so that one room is oversampled).
- A new wipe should always be used for each spot sampled.
- No more than four different wipes should be inserted into a single container for a composite sample. Acceptable recovery rates (80–120 percent of the "true" value) have been found when no more than four wipes are analyzed as a single sample (Jacobs, 1993c).

While a risk assessor should exercise professional judgment about the number and location of samples, three or four composite dust samples are sufficient for most evaluations in smaller dwellings.

In an unoccupied dwelling or a dwelling facing turnover, the areas that are most likely to have lead-contaminated dust should be sampled. In general, floor samples should be collected in the four rooms with the greatest evidence of chipping and peeling paint. In a dwelling where children reside, however, areas where young children are most likely to be exposed to lead hazards should be sampled. The recommended subsampling locations for houses with children are the following:

- Principal playroom for children (usually the TV room, living room, or dining room).

- Kitchen.
- Bedroom of the youngest child, who is over 6 months of age (children under 6 months are unlikely to be exposed to dust).
- Bedroom of the next oldest child.

The preceding locations for subsamples can be used for both single-family and multifamily dwelling risk assessments. However, substitute locations will be necessary in dwellings where the room designations cannot be determined. For example, in vacant units, the living room should be substituted for the playroom and the smallest bedroom for the youngest child's room.

3. Single-Surface Dust Sampling

If composite sampling is not used, at least six to eight single-surface dust samples are necessary to evaluate the hazards in each dwelling. Children are most likely to come into contact with dust in the following areas:

- Entryway (including porches).
- Children's principal play area (usually the TV room, living room, or dining room).
- Children's bedrooms.
- Kitchen.
- Bathroom.

Within these rooms, components that are likely to have high dust levels are:

- Floors near friction or impact spots or in areas with deteriorated paint.
- Interior window sills (of frequently opened windows).
- Window troughs (of frequently opened windows).
- Cabinets with deteriorated paint (housing dishes, toothbrushes, eating utensils, etc.).

Risk assessors should combine this general guidance with the data from the visual inspection and any information gathered about the residents' use patterns to determine the exact number and location of dust samples to be collected. For a multiple-dwelling assessment, these suggestions may be used to assist the risk assessor in developing a sampling plan for each dwelling. An example of a dust sampling plan is shown on the next page. This plan guarantees a mix of dust samples from floors, interior window sills, and window troughs, with a preponderance of samples collected from floors, which are more frequently contacted by children.

In some cases, a mixture of single-surface and composite samples may be the most appropriate approach. Composite samples should be used when all the surfaces are fairly similar. Single-surface sampling should be used on surfaces that are unique in some way. For example, if there is a single window trough that serves as a storage space for toys, then it should not be sampled by a composite sample, since information is needed about that specific location. The selection of composite or single-surface sampling is a professional judgment that should be made by a certified risk assessor, and should be based on EPA standards when they are promulgated.

4. Common Areas (Multifamily Housing Only)

When sampling low-rise buildings (four stories or less), the risk assessor should collect two additional dust wipe samples: one from the entry area floor and one from the floor of the first-story landing of a common hallway or stairway. If there is a hallway window that is frequently used, the risk assessor should collect an interior window sill or window trough sample from this window and substitute this sample for the floor sample from the first-floor landing.

In high-rise buildings, the risk assessor should also collect two additional dust samples from the corridor of every fourth floor. The dust samples should be collected from floor areas and window troughs. If the window cannot be opened, or there is no trough present, a sample from the interior window sill should be collected. In addition, two dust samples should be collected from stairways: one from the stair treads, and one from the landing. When collecting the dust samples, the risk assessor should

Example of a Dust Sampling Plan

Dust samples should be collected from each of the following locations:

- One from the floor of the child's principal play area, TV room, or living room).
- One from the interior window sill of the most frequently opened window in the child's principal play area.
- One from the floor of the kitchen.
- One from the window trough of the kitchen window (if inaccessible, an interior window sill sample should be collected).
- One from the floor of the bedroom of the youngest child (older than 6 months).
- One from the interior window sill of the bedroom of the youngest child (older than 6 months).
- One from the floor of the bedroom of the next oldest child, if any.
- One from the window trough of the bedroom of the next oldest child, if any (if inaccessible, an interior window sill sample should be collected).

At least one window trough sample should be collected in each dwelling. If no playroom can be identified, the living room should be sampled. If the youngest child's bedroom cannot be identified, the smallest bedroom should be sampled.

Under this plan, three composite samples *or* eight single-surface samples would be collected. The risk assessor should use professional judgment to determine which method is most appropriate.

In some dwellings, it may be appropriate to delete or add a sample location. For example, if a window is never opened, the window trough should not be sampled. If an additional location is identified that displays both a visible accumulation of dust *and* has obviously been exposed to a child, an additional sample from that location should be collected. A dusty tabletop in the child's play area, or a cabinet with deteriorated paint that holds dishes, aresurfaces that should be sampled.

record the conditions of all painted surfaces in the corridor or stairway where the samples are collected.

5. Dust Sampling in Onsite Community Buildings, Day Care, Recreational, or Other Spaces Frequented by Children

For spaces up to 2,000 square feet, dust samples should be collected as follows:

- Floors: Collect two dust samples from widely separated locations in "high-traffic" areas regularly used or accessible to children.
- Windows: Collect two samples, one from an interior window sill and the other from a window trough.

For spaces over 2,000 square feet, dust samples should be collected as follows:

- Floors: Collect one additional sample for each increment of 2,000 square feet.
- Windows: Collect one additional sample of either an interior window sill or a window trough for each additional increment of 2,000 square feet.

In the building's management office, one dust sample should be collected from the floor of the resident waiting area (if children are ever present in the area); two samples should be collected if the area is more than 400 square feet. Dust samples may be composited according to the rules explained earlier.

C. Paint Sampling

As part of the risk assessment, the risk assessor should determine whether any deteriorated paint is lead-based and therefore constitutes a lead hazard. If a paint inspection has been conducted, and the risk assessor believes that the inspection adequately follows the principles of testing described in Chapter 7, then the inspection results should be used to determine which deteriorated surfaces are lead hazards. If an inspection has not been completed, or the risk assessor questions its reliability, building components that exhibit deteriorated paint should be analyzed. Paint-chip samples should be collected, or measured by x-ray fluorescence (XRF) analysis *after* dust sampling is conducted in order to minimize the possibility of cross-contamination of dust and paint samples.

1. Evaluating Previous Paint Testing

If previous testing of lead-based paint has been completed, the risk assessor should review the testing report to determine if the results are reliable. Past inspections may not conform to current standards of care and may not have accounted for important sources of error, possibly resulting in an incorrect determination of the location of lead-based paint.

The risk assessor should review the previous report using the checklist shown in Table 5.4. Chapter 7 contains detailed instructions on how repeated paint inspections can be completed.

If the answer to any of the Table 5.4 questions is negative, the past inspection or a portion of that inspection may not be reliable. All surfaces with questionable readings should be treated as though they were never tested. If the inspection report will be used to make decisions in the future, the owner should be encouraged to retest all of the surfaces where the results are questionable. It is usually *not* necessary to retest all surfaces.

If Table 5.4 indicates that paint testing was adequate, the risk assessor can use the previous results without additional sampling.

2. Deteriorated Paint Analysis

Deteriorated paint analysis can be performed with either a portable XRF lead-based paint analyzer or by laboratory paint-chip analysis. More information on XRF testing can be found in Chapter 7. Risk assessors should be aware that most XRF analyzers can only be used on surfaces where the paint is intact over an area of at least 3 square inches with all layers present. XRF testing should not be used to analyze peeling paint or paint chips. Peeling or chipped paint should only be analyzed by a laboratory, unless an intact area nearby can be used for XRF analysis. Other methods, such as spreading pulverized paint chips out on a sheet of paper and then analyzing them by XRF, should not be used for risk assessment purposes at this time because equivalence with other standard analytical methods has not been established.

Paint-chip samples for laboratory analysis are collected by removing *all* layers of paint from the surface without removing any substrate. It is important to collect all layers of paint from a sample location, not just the peeling layers. All layers of paint should be included in the sample for the following reasons: (1) All layers may be removed during the scraping involved in preparing the surface for repainting (repair process); (2) the result of the paint-chip analysis should be comparable to an XRF reading, which reads all layers; and (3) the cost of analyzing a single layer is the same as the cost of analyzing only the deteriorated layers. A complete protocol for sampling paint (intact, as well as deteriorated paint) can be found in Chapter 7 and Appendix 13.2. Minor cleanup of the immediate area should be done with wet wipes following any destructive paint-chip sampling effort.

One paint-chip sample should be collected from all similar building components with deteriorated paint that have similar painting histories. Paint chips should be collected from the exterior as well as the interior of the dwelling. As a rule of thumb, no more than five deteriorated painted surfaces are sampled for most risk assessments. If more surfaces must be sampled,

Table 5.4 Review of Previous Lead-Based Paint Inspections

		Yes	No
1	Did the report clearly explain the entire testing program and include an executive summary in narrative form?		
2	Did the report provide an itemized list of similar building components (testing combinations) and the percentage of each component that tested positive, negative, and inconclusive? (Percentages are not applicable for single-family dwellings.)		
3	Did the report include test results for the common areas and building exteriors as well as the interior of the dwelling units?		
4	Were all of the painted surfaces that are known to exist in the dwelling units, common areas, and building exteriors included in the itemized list of components that were tested?		
5	If confirmation testing (laboratory testing) was necessary, did the testing or inspection firm amend the final report and revise the list of surfaces that tested positive, negative, and inconclusive?		
6	Was the unit selection process performed randomly?		
7	Is the name of the XRF manufacturer and the model, serial numbers of the XRF that was used in each unit recorded in the report?		
8	Did the report record the XRF calibration checks for each day that testing was performed?		
9	Did the calibration checks indicate that the instrument was operating within the Quality Control Value (see Chapter 7)?		
10	Were the required number of readings collected for each surface?		
11	Were substrate corrections performed (if necessary)?		
12	Were confirmatory paint-chip samples collected if XRF readings were in the inconclusive range?		
13	Was the procedure that was used to collect the paint-chip samples described?		
14	Was the laboratory that analyzed the paint samples identified?		

the owner should consider having a paint inspection done together with the risk assessment (see Chapter 7).

Wet chemical field test kits should not be used to analyze paint at this time. Although they demonstrate promise for the future, the chemical test kits are not yet sufficiently reliable for routine analysis of deteriorated paint, dust, or soil (RTI, 1991; Jacobs, 1991a; CMHC, 1993). However, if it is not possible to conduct XRF or laboratory paint-chip analysis, the kits may be used. Current EPA/HUD recommendations on the use of these kits can be obtained by calling 1–800–LEAD–FYI. It is possible that some kits may be approved in the future (see Chapter 7).

Composite Paint-Chip Sampling. A risk assessor can choose to perform either single-surface or composite sampling of paint chips. Just as in composite dust sampling, it is possible to lower the cost of paint-chip analysis by combining individual samples into a single sample (i.e., by choosing composite sampling over single-surface sampling). As with all composite sampling, composite paint-chip sampling provides limited information in that it will not reveal exactly which surface is coated with lead-based paint. To conduct composite paint-chip sampling, each subsample added to the composite should be equal in size (about 1 square inch) and weight. For this reason, compositing of paint chips is best performed in the laboratory, where size and weight can be controlled. Due to laboratory restrictions, no more than five subsamples should be included in a single composite paint-chip sample. The laboratory must be instructed to analyze the *entire* sample (not a portion of the sample), or to completely homogenize the entire sample and analyze a sub-sample. Homogenization procedures are available from the EPA Lead Information Center (1–800–LEAD–FYI).

The lead-based paint standard should be divided by the number of subsamples contained in the composite sample to determine if any individual subsample can be above the standard. As shown in the following equation:

$$\begin{array}{c}\text{Composite}\\\text{Paint Standard}\end{array} = \frac{\text{Paint Standard}}{\text{Number of Subsamples}}$$

Consider the following example: A risk assessor identifies five surfaces with deteriorated paint. All five surfaces are sampled in an equivalent manner. Half of each sample is retained (in a separate container) by the risk assessor or laboratory, and half is used to form a single composite paint-chip sample. Since there are *five* subsamples, the composite lead-based paint standard *for this sample* is:

$$\frac{1 \text{ mg/cm}^2}{5 \text{ subsamples}} = 0.2 \text{ mg/cm}^2$$

or

$$\frac{5{,}000\ \mu\text{g/g}}{5 \text{ subsamples}} = 1{,}000\ \mu\text{g/g}$$

If the laboratory results are less than 0.2 mg/cm^2 or 1,000 µg/g, none of the individual subsamples can possibly contain lead at or above the national standard of 1 mg/cm^2 and therefore no further action is necessary. If the lab result is greater than 0.2 mg/cm^2, the paint subsamples that were retained should be submitted for individual analysis to determine if any of the subsamples contain lead equal to or greater than 1 mg/cm^2 or 5,000 µg/g. Composite paint-chip sampling is essentially a negative screen (i.e., it can prove that lead-based paint is *not* present). Proof that lead-based paint *is* present can only be established through single-surface sample analysis.

Composite sample results can be expressed in either mg/cm^2 or µg/g. To report the results in mg/cm^2, all subsamples must have the same surface area. To report the result in µg/g, all subsamples must be of equal weight. Since it is not feasible to weigh samples in the field, composite paint-chip samples should generally be reported in mg/cm^2 (i.e., it *is* feasible to measure the size of the area of the paint sample).

Why is the standard for a composite paint chip samples reduced while the standard for a composite dust sample remains unchanged, regardless of the number of subsamples included? The answer involves how the results will be used. The composite dust sample will determine whether cleaning is needed across all floors or all windows. The cost of cleaning an additional room is marginal, especially if the unit is vacant. However, deteriorated paint may be repaired in a number of different ways, making it necessary to know exactly *which* surface is contaminated. Abatement or interim control of a single building component may cost hundreds of dollars, while the cost of cleaning an additional room is far lower. Thus, compositing for paint is essentially a *screening* process to determine whether or not it is possible for any subsample to be above 1 mg/cm^2. For dust, the compositing process yields an average across all surfaces to determine if cleaning is needed. All dust and paint-chip compositing must be carefully coordinated with the laboratory.

Chewed Surfaces. Surfaces with deteriorated paint and surfaces that have been chewed (or where chewing and mouthing are reported) should be tested. Chewed surfaces could include interior window sills, balusters, shelves, stairs, and other surfaces accessible to children's mouths. Deteriorated paint surfaces that display teeth marks or that have been identified as a site of mouthing should be analyzed either by paint-chip analysis or XRF testing. Surfaces with *intact* paint where chewing or mouthing is suspected should be analyzed with an XRF analyzer, when available. Although a chewed surface is by definition deteriorated, paint-chip sampling is *not* recommended for intact, chewed surfaces unless the surface can be covered with a durable material immediately. Disturbing intact paint may make a child more curious about the surface and may increase the likelihood of exposure. If no testing occurs, the surface should be assumed to be a lead-based paint hazard, and should be treated accordingly.

Intact Paint on Friction and Impact Surfaces. In general, paint-chip samples should not be collected from intact paint in good condition, since intact paint does not pose a lead hazard. Intact paint on friction or impact surfaces also does not need to be sampled, since any dust hazards that are being produced will be identified by dust sampling. If worn paint is seen on a friction or impact surface, the risk assessor should consider collecting a dust sample near that area. XRF or paint-chip analysis of worn painted areas is not recommended, since some of the lead-containing layer may have worn away. Usually, thicker sections of paint film should be analyzed to determine the presence of lead-based paint.

There is one exception to the general rule against sampling intact paint: If certain areas of intact paint are expected to be disturbed in the future due to renovation, maintenance, or other work, the paint in those areas should be analyzed by paint-chip analysis or XRF testing.

Deteriorated lead-based paint on furniture also constitutes a lead hazard, but it is the responsibility of the owner of the furniture to resolve those hazards. A risk assessor should strongly recommend to dwelling owners that any furniture with deteriorated paint be analyzed. In rental dwellings, deteriorated paint from resident-owned furniture need not be sampled, since the building owner does not own the furniture and cannot control its correction if a hazard is found. However, the risk assessor should suggest to property owners that it may be in their best interest (as well as the interests of the residents) to identify all lead-based paint hazards. In some cases, the residents themselves may agree to pay for an analysis of their furniture. Whoever pays for the analysis, it must be clear that the responsibility for treatment or removal of any resident-owned furniture rests with the resident. When no paint samples are collected, the risk assessor should still record the presence of deteriorated paint on old furniture in the final report.

D. Soil Sampling

The risk assessor should determine whether the soil outside of a dwelling poses a significant hazard to children. To accomplish this, it will be necessary to determine not only the concentration of lead in the soil, but also the use pattern (i.e., the frequency of contact and use of soil) for different soil locations and conditions. Since only areas of bare soil are considered potential lead-based paint hazards under Title X, the risk assessor should only sample areas of bare soil unless otherwise requested. Except for play areas, yard or soil areas containing a total of less than 9 square feet of bare soil are not considered to be hazardous and need not be sampled. A property owner may wish to have additional sites sampled if the ground covering on those sites may be disturbed in the future (e.g., by gardening or excavation).

Bare soil areas to be sampled for lead contamination include:

- Outdoor play areas.
- Building foundation or drip line.
- Vegetable gardens, pet sleeping areas, bare pathways.
- Sandboxes.

A minimum of two composite samples per dwelling or building sampled are recommended: one sample from the child's principal play area, one sample from bare soil areas in the front or back yard (if present), and/or an additional sample from the foundation drip line. The yard and building perimeter drip line areas can be combined into a single composite sample, but the play areas should be composited as a separate sample. If there is *no* bare soil, soil sampling is not necessary. However, in most cases, there will be at least small bare areas that should be sampled.

Samples may be collected using a coring tool to acquire the top half inch (1 cm) of soil. Alternatively, a stainless steel scoop or the lip of the sample container may be used. Soil coring devices may not be useful in sandy, dry, or friable soil.

Each composite sample should consist of approximately equal soil subsamples collected from 3–10 distinct locations roughly equidistant from each other along an axis. For samples collected along the foundation drip line, subsamples should be collected at least 2–6 feet away from each other. At other sampling locations, samples should be collected at roughly equidistant points along each axis of an "x" shaped grid.

If paint chips are present in the soil, they should be included as part of the soil sample. However, there should be no special attempt to oversample paint chips. The laboratory should be instructed to disaggregate ("break up") paint chips by forcing them through a sieve in the laboratory. Although paint chips should not be oversampled, they should also not be excluded from the soil sample, since they are part of the soil matrix.

Since it is not necessary to know the lead concentration in each soil subsample, the soil standard is *not* divided by the number of subsamples included in the composite sample. The sample result for the soil composite sample should be compared directly to the standard, as is the case for dust.

E. Water Sampling

Water sampling is not required for a routine risk assessment, but may be requested by the property owner. Local water authorities are already mandated by the EPA to monitor the lead levels of the water they supply. If the owner is concerned that lead may be leaching into the water between the service line and the faucet, samples can be collected and analyzed using the standard EPA protocol (see Appendix 13.5).

F. Lead Hazard Screen Risk Assessment Sampling Protocol

For a lead hazard screen risk assessment, the first step is to determine whether the dwelling is in good condition by completing Form 5.1. The risk assessor should take a 5- to 15-minute tour of the dwelling to note paint and building conditions, and to decide where to take dust samples. If the assessor observes painted surfaces in "poor" condition, then paint samples should be collected (or the painted surfaces should be measured by XRF) during the lead hazard screen risk assessment. The deteriorated paint sampling protocol in a screen is identical to the sampling performed in a full risk assessment. The lead hazard screen risk assessment is unlikely to be cost effective in dwellings in poor condition; in these situations, a full risk assessment should be completed to avoid the expense of a screen and a repeated trip to the site by a risk assessor.

In a lead hazard screen risk assessment, two composite dust samples are collected, one from floors and the other from window troughs. Each composite should include dust samples from the child's principal play area, the child's bedroom, the main entryway (usually the front porch or interior entryway), and one additional location to be determined by the risk assessor. The entryway is sampled in the screen since no soil samples are typically collected (soil sampling is optional). However, if there is evidence of paint chips from an earlier exterior repainting job, soil sampling should be done as part of the screen. A screen does not include any water or air sampling, and does not gather any data on property management or condition, which will be collected only if a full risk assessment is needed. The evaluation criteria for a screen are also different (see Section V of this chapter) than those for a full risk assessment.

III. Risk Assessments for Different Size Evaluations

The scope of the risk assessment will be determined in part by the number of dwellings that need to be evaluated. For single-family, owner-occupied dwellings, the basic information that the risk assessor needs to complete a comprehensive assessment is relatively easy to collect. A short interview with the owner will provide information about resident use patterns, past maintenance practices, and the resources that the owner can devote to hazard control. However, for an evaluation of a large number of rental dwellings, the assessor must gather information from the owner about the residents, the management company (if any), and the maintenance staff in order to confidently assess the viability of various hazard control options. Therefore, the protocols for collecting information from owners of multiple dwellings are more extensive than the protocols for owner-occupants.

At the same time, owners with a large number of dwellings to be evaluated may be able to reduce the per-unit costs of the risk assessment greatly. If, in the judgment of the risk assessor, the dwellings to be evaluated are sufficiently *similar*, the protocols allow the risk assessor to limit sampling to the dwellings that are most likely to present immediate lead hazards to residents, as described below. The environmental sampling from these targeted similar dwellings is used to represent the lead-based paint hazards in all dwellings. For the purposes of risk assessment, the term *similar dwellings* describes those dwellings that were built at the same time, have a common maintenance and management history, have a common painting history, and are of similar construction. Similar dwellings do not need to be contained in a single housing development or in a single building to meet this definition; they also need not have the same number of rooms.

This section describes slightly different risk assessment protocols for the following situations:

- Assessment of an owner-occupied, single-family dwelling.
- Assessment of five or more similar rental dwellings.
- Assessment of less than five similar rental dwellings or multiple dwellings that are *not similar*.

Table 5.5 summarizes the key elements of a risk assessment for each category of assessment.

Like many recommendations in these *Guidelines*, these categories should be modified when appropriate. For example, when evaluating a duplex or three-dwelling building where one dwelling is owner-occupied, the single-family protocols should be used with some minor modifications. In large multiple-unit dwellings that are not similar, a risk assessor may be able to use dwelling selection procedures to contain costs. The selection process must be done with special care and with limitations fully described. To assist the risk assessor, standard risk assessment forms have been developed and are provided at the end of this chapter.

A. Risk Assessments for Owner-Occupied, Single-Family Dwellings

Evaluations in owner-occupied, single-family dwellings should include:

- An interview with the homeowner about resident use patterns and potential lead hazards.
- A visual assessment of the condition of the building and painted surfaces.
- Environmental sampling of deteriorated paint, dust, and soil.

The following forms should be used in the assessment of owner-occupied, single-family dwellings:

Table 5.5 Risk Assessment Approach For Different Size Evaluations

Action Required	Owner-Occupied, Single-Family Dwellings	Five or More Similar Rental Dwellings	Less Than Five Rental Dwellings or Rental Dwellings That Are Not Similar
Assess every dwelling	Yes	No	Yes*
Deteriorated paint sampling (if no inspection conducted)	Yes	Yes	Yes
Dust sampling	Yes	Yes	Yes
Bare soil sampling	Yes	Yes	Yes
Water sampling	Optional	Optional	Optional
Air sampling	No	No	No
Management system analysis	Not applicable	Optional	Optional
Maintenance work systems modified	Cleaning and repair practices modified	Optional	Optional
Housing condition and characteristics assessment	Yes	Yes	Yes
Demographics and use patterns description	Yes	Yes	Yes

* There may be occasions when it is not necessary to sample all nonsimilar dwellings.

- Form 5.0—Resident Questionnaire.
- Form 5.1—Building Condition Form.
- Form 5.2—Paint Conditions on Selected Surfaces.
- Form 5.3—Field Sampling Form for Deteriorated Paint (single-surface) [or Form 5.3a (composite)].
- Form 5.4—Field Sampling Form for Dust (single-surface) [or Form 5.4a (composite)].
- Form 5.5—Field Sampling Form for Soil.

B. Risk Assessments for Five or More Similar Dwellings

Risk assessments for five or more similar dwellings should include:

- Information from the owner (or owner's representative) about the condition of the property, the age and location of children in the residence (if known), and the management and maintenance practices for the dwellings.
- The selection of dwellings for targeted sampling.
- A visual assessment of the condition of the building and painted surfaces in the targeted dwellings.
- Environmental sampling of deteriorated paint, dust, and soil in the targeted dwellings (and common areas of multifamily developments).

The following forms should be used for evaluations of five or more similar dwellings:

- Form 5.1—Building Condition Form.

- Form 5.3—Field Sampling Form for Deteriorated Paint (single-surface) [or Form 5.3a (composite)].
- Form 5.4—Field Sampling Form for Dust (single-surface) [or Form 5.4a (composite)].
- Form 5.5—Field Sampling Form for Soil.
- Form 5.6—Management Data for Rental Dwellings.
- Form 5.7—Maintenance Data for Rental Dwellings.

1. Targeted, Worst Case, and Random Sampling

The risk assessment protocol described here uses a targeted sampling strategy. Targeted sampling selects dwellings that are most likely to contain lead-based paint hazards to represent the other dwellings *based on information supplied by the owner* (i.e., units are not selected randomly or on the basis of visual evidence). The sampling protocol assumes that if the selected dwellings are free of lead hazards, it is highly probable that the other similar dwellings are also free of lead hazards. Targeted sampling has been used in public housing risk assessments for several years. This sampling protocol reduces the cost of assessment and is unlikely to miss significant lead hazards.

Alternatively, similar dwellings can be evaluated with worst case sampling or random sampling. Worst case sampling requires a walk-through survey of *all* dwellings by the risk assessor in order to select the highest-risk dwellings based on direct visual evidence. Worst case sampling is not practical for most multiple dwellings, since it is nearly impossible to gain entry to all units in an expeditious fashion.

Some concerns have been raised about both targeted and worst case sampling, because it is not possible to quantify the degree of certainty associated with the findings as is the case for random sampling. However, if the risk assessor is conscientious about the proper selection of dwellings to be sampled (using the dwelling selection criteria) and is confident that the target dwellings meet the selection and similarity criteria, then the risk in a given development can be characterized sufficiently for the purpose of hazard control.

If the owner requires a statistically significant degree of confidence about the existence of lead-based paint hazards, random sampling should be used. Random sampling is recommended for lead-based paint inspections because the results are often used to develop more expensive, long-term hazard control measures. A full discussion of random sampling and a random sampling protocol can be found in Chapter 7. Random sampling in multifamily settings with more than 20 units usually requires more dwellings to be sampled and therefore may increase the cost of the risk assessment compared with targeted or worst case sampling.

The risk assessor must be confident that targeted dwellings meet the dwelling selection criteria defined below. Targeted sampling should not be conducted if the owner is unable to provide accurate information about the occupancy status and physical condition of the dwellings to be sampled. If it appears that this information is unavailable or is being concealed by the owner, the risk assessor should resort to random or worst case sampling. Regardless of the sampling method, if any of the sampled dwellings contain identified lead hazards, all similar dwellings should also be assumed to contain similar hazards.

Number of Dwellings To Be Sampled. Table 5.6 describes the number of dwellings that are needed for targeted sampling. Targeted sampling cannot be used for evaluations of fewer than five similar dwellings. When fewer than five similar dwellings are being evaluated, *all* units should be sampled. The recommendations contained in Table 5.6 are drawn in part from a public housing risk assessment/insurance program. The empirical evidence suggests that the recommended number of units sampled adequately characterizes the risk in the entire housing development (HES, 1993).

When determining the number of targeted dwellings, dwellings that are known to currently house children with elevated blood lead levels should be excluded from the total unless there are more than 10 such units, in which case they should be added to the total. Dwellings housing children with blood lead levels greater than or equal to 20 µg/dL (or a persistent 15 µg/dL upon repeated testing) require environmental investigations (CDC, 1991b) different from the procedure described here (see Chapter 16).

Each and every dwelling housing a child with an elevated blood lead level must be investigated independently. This investigation may be performed by either the local health authority or the risk assessor. If, after consultation with the health department, it is agreed that the risk assessor will perform the investigation, the evaluation should use the protocol that is described in Chapter 16 for dwellings housing children with elevated blood lead levels. This investigation should be completed *in addition to* the other units investigated as part of the risk assessment.

Since blood lead levels are confidential medical information, owners may not know whether children with elevated blood lead levels reside in their dwellings. Nevertheless, the risk assessor should request this information from the owner in order to try to better target the study.

Dwelling selection criteria. The selection criteria found here offer general guidance for selecting targeted dwellings. Risk assessors should obtain the information needed from the owner's records (if available) or through interviewing the owner. Targeted dwellings should meet as many of the following criteria as possible(criteria are listed in order of importance).

- Dwellings cited with housing or building code violations within the past year.
- Dwellings that the owner believes are in poor condition.
- Dwellings that contain two or more children between the ages of 6 months and 6 years. (Preference should be given to dwellings housing the largest number of children.)

Table 5.6 Minimum Number of Targeted Dwellings To Be Sampled Among Similar Dwellings (random sampling may require additional units)

Number of Similar Dwellings	Number of Dwellings to Sample*
1–4	All
5–20	4 units or 50% (whichever is greater)**
21–75	10 units or 20% (whichever is greater)**
76–125	17
126–175	19
176–225	20
226–300	21
301–400	22
401–500	23
501+	24 + 1 dwelling for each additional increment of 100 dwellings or less

* Does not include dwellings housing children with elevated blood lead levels.

**For percentages, round up to determine number of dwellings to be sampled.

- Dwellings that serve as day-care facilities.
- Dwellings prepared for reoccupancy within the past 3 months.

If additional dwellings are required to meet the minimum sampling number specified in Table 5.6, the risk assessor should select them randomly.

If there are a number of dwellings that all meet the same criteria, then the dwellings with the largest number of children under the age of 6 should be selected. (Children tend to cause increased wear and tear on painted surfaces; therefore, dwellings where children reside are more likely to contain leaded dust hazards.) When possible, at least one dwelling in the sample should have been recently prepared for reoccupancy (although it need not be vacant), since the repainting and other repairs that are often conducted during vacancy can create a leaded dust hazard. However, the risk assessor should not sample *only* dwellings that have recently been cleaned and repainted, since this would not accurately represent the conditions in the rest of the dwellings. If there are too many units that all meet the same criteria, the required number should be eliminated randomly. (See Chapter 7 for a discussion of random selection methods.) There can be many combinations of targeted dwellings that will all meet the selection criteria. The risk assessor should document which of the criteria were used to designate the dwelling as a targeted unit on the field sampling forms [(Forms 5.3 (5.3a), 5.4 (5.4a), and 5.5)]. The "Example of Targeted Dwelling Selection" that follows shows how such a targeting system works.

C. Risk Assessments of Fewer Than Five Rental Dwellings and Multiple Dwellings That Are Not Similar

When evaluating fewer than five similar rental dwellings or multiple dwellings that are not similar, each of the dwellings should be assessed individually. The risk assessor will not be able to draw solid conclusions from a smaller sample. Current evidence from the public housing risk assessment program suggests that hazards in different single-family, scattered-site dwelling units vary greatly (HES, 1993), unlike similar multifamily dwelling units where a clear pattern of hazards typically exists among dwellings.

Risk assessments of fewer than five similar dwellings or multiple dwellings that are not similar should include:

- The collection of information from the owner (or owner's representative) about the condition of the property, the age and location of children in residence, and the management and maintenance practices for the dwelling (optional).
- A visual assessment of the condition of the building(s) and painted surfaces of all dwellings.
- Environmental sampling of deteriorated paint, dust, and soil in all dwellings (and common areas of multifamily developments).

The following forms should be used for this type of evaluation:

- Form 5.1—Building Condition Form.
- Form 5.3—Field Sampling Form for Deteriorated Paint (single-surface) [or Form 5.3a (composite)].
- Form 5.4—Field Sampling Form for Dust (single-surface) [or Form 5.4a (composite)].
- Form 5.5—Field Sampling Form for Soil.
- Form 5.6—Management Data for Rental Dwellings.
- Form 5.7—Maintenance Data for Rental Dwellings.

1. Assessments of Five or More Dwellings That Are Not Similar

Owners of a large number of dwellings that are not similar may find the costs of a complete risk assessment daunting. These *Guidelines* therefore recommend that risk assessors use their professional judgment to determine whether there is a pattern of lead hazards among dwellings. If a clear pattern emerges, it may not be necessary to evaluate all dwellings.

The sampling method that should be employed is a modification of the targeted sampling model. Usually, it will be necessary to sample more dwellings due to increased variability. The risk assessor should collect information about the condition of the building(s) and the age and location of children in residence, and rank the dwellings based on the selection criteria. The risk assessor should then sample 25 percent of the total number of dwellings or five dwellings (whichever is greater). The first group of dwellings to be sampled should be chosen from the units thought to be at highest risk. The results should be evaluated to determine if a clear pattern of lead-based paint hazards can be discerned. If no clear pattern emerges, additional dwellings should be sampled until a pattern of hazard severity and location becomes apparent or until all dwellings have been sampled. For example, a risk assessor evaluating 100 different dwellings selects a sample of 25 targeted dwellings. The risk assessor finds that all of the targeted dwellings have high leaded dust levels in the window troughs, but nowhere else. In this situation, the risk assessor may suggest to the owner that the window troughs in all 100 dwellings are likely to be contaminated and therefore should be cleaned without further sampling. The owner must decide whether to follow this recommendation or continue the risk assessment for additional dwellings.

2. Assessments of Fewer Than Five Similar Dwellings

When conducting evaluations of less than five dwellings, risk assessors may find that it is appropriate to modify the amount of information they request from owners. Owners of a small number of dwellings are likely to have simplified management structures (e.g., the owner acts as both manager and maintenance worker). If this is the case, the risk assessor should shorten both the management and maintenance questionnaires.

For small evaluations, the risk assessor may find it helpful to interview residents using the resident questionnaire (after obtaining permission to do so from the owner). Risk assessors should notify residents that the questionnaire is optional and should not make more than one trip to the dwelling to collect the information. For large evaluations, the use of the questionnaire is not feasible.

D. Optional Analysis of Management and Maintenance Practices

Many forms of lead hazard control will require property management planning and careful maintenance work on surfaces that are known or suspected to contain lead-based paint. To help owners undertake these activities, risk assessors can collect information on how management and maintenance work is structured on a given property by using Forms 5.6 and 5.7. Information on these forms will help the risk assessor make practical recommendations on how maintenance work can be done safely for both workers and resident children. Analysis of management and maintenance practices is recommended but not required.

IV. Laboratory Analytical Procedures

A. Analytical Methods

Paint samples are to be analyzed according to the methods for total lead analysis specified in Appendix 14.1 or ASTM ES–28–94, ASTM ES–36–94 (or ES–37–94), and ASTM ES–1613–94. For risk assessment purposes, paint must not be analyzed using the Toxicity Characteristic Leading Procedure (TCLP) for hazardous waste characterization (leachable lead). All laboratories performing analyses of lead in soil, dust, and paint should be participants in EPA's National Lead Laboratory Accreditation Program and be accredited by an organization recognized by EPA (see Chapter 2 and Appendix 14.1).

Example of Targeted Dwelling Selection

A risk assessor is hired to conduct a risk assessment for 30 dwellings owned by a single property owner. Twenty-five of these dwellings are apartments in the same building, have similar construction and painting histories, and were acquired simultaneously. The other five were acquired from different owners at different times, have had little previous rehabilitation work, and have different construction styles. One of the 25 similar dwellings is known to house a child with an elevated blood lead level. The local health department has already informed the risk assessor that the department has no plans to evaluate the dwelling due to a staffing shortage.

In this case, the risk assessor will evaluate the following:
Five dwellings of different construction.
One dwelling housing the child with the elevated blood lead level (see Chapter 16).
Ten dwellings of similar construction (in Table 5.3, 24 total dwellings require 10 dwellings to be sampled).

The risk assessor will conduct sampling in 16 dwellings, with the 10 targeted dwellings used to represent the 24 similar dwellings that do not house children with elevated blood lead levels.

For the 24 similar dwellings, the owner has provided the following information about residents:
Six dwellings have three children under age 6.
Three dwellings have two children under age 6.
Five dwellings have one child under age 6.
Nine dwellings have an unknown number of children.
One dwelling is vacant and has recently been prepared for reoccupancy.

In addition, the owner has supplied the following resident use and maintenance information:
Two dwellings have building code violations (one with three children, one with one child).
Three dwellings have a history of chronic maintenance problems and are in relatively poor condition (two with an unknown number of children, one with two children).
There are no known day-care facilities.

Based on this information, the risk assessor targets the following dwellings:
Two dwellings with building code violations (one with three young children).
Three dwellings rated in poor condition.
One dwelling recently prepared for reoccupancy.

This yields six dwellings. The final four dwellings should be selected from among the five remaining similar dwellings that house three young children. Since there are no distinguishing factors among the five dwellings, the final four dwellings are selected randomly from this group.

B. Special Quality Control Procedures for Wipe Samples

Because of inadequate digestion techniques, the use of commercial wipe media may result in low recovery rates in the laboratory (Jacobs, 1991c). Currently, no laboratory proficiency testing program manufactures durable wipe material spiked with known amounts of leaded dust. For example, the Environmental Lead Proficiency Analytical Testing (ELPAT) program supplies Whatman™ filters spiked with known amounts of leaded dust, but Whatman™ filters have not been found to be sufficiently durable in the field. Therefore, the analytical recovery results from spiked Whatman™ filters may not reflect the results for more durable wipe media. As a result, Whatman™ filters are not recommended for risk assessment or clearance sampling purposes. Risk assessors should use more durable wipe media, such as Little Ones Baby Wash Cloths™ and Little Ones Diaper Wipes™ (both manufactured for KMart), since they have been shown to exhibit recovery rates between 80 to 120 percent on a routine basis when spiked with leaded dust (HES, 1992). The National Institute for Occupational Safety and Health (NIOSH) has reported that Wash'n Dry™ wipes have acceptable recovery rates, although this has not been established in routine practice (NIOSH, 1993b). Other media may also have acceptable recovery rates, but must be evaluated before use. Other acceptable brands include Pure and Gentle Baby Wipes™, Walgreens Wet Wiper™, and Fame Baby Wipes™.

Laboratories can usually prepare spiked wipes upon request by risk assessors. Since there is no national proficiency program that examines laboratory performance of digestion procedures, it is necessary for risk assessors to insert spiked wipe samples with known amounts of leaded dust, at a frequency of 1 spiked wipe per 50 samples (see Appendixes 13 and 14.1 for complete protocol). The laboratory should be blinded to the amount of leaded dust on each wipe. These spiked samples are *in addition to* spiked samples prepared by the laboratory for its internal quality control/quality assurance program. Wipe samples should be spiked with leaded dust in the range of 50–300 µg lead/wipe (generally, 100 µg/ft^2 is the region of interest and 1 square foot is the area usually wiped). The risk assessor should relabel (but not repackage) the spiked wipe samples so that the laboratory is as "blind" as possible to which samples are spiked samples and which samples are field samples. Repackaging will result in some loss of leaded dust from the sample. Containers for spiked samples and field samples should be identical, and both composite and single-surface wipes should be spiked. Wipes can be spiked with Urban Particulate Standard Reference Material 1648 or Powdered Lead-Based Paint Standard Reference Material 1579a, both available from the National Institute for Standards and Technology, or an equivalent "secondary" reference material, such as that used in the ELPAT program. EPA recommends that wipe samples be spiked with leaded dust, not lead in solution (EPA, 1993b).

At the present time, blind spiking is the only way for a risk assessor to judge the performance of a laboratory's digestion procedure on commercial wipes. If the results of the blind spiked samples are within 20 percent of the actual value of lead on the wipe, then the laboratory's performance is acceptable. If the results are outside of this range, the risk assessor should consult with the laboratory about the discrepancy. Retesting *may* be necessary if questions about the laboratory results cannot be resolved. Risk assessors should also record the lot number of the wipes as a way of monitoring the performance of that lot.

V. Evaluation of Findings

The ultimate goal of any risk assessment is to use the data gathered from the questionnaires and/or interviews, the visual inspection, and the environmental sampling to determine whether any lead-based paint hazards are present. (Hazardous levels of lead for risk assessment purposes are summarized in Table 5.7.) If lead hazards are found, the risk assessor will also identify acceptable options for controlling the hazards in each property. These options should allow the property owner to make an informed decision about what actions should be taken to protect the health of current and future residents. The risk assessor's recommendations could include hazard control measures to correct current lead-based paint hazards, and/or new property management and maintenance policies designed to prevent hazards from occurring or recurring.

A. Evaluating Lead-Based Paint Hazards

Table 5.7 shows the criteria to be used for interpreting environmental samples collected during lead-based paint risk assessments.

1. Dust

Until EPA releases its health-based leaded dust standards (as mandated by Title X under TSCA, Title IV, Section 403), the HUD interim dust standards in Table 5.7 should be used to determine if hazardous leaded dust levels are present. These interim standards may change as a result of ongoing research. If leaded dust samples collected by wipe sampling exceed the levels in Table 5.7, a lead-based paint hazard exists. (Even though this is technically a "dust hazard," the term "lead-based paint hazard" is used to remain consistent with the statutory definition in Title X.)

Vacuum sampling methods may also be acceptable, although each vacuum method will need its own standard. At this time HUD does not have interim standards for leaded dust using vacuum sampling.

Since the results represent *all* surfaces sampled, composite dust sampling results should *not* be divided by the number of subsamples collected.

Some State and local jurisdictions use different standards for lead-contaminated dust. At least one State (Rhode Island) measures hazardous levels of lead in dust in parts per million (known as concentration), instead of micrograms per square foot (known as loading). If it is necessary for the dwelling to pass a local lead-contaminated dust standard, the risk assessor should be familiar with the local standard and how that standard is measured. Loading is a better indicator of elevated blood lead levels and total amount of leaded dust present inside the dwelling and is easily measured by the most widespread and inexpensive method of settled dust sampling (wipe sampling). In addition, cleaning can reduce loading but not necessarily concentration. Thus, loading is the most informative measure for risk assessment and postabatement clearance purposes currently available. Vacuum sampling can determine both concentration and loading, while wipe sampling measures loading only.

For all hazard evaluations, the data should be examined to determine if consistent patterns emerge (e.g., the window troughs contain high levels, while floors and interior sills are low); such patterns will aid in the development of recommendations for focused, cost-effective control measures.

Table 5.7 Hazard Levels for Lead-Based Paint Risk Assessments

Media	Level	
Deteriorated paint (single-surface)	5,000 µg/g or 1 mg/cm^2	
Deteriorated paint (composite)	$\frac{\text{5,000 µg/g or 1 mg/cm}^2}{\text{Number of subsamples}}$	
Dust (wipe sampling only) (includes both single-surface and composite)	Risk assessment	Risk assessment screen (dwellings in good condition only) —
Carpeted floors*	100 µg/ft^2	50 µg/ft^2
Hard floors*	100 µg/ft^2	50 µg/ft^2
Interior window sills	500 µg/ft^2	250 µg/ft^2
Window troughs	800 µg/ft^2	400 µg/ft^2
Bare soil (dwelling perimeter and yard)	2,000 µg/g	
Bare soil (small high-contact areas, such as sandboxes and gardens)	400 µg/g	
Water (optional)—first draw	15 ppb (µg/L)	

* Whenever possible, sample hard floors, not carpets.

2. Paint

If paint contains lead equal to or greater than the following levels, it is considered to be lead-based paint under the Lead-Based Paint Poisoning Prevention Act:

- 5,000 µg/g (also expressed as 0.5 percent, 5,000 mg/kg, or 5,000 ppm by weight). (Paint chips analyzed in the laboratory by atomic absorption spectroscopy or inductively coupled plasma emission spectroscopy will usually be reported by weight percent.)
- 1.0 mg/cm^2 (XRF machines report lead content by area).

The standards may be lower (i.e., more stringent) in some State and local jurisdictions. In addition, paint that has lead just below the standard can still pose a health hazard. For example, deteriorated paint with 4,000 µg/g is more hazardous than intact paint with 5,000 µg/g of lead. Any component that contains deteriorated lead-based paint is a lead hazard and should be treated. If the amount of lead in deteriorated paint is below the regulatory limit, lead hazard control measures are not necessary to prevent exposures to lead (although paint stabilization is still recommended). Any component with deteriorated paint that is not tested and does not have a painting history similar to a tested component should be considered a lead-based paint hazard. In the event that all paint-chip samples are below the standard, the owner cannot assume that *all* surfaces in the dwelling are free of lead-based paint, since all surfaces were not tested. Instead, the owner can have a paint inspection performed if a surface-by-surface analysis is needed.

3. Bare Soil

EPA is also developing residential soil lead standards under Title X. Until the standard has been established, the following level of lead in soil should be considered hazardous:

- 2,000 µg/g (bare soil only)—perimeter and yard samples.
- 400 µg/g bare soil in small, high-contact areas (e.g., sandboxes, gardens).

Areas of bare soil that contain levels of lead that exceed 2,000 µg/g should be considered a lead hazard and should be treated accordingly. The soil standard is lower in some State and local jurisdictions. Soil that is covered with grass or other covering does not need to be treated, although the covering needs to be maintained properly. Soil in play areas is considered hazardous at even lower lead levels since children's contact will be greater. The soil standard for high-contact areas is 400 µg/g.

Risk assessors may be asked to collect soil samples before exterior abatement or interim control work for clearance purposes (see Chapter 15) to determine baseline levels. These samples may be archived and not analyzed at all unless soil levels exceed clearance standards after the hazard control work has been completed.

4. Hazard Evaluation by Targeted, Worst Case, or Random Sampling

Dust. When leaded dust is evaluated with targeted, worst-case, or random sampling, the risk assessor should calculate the arithmetic mean of the results for each type of component sampled (i.e., floors, interior window sills, window troughs, and carpets) by room type and entryway. If the mean leaded dust level for a component in the target dwellings equals or exceeds the dust standards described in Table 5.7, then a lead hazard has been identified for that component in all dwellings.

For example, if the mean dust level for window troughs in the targeted dwellings is 4,500 µg/ft^2 (above the standard of 800 µg/ft^2), then all window troughs in the housing development should be considered hazardous and treated accordingly.

If the mean is below the standard, but some of the individual sample results are above the standard, those individual surfaces and all other similar surfaces should be treated. The risk assessor should attempt to identify any common characteristics of the elevated samples. Where results are ambiguous, further sampling may be needed, or the owner may decide that the cost of cleaning is less than the cost of additional sampling, in which case further evaluation is bypassed.

Paint. Targeted sampling presumes that all dwellings under assessment have similar (but not identical) painting histories. Therefore, if the bathroom door in one dwelling is coated with lead-based paint, then it is highly likely that bathroom doors in all similar dwellings are also coated with lead-based paint. To determine that lead-based paint is *not* present throughout a development, see Chapter 7.

The results of the paint-chip sampling should be analyzed by component and location. If all components at a given location are above the paint standard or all are below, then the risk assessor can assume that this condition is true for the total population of similar dwellings. However, if a component (e.g., living room baseboards) contains lead-based paint in some dwellings and not in others, the owner must assume that all similar components present a lead hazard unless a paint inspection shows otherwise.

5. Water

Water sampling, which is optional for a routine risk assessment, can be interpreted using the current EPA action level for lead in drinking water, which is:

- 15 ppb (15 µg/L)—drawn as a 1-liter first draw after the water has remained in the pipe for at least 6 hours.

If first-draw tap water samples exceed 15 ppb lead, the risk assessor should recommend that the homeowner contact the local water department to determine if corrosion control or other control measures are in the process of being implemented. Call the EPA Lead Information Center at 1–800–LEAD–FYI for further information on water sampling and interpretation of results. The risk assessor should inform the owner and/or resident that often the simplest way to reduce lead in drinking water is to flush the water lines by letting the cold water kitchen tap run for a minute or two whenever the water has not been used for 6 hours. This helps only if the lead is from the home's plumbing, not the service lines.

6. Other Lead Sources

If other lead sources are discovered in the dwelling, the risk assessor should contact the local health department or the local childhood lead poisoning prevention program for assistance in devising control strategies and assessing the degree of risk. For information on other sources, consult the EPA pamphlet titled, *Lead-Based Paint: Protect Your Family*. If it appears that a parent or other resident works in a lead industry and is bringing lead hazards into the house, the Occupational Safety and Health Administration (OSHA) can be notified anonymously by the resident. The OSHA lead standard contains important provisions to prevent workers from "taking home" occupational leaded dust.

B. Evaluating Management Policies

Except in the case of complete removal of all lead-based paint (or all components coated with lead-based paint), some type of ongoing management and maintenance of lead hazards will be required for all properties. Homeowners and owners of only a few dwellings will generally have to take on this responsibility themselves. When a risk assessor begins to describe hazard control options to these owners, it is important that the ongoing management and maintenance, monitoring, and reevaluation requirements are explained fully for each option.

For owners of larger multiple dwellings, adequate management staff may already be in place, but this new responsibility may not be understood. The owner should assign responsibility for managing the various aspects of a lead hazard control program, and the program should be described in a Lead Hazard Control Policy Statement. The Statement documents the owner's awareness of the lead hazard problem and intention to control it. In addition, the Statement authorizes a specific individual to carry out the lead hazard control plan; assigning clear responsibility to a single individual is especially important for multiple owners and property management companies. The owner (with input from the risk assessor) should determine which employees are best positioned to conduct the following activities:

- Training and management of staff who will maintain hazard controls.
- Periodic surveillance of lead hazards and hazard controls.
- Resident reports of deteriorated paint.
- Reports of resident children with elevated blood lead levels.
- Controlled maintenance and repair work.
- Other lead-related activities or problems.

The risk assessor should recommend that the responsible individual acquire training. Often, the best person for this role is someone in authority who has received previous training and who has demonstrated concern about the issue.

The dwelling turnover process should be reviewed to determine if work practices and cleaning efforts require modification. The risk assessor should decide what types of wet cleaning and repainting efforts can be achieved safely by the owner. Environmental data gathered from dwellings recently prepared for reoccupancy should be examined to determine if hazard control measures are taking place while the dwelling is vacant (when such measures are often much easier and cheaper to complete).

As part of the management evaluation process, the risk assessor should examine the owner's occupational safety and health program. Training is essential for maintenance personnel to ensure that they are protected and that they do not inadvertently create lead hazards in the course of their duties. If qualified, the risk assessor should determine if respirator usage (and a respirator program), a medical surveillance program, or specialized equipment (notably a HEPA vacuum) are needed. If the risk assessor is not qualified to make such judgments, the OSHA lead pamphlet should be given to the owner.

The risk assessor should help the owner decide what immediate actions to take if a child with an elevated blood lead level appears. For example, the owner should consider what options are available to house the family temporarily (e.g., in one of the owner's lead-safe dwellings) if it appears the original dwelling may contain the source of lead. At a minimum, the owner must know where alternate housing can be found on a rapid response basis.

Some property owners perform periodic general housing quality inspections, either on turnover or on a set schedule. The risk assessor should assist the owner in developing a plan for evaluating the condition of suspected or

Example of a Lead Hazard Control Policy Statement

XYZ Property Management Company is committed to controlling lead-based paint hazards in all its dwellings. ___________________________(name), ___________________________(position or job title), has my authority to direct all activities associated with lead hazard control, including directing training, issuing special work orders, informing residents, responding to cases of children with elevated blood lead levels, correcting lead-based paint hazards on an emergency repair basis, and any other efforts that may be appropriate. The company's plan to control such hazards is detailed in a risk assessment report and lead hazard control plan.

(Signed) _____________________________________ ________________ (Date)
(Owner)

(Signed) _____________________________________ ________________ (Date)
(Lead Hazard Control Program Manager)

known sources of lead-based paint during these routine inspections.

The risk asssessor can also help a larger property owner decide which properties should be assessed first, through developing a risk assessment/hazard control plan.

C. Maintenance of Multiple Dwellings

In the course of the risk assessment, the risk assessor should determine if current maintenance practices are adequate to control lead hazards. Specifically, repainting should be performed at least every 5 years (more frequently when paint appears to be in poor condition). When repainting, the owner should be encouraged to use a lead-specific cleaner or deglossing agent to prepare the surface, and/or change to wet scraping and sanding, followed by the appropriate cleaning procedures described in Chapters11 and 14. Specialized cleaning should always be performed following maintenance or repainting when surfaces known or suspected to contain lead-based paint are disturbed.

If the property owner uses standard work order forms, the risk assessor should determine whether they contain proper instructions about working on known or suspected lead-based painted surfaces. For example, the work orders should instruct workers when to use respirators and special cleaning measures (see Chapter 17).

The quality of the maintenance operation should also be evaluated from the prevalence of building or housing code violations, the condition of paint, and the condition of the building as rated on Form 5.1. If the building is in "poor condition," if there have been more than two code violations over the past 2 years, or if the condition of the paint is especially poor, then the risk assessor should conclude that maintenance is deficient and that lead-based paint hazards may not be adequately managed. Such a situation requires a more frequent monitoring schedule (unless full removal is completed). See Chapter 6 for further details.

D. Lead Hazard Screen Risk Assessments in Dwellings in Good Condition

Different criteria are employed to evaluate the results of lead hazard screen risk assessments, which are limited to dwellings that are in good to fair condition. Since less data and fewer samples are collected, more stringent standards are applied to determine if a full risk assessment is needed. This helps minimize the possibility of failing to detect a lead-based paint hazard.

If the results of the composite dust or composite paint samples are greater than the levels shown in Table 5.7, a full risk assessment should be performed to determine if hazards truly exist. The screen criteria were developed by dividing the hazard standards in half for floors and window troughs. (Interior window sills should not be sampled for screening purposes.) By reducing the standards in half, the ability of the screen to detect potential lead hazards is increased.

Deteriorated paint measurements or paint-chip sample result criteria are the same as for a full risk assessment. If lead levels exceed this level, then a full risk assessment should be completed.

VI. Report

The final report complied by the risk assessor documents the findings of the risk assessment and identified control methods. This section describes the format of such a report, as well as general guidance on how to provide control options. The hazard control chapters of these *Guidelines* provide further information on the various forms of lead hazard control. See Appendix 8 for two examples of risk assessment reports.

A. Site-Specific Hazard Control Options

First, the report should state whether any lead hazards were found at the dwelling. Once the nature, severity, and location of identified lead hazards are understood, the risk assessor should inform the owner of the range of acceptable hazard control measures. These control

Table 5.8 Main Hazard Control Options That Could Be Identified in Risk Assessments

Treatment Option	Dust[1] on Floor	Dust[1] on Windows	Paint[2] on Doors	Paint[2] on Windows	Paint[2] on Floor and Walls	Paint[2] on Trim	High Soil Lead Levels
Dust removal	X	X	X	X	X	X	X
Paint film stabilization			X	X	X	X	
Friction reduction treatments	X	X		X		X	
Impact reduction treatments	X	X	X			X	
Planting grass	X						X
Planting sod	X						X
Paving the soil	X						X
Encapsulation					X	X	
Enclosure					X	X	
Paint removal by heat gun[3]			X	X	X	X	
Paint removal by chemical[3]			X	X	X	X	
Paint removal by contained abrasive[3]			X	X	X	X	
Soil removal	X	X					X
Building component replacement			X	X	X	X	

[1] Lead-contaminated dust.

[2] Deteriorated lead-based paint.

[3] Limited areas only.

measures range from various short-term interim controls (e.g., specialized cleaning, minor wet scraping, and repainting) to long-term abatement methods (e.g., building component replacement, enclosure, and paint removal). Table 5.8 lists the major options and scenarios, although the number of possibilities and combinations is virtually unlimited. For example, if the risk assessor finds that window troughs are highly contaminated with leaded dust and deteriorated lead-based paint, but the owner has very limited resources, dust removal and paint film stabilization would be the most appropriate course of action. However, if more resources are available, the entire window should be replaced.

1. Education

The risk assessor also has a special role to play in educating the various parties involved in lead poisoning prevention. Title X specifically states that lead hazard control efforts should include education, since it is critical to the success of any interim control or abatement plan. This includes education for management and maintenance staff and residents. While the risk assessor cannot be expected to train and educate everyone, some simple steps can and should be taken in the process of developing the final report.

Management Staff Education. While meeting with the owner or property manager to describe the lead hazard control options available, the risk assessor can help educate them on the seriousness of lead hazards. The EPA lead hazard information pamphlet or other local literature should be handed out (usually available at no charge to the risk assessor or owner from the National Lead Information Center).

Maintenance Staff. The risk assessor should inform the owner of the OSHA Lead Standard requirements as they apply to maintenance workers who may be involved in repair work on surfaces coated with lead-based paint and the employer's obligation to train those workers (see Chapter 9).

Residents. The risk assessor should also take every opportunity to educate residents on what they can do to reduce their exposure to lead-based paint hazards. The EPA lead hazard information brochure can be helpful here and can be obtained by calling 1–800–LEAD–FYI. Information on local childhood lead poisoning prevention programs and blood lead screening services should also be provided.

B. Cost and Feasibility

1. Cost

Each owner will have a different level of available funding. Some will be able to make a long-term investment that will require a large capital outlay, but will be less expensive in the long run, adding to the value of the property. Others will be unable to make this type of investment and will opt for short-term measures that require smaller initial outlays and more frequent monitoring. The risk assessor should endeavor to provide information that will permit the owner to make an informed decision on this complex issue. The owner, not the risk assessor, must make the final decision. Costs for various treatments vary considerably from one locale to the next and are also subject to market conditions, making it difficult to provide firm cost figures. However, the risk assessor should provide a very rough estimate of cost for each control option based on local conditions. Cost estimates can be provided on either a dwelling-unit basis or a building-component basis.

2. Feasibility

In addition to cost, the risk assessor should identify treatments that are unlikely to be effective, such as:

- Repainting or encapsulating an area of deteriorated paint caused by moisture problems (leaky roof, poor vapor barrier, uncorrected plumbing problem, window air conditioner, etc.) without correcting the moisture problem first.
- Repainting or encapsulating an area subject to impact and friction.
- Repainting or encapsulating deteriorated paint or varnish without preparing the surface first.

- Attaching encapsulants or enclosures to deteriorating structural members that may not be able to support the integrity of the enclosure or the additional weight of the encapsulant.
- Applying liquid encapsulants to deteriorated substrates.
- Replacing window sashes in frames that are severely deteriorated.
- Washing horizontal surfaces without stabilizing chalking vertical painted surfaces.
- Cleaning surfaces that are not sealed or made "cleanable."
- Cleaning highly soiled furnishings and carpets, instead of replacing them.
- Mulching or covering lead-contaminated soil in areas where pets tend to sleep or dig.
- Planting grass seed in high-traffic areas.

Of course, the risk assessor must also emphasize the severe danger of using prohibited methods of lead hazard control, such as uncontained abrasive, sand, or water blasting; power sanding; or open-flame burning of painted surfaces.

C. How to Determine Site-Specific Reevaluation Schedules

The risk assessor is responsible for recommending a site-specific reevaluation schedule. The schedule depends on a variety of factors, including the hazard control method implemented, the general condition and maintenance of the building, and the degree of leaded dust contamination. Chapter 6 contains a complete discussion of Standard Reevaluation Schedules.

D. Recommendations to Owners When No Hazards Are Identified

If no lead hazards are identified, but no lead-based paint inspection has been completed, the risk assessor should recommend to the owner that the painted surfaces be treated as though they contain lead. The risk assessor should encourage the owner to obtain an inspection, since no further reevaluation may be needed if it can be shown that no lead-based paint is present. Otherwise, the risk assessor should simply indicate that lead hazards are well controlled for now, but that lead hazards could still emerge in the event of paint deterioration or disturbance.

E. Report Format and Statements of Compliance

The following format is recommended for risk assessment reports:

Part I: Identifying Information

Identity of dwelling(s) covered by report, identity of property(ies).

1. Risk Assessor, Name and Number of Certificate (or License), and State Issuing Certificate/License.
2. Property Owner Name, Address, and Phone Number.
3. Date of Report and Date of Environmental Sampling.

Part II: Completed Management, Maintenance, and Environmental Results Forms and Analyses

4. List of Location and Type of Identified Lead Hazards and Summary of Optional Hazard Control Methods (including an indication of which hazards are priorities—this summary should be suitable for use as notification to residents).
5. Optional Management Information (Form 5.6) (not required for homeowners).
6. Maintenance/Paint Condition Information (Form 5.2 or 5.7).
7. Building Condition (Form 5.1).
8. Brief Narrative Description of Dwelling Selection Process (not required if all dwellings were sampled).

9. Analysis of Previous XRF Testing Report (if applicable).

10. Deteriorated Paint Sampling Results (Form 5.3 or 5.3a).

11. Dust Sampling Results (Form 5.4 or 5.4a).

12. Soil Sampling Results (Form 5.5).

13. Other Sampling Results (if applicable).

Part III: Lead Hazard Control Plan

14. Lead-Based Paint Policy Statement (not applicable for homeowners).

15. Name of Individual in Charge of Lead-Based Paint Hazard Control Program.

16. Recommended Changes to Work Order System and Property Management (optional, not applicable for homeowners or property owners without work order systems).

17. Acceptable Interim Control Options and Estimated Costs.

18. Acceptable Abatement Options and Estimated Costs.

19. Reevaluation Schedule (if applicable).

The information outlined above should be presented to the owner for consideration. The risk assessor should explain the various hazard control options and answer any questions that might arise. With or without the help of the risk assessor, the owner must decide which hazard control option is most appropriate. The final report for the owner should include the following information:

20. Interim Control/Abatement to Be Implemented in This Property (if known by the risk assessor).

21. A Training Plan for Managers, Maintenance Supervisors, and Workers (including named individuals), if applicable.

22. Method of Resident Notification of Results of Risk Assessment and Lead Hazard Control Program (not applicable for homeowners). Note: This section should include a discussion of how residents are to be educated about lead poisoning, *before* the risk assessment results are released.

23. Signature (Risk Assessor) and Date.

Part IV: Appendix

24. All Laboratory Raw Data.

See Appendix 8 for two examples of completed risk assessment reports.

If the owner remains undecided about which hazard control method to use, the risk assessor should state that no hazard controls have been implemented as of the date on the report. Subject to Federal and local laws and regulations, a statement of lead-based paint hazard compliance (with an expiration date based on the Reevaluation Schedule) may be provided by the risk assessor (or local enforcement agency) following the successful implementation of the accepted interim control or abatement method(s) and any associated clearance sampling.

Form 5.0
Resident Questionnaire
(To be completed by risk assessor via interview with resident.)

Children/Children's Habits

1. (a) Do you have any children that live in your home? Yes _____ No_____
(If no children, skip to Question 5.)
(b) If yes, how many?_____ Ages? _____ _____ _____ _____ _____
(c) Record blood lead levels, if known. _____ _____ _____ _____ _____
(d) Are there women of child-bearing age present? Yes _____ No_____
2. Location of the rooms/areas where each child sleeps, eats, and plays.

Name of child	Location of bedroom	Location of all rooms where child eats	Primary location where child plays *indoors*	Primary location where child plays *outdoors*

3. Where are toys stored/kept? ____
4. Is there any visible evidence of chewed or peeling paint on the woodwork, furniture, or toys?
Yes _____ No _____

Family Use Patterns

5. Which entrances are used most frequently? __________________
6. Which windows are opened most frequently? __________________
7. Do you use window air conditioners? If yes, where? __________________
(Condensation often causes paint deterioration)
8. (a) Do any household members garden? Yes _____ No _____
(b) Location of garden. __________________
(c) Are you planning any landscaping activities that will remove grass or ground covering? Yes______ No_____
9. (a) How often is the household cleaned? __________________
(b) What cleaning methods do you use? __________________
10. (a) Did you recently complete any building renovations? Yes _____ No _____
(b) If yes, where? __________________
(c) Was building debris stored in the yard? If yes, where? _________________
11. Are you planning any building renovations? If yes, where? __________________
12. (a) Do any household members work in a lead-related industry? Yes _____ No _____
(b) If yes, where are dirty work clothes placed and cleaned? __________________

Form 5.1
Building Condition Form

Condition	Yes	No
Roof missing parts of surfaces (tiles, boards, shakes, etc.)		
Roof has holes or large cracks		
Gutters or downspouts broken		
Chimney masonry cracked, bricks loose or missing, obviously out of plumb		
Exterior or interior walls have obvious large cracks or holes, requiring more than routine pointing (if masonry) or painting		
Exterior siding has missing boards or shingles		
Water stains on interior walls or ceilings		
Plaster walls or ceilings deteriorated		
Two or more windows or doors broken, missing, or boarded up		
Porch or steps have major elements broken, missing, or boarded up		
Foundation has major cracks, missing material, structure leans, or visibly unsound		
* Total number		

* If the “Yes” column has two or more checks, the dwelling is usually considered to be in poor condition for the purposes of a risk assessment. However, specific conditions and extenuating circumstances should be considered before determining the final condition of the dwelling and the appropriateness of a lead hazard screen.

Notes:

Form 5.2
Paint Conditions on Selected Surfaces
(Single-Family, Owner-Occupied)

Building component	Location Notes	Paint condition (intact, fair, poor, or not present) to be completed by risk assessor	Deterioration due to friction or impact?	Deterioration due to moisture?	Location of painted component with visible bite marks
Building siding					
Exterior trim					
Exterior windows					
Exterior doors					
Railings					
Porch floors					
Other porch surfaces					
Interior doors					
Ceilings					
Walls					
Interior windows					
Interior floors					
Interior trim					
Stairways					
Radiator (or radiator cover)					
Kitchen cabinets					
Bathroom cabinets					
Other surfaces:					

If the overall condition of a component is similar throughout a dwelling, that condition should be recorded. If a component in a couple of locations is in poor condition, but the overall condition is good or fair, the specific sites of the badly deteriorated paint should be noted. The specific locations of any component with bite marks should be recorded.

Form 5.3
Field Sampling Form for Deteriorated Paint
(One form for each housing unit, common area, or exterior)

Name of risk assessor ____________________________

Name of property owner ____________________________

Property address _____________________ Apt. no.____________

Dwelling selection protocol _____All dwellings _____Targeted _____Worst case _____Random

Target dwelling criteria (check all that apply)

_____ Code violations
_____ Judged to be in poor condition
_____ Presence of two or more children between ages of 6 months and 6 years
_____ Serves as day-care facility
_____ Recently prepared for reoccupancy
_____ Random sampling

Sample number	Room	Building component	Lead (mg/cm^2 or µg/g)
HUD interim standard			5,000 µg/g or 1 mg/cm^2

Sample *all* layers of paint, not just deteriorated paint layers.

Total number of samples on this page________

Page _________ of _________

Date of sample collection____/____/____ Date shipped to lab____/____/____

Shipped by ___________________________________ Received by __________________________________
(signature) (signature)

Date results reported ____/____/____ Analyzed by________________________________

Approved by________________________________

Form 5.3a
Field Sampling Form for Deteriorated Paint
(Composite Sampling)

Name of risk assessor ___________________________

Name of property owner ___________________________

Property address ____________________ Apt. no.___________

Dwelling selection protocol _____All dwellings _____Targeted _____Worst case _____Random

Target dwelling criteria (check all that apply)

_____ Code violations
_____ Judged to be in poor condition
_____ Presence of two or more children between ages of 6 months and 6 years
_____ Serves as day-care facility
_____ Recently prepared for reoccupancy

Composite samples number	Component sample	Rooms included in sample	Duplicate subsample number	Size of subsample (cm)	Lab result (mg/cm^2)	Lab result ($\mu g/g$)
HUD interim standard*					1.0*	5,000*

* For composite samples, the HUD standard must be divided by the number of subsamples in the composite sample.

Total number of samples on this page________

Page _________ of _________

Date of sample collection____/____/____ Date shipped to lab____/____/____

Shipped by ________________________________ Received by ________________________________
(signature) (signature)

Form 5.4
Field Sampling Form for Dust
(Single-Surface Sampling)

Name of risk assessor ___________________________

Name of property owner ___________________________

Property address ____________________ Apt. no.___________

Dwelling selection protocol _____ All dwellings _____ Targeted _____ Worst case _____ Random

Target dwelling criteria (check all that apply)

_____ Code violations
_____ Judged to be in poor condition
_____ Presence of two or more children between ages of 6 months and 6 years
_____ Serves as day-care facility
_____ Recently prepared for reoccupancy

Sample number	Room (record name of room used by the owner or resident)	Surface type (circle the type)	Is surface smooth and cleanable?	Dimensions[1] of sample area (inches x inches)	Area (ft^2)	Result of lab analysis ($\mu g/ft^2$)
	Playroom __________	Floor		____ x ____		
	Playroom __________	Interior window sill or window trough		____ x ____		
	Kitchen __________	Floor		____ x ____		
	Kitchen __________	Interior window sill or window trough		____ x ____		
	Bedroom 1 __________	Floor		____ x ____		
	Bedroom 1 __________	Interior window sill or window trough		____ x ____		
	Bedroom 2 __________	Floor		____ x ____		
	Bedroom 2 __________	Interior window sill or window trough		____ x ____		
				____ x ____		
				____ x ____		

[1] Measure to the nearest 1/8 inch.

HUD standards: 100 $\mu g/ft^2$ (floors), 500 $\mu g/ft^2$ (interior window sills), 800 $\mu g/ft^2$ (window troughs)

Total number of samples on this page________

Page _________ of _________

Date of sample collection____/____/____ Date shipped to lab____/____/____

Shipped by ______________________________ Received by ________________________________
(signature) (signature)

Form 5.4a
Field Sampling Form for Dust
(Composite Sampling)

Name of risk assessor ___________________________

Name of property owner ___________________________

Property address ____________________ Apt. no.___________

Dwelling selection protocol _____ All dwellings _____ Targeted _____ Worst case _____ Random

Target dwelling criteria (check all that apply)

_____ Code violations
_____ Judged to be in poor condition
_____ Presence of two or more children between ages of 6 months and 6 years
_____ Serves as day-care facility
_____ Recently prepared for reoccupancy

Sample number	(Record name of rooms used by the owner or resident to be included in sample)	Dimension[1] of surface sampled in each room (inches x inches)	Total surface area sampled (ft^2)	Type of surface sampled	Is surface smooth and cleanable?	Lab result ($\mu g/ft^2$)
		_____ x _____ _____ x _____ _____ x _____ _____ x _____		Smooth floors		
		_____ x _____ _____ x _____ _____ x _____ _____ x _____		Carpeted floors		
		_____ x _____ _____ x _____ _____ x _____ _____ x _____		Interior window sills		
		_____ x _____ _____ x _____ _____ x _____ _____ x _____		Window troughs		

[1] Measure to the nearest 1/8 inch.

HUD standards: 100 $\mu g/ft^2$ (floors), 500 $\mu g/ft^2$ (interior window sills), 800 $\mu g/ft^2$ (window troughs)

Total number of samples on this page________

Page _________ of _________

Date of sample collection____/____/____ Date shipped to lab____/____/____

Shipped by ________________________________ Received by ________________________________
(signature) (signature)

Form 5.5
Field Sampling Form for Soil
(Composite Sampling Only)

Name of risk assessor ____________________________

Name of property owner ____________________________

Property address ____________________________

Sample number	Location	Bare or covered	Lab result (µg/g)
	Building perimeter		
	Building perimeter		
	Play area 1 (describe) ___________		
	Play area 2 (describe) ____________		
HUD interim standard for play area			400
HUD interim standard for perimeter			2,000

Collect only the top 1/2 inch of soil.

Total number of samples on this page________

Page __________ of __________

Date of sample collection____/____/____ Date shipped to lab____/____/____

Shipped by ___________________________________ Received by ___________________________________
(signature) (signature)

User Instructions for Form 5.6

The risk assessor should use Form 5.6 to evaluate the property owner's management capabilities with regard to lead-based paint hazard controls. The risk assessor should briefly explain the purpose and content of the form to the owner to make sure that the type and scope of information requested is understood. All of the information should be supplied by the owner or a representative of the owner, either in writing or through an interview.

Part 1 of Form 5.6 requests background information about the property and additional data about the physical condition of each dwelling and the number of young children in residence.

Part 2 requests information about the management of the dwellings:

1. Staffing

Determine which management and maintenance personnel (by name and job title) are charged with responsibility for dealing with lead-based paint hazards. This typically includes the owner, manager, director of maintenance, centralized maintenance staff, and site maintenance staff. The risk assessor can help the owner determine which staff positions could be involved in lead hazard control efforts and identify the key contact persons.

Smaller scale multifamily housing is more likely to have a simplified management structure. Indeed, the owner may also act as manager and maintenance worker. If there is a division of labor between owner and manager, or manager and maintenance worker, the risk assessor should attempt to determine who has the recognized authority to handle lead-based paint issues.

2. Lead Hazard Control Policy Statement (optional)

Determine if the property management has established a lead hazard control policy statement. If so, review the statement. If no statement exists, the risk assessor may help the owner draft such a statement as an indication of a good faith effort to control lead hazards. See the section on Management of Multiple Dwellings for a sample lead hazard control policy statement.

3. Previous Lead-Based Paint Evaluations

Determine if previous lead-based paint testing has been completed. If so, obtain and review a copy of the report, using the criteria outlined in the section on Evaluating Previous Paint Testing.

4. Previous Lead Hazard Control Activity

Determine if previous lead-based paint abatement or hazard reduction has been completed. If so, obtain and review a copy of the report. Determine if clearance dust testing was completed following abatement.

5. Turnover Procedure

Determine how a vacant dwelling is prepared for reoccupancy. For example, the method of cleaning used on a dwelling prior to turnover should be analyzed.

6. Employee Health and Safety Plan

Determine if the property management has an employee health and safety plan. Employees working with lead hazards are required by OSHA to be involved in a Hazard Communication Program. After reviewing the current state of knowledge and hazard control practices, the risk assessor should help the owner develop site-specific management and maintenance plans.

7. HEPA Vacuum

Determine if a HEPA vacuum is available to clean up lead-contaminated dust.

8. Onsite Day-Care Facilities

User Instructions for Form 5.6

Determine if the property management operates or permits the onsite operation of day-care facilities (either formal or informal). Also, determine if there are onsite recreation halls or facilities operated by the owner that are frequented by young children. These spaces should be sampled by the risk assessor.

9. Management of Cases of Children with Elevated Blood Lead Levels

Determine if the property management has a plan to deal with children who have an elevated blood lead level. If necessary, the risk assessor should help the owner develop a plan.

10. Routine Inspections

If the owner or manager conducts periodic housing quality inspections, determine whether or not those inspections examine the condition of painted surfaces and could be used to identify lead hazards. The risk assessor will often recommend that the owner or manager conduct periodic inspections to ensure that lead hazard control treatments retain their effectiveness.

11. Code Violations

Determine if the dwellings have been cited for any housing code violations in the past several years. Dwellings that have been cited should be identified for targeted sampling.

12. Resident Notification

Determine if the owner has notified residents about known lead hazards at the property.

Form 5.6
Management Data for Risk Assessment of Lead-Based Paint Hazards in Rental Dwellings (Optional)

NOTE: This form is designed for multiple rental dwellings under one ownership. Such dwellings may be in one property or many.

Part 1: Identifying information

Name of property owner ____

Name of building or development (if applicable) ______________________________

Number of dwelling units___________

Number of buildings_______

Number of individual dwelling units/building _____

Date of construction (if one property) ___________ (if between 1960–1978, consider a screen risk assessment)

Date of substantial rehab, if any _______

List of addresses of dwellings (attach list if more than 10 dwellings are present)

Street address, city, State	Dwelling unit no.	Year built (if known)	Number of children 0–6 years old	Recent code violation reported by owner?	Chronic maintenance problem reported by owner?

Record number and locations of common child play areas (onsite playground, backyards, etc.)

Number ____

______________________ ______________________ ____________________

______________________ ______________________ ____________________

______________________ ______________________ ____________________

Form 5.6 (continued)

Part 2: Management Information

1. List names of individuals who have responsibility for lead-based paint. Include owner, property manager (if applicable), maintenance supervisor and staff (if applicable), and others. Include any training in lead hazard control work (by inspector, supervisor, worker, etc.) that has been completed. Use additional pages, if necessary.

   This information will be needed to devise the risk management plan contained in the risk assessor's report.

Name	Position	Training completed (if none, enter "None")
	Owner	
	Property manager	
	Maintenance	

2. Have there been previous lead-based paint evaluations?

   ______ Yes ______ No (If yes, attach the report)

3. Has there been previous lead hazard control activity?

   ______ Yes ______ No (If yes, attach the report)

4. Maintenance usually conducted at time of dwelling turnover, including typical cleaning, repainting, and repair activity.

   Repainting: ____________________________________
   Cleaning: ____________________________________
   Repair: ____________________________________
   Other: ____________________________________
   Comments: ____________________________________

5. Employee and worker safety plan

   a. Is there an occupational safety and health plan for maintenance workers?

      ______ Yes ______ No (If yes, attach plan)

   b. Are workers trained in lead hazard recognition?

      ______ Yes ______ No If yes, who performed the training? ____________________________

Form 5.6 (continued)

c. Are workers involved in a hazard communication program?

______ Yes ______ No

d. Are workers trained in proper use of respirators?

______ Yes ______ No

e. Is there a medical surveillance program?

______ Yes ______ No

6. Is a HEPA vacuum available?

______ Yes ______ No

7. Are there any onsite licensed or unlicensed day-care facilities?

______ Yes ______ No If yes, give location ___________________________

8. Planning for resident children with elevated blood lead levels

a. Who would respond for the owner if a resident child with an elevated blood lead level is identified?

____

b. Is there a plan to relocate such children?

______ Yes ______ No If yes, where? __________________________________

c. Does the owner know if there ever has been a resident child with an elevated blood lead level?

______ Yes ______ No ______Unknown

9. Owner Inspections

a. Are there periodic inspections of all dwellings by the owner?

______ Yes ______ No If yes, how often? _____________________________

b. Is the paint condition assessed during these inspections?

______ Yes ______ No

10. Have any of the dwellings ever received a housing code violation notice?

______ Yes ______ No ______ Unknown

If yes, describe code violation____

11. If previously detected, unabated lead-based paint exists in the dwelling, have the residents been informed?

______ Yes ______ No ______Not Applicable

Form 5.7
Maintenance Data for Rental Dwellings

Recorded during onsite investigation.

1. Condition of paint on selected surfaces

Building component	Paint condition (intact, fair, poor, or not present) to be completed by risk assessor	Deterioration due to friction or impact	Deterioration due to moisture	Location of painted component with visible bite marks
Building siding				
Exterior trim				
Exterior windows				
Exterior doors				
Railings				
Porch floors				
Other porch surfaces				
Interior doors				
Ceilings				
Walls				
Interior windows				
Interior floors				
Interior trim				
Stairways				
Radiator (or radiator cover)				
Kitchen cabinets				
Bathroom cabinets				
Other surfaces:				

If the overall condition of a component is similar throughout a dwelling, that condition should be recorded. If a component in a couple of locations is in poor condition, but the overall condition is good or fair, the specific sites of the badly deteriorated paint should be noted. The specific locations of any component with bite marks should be recorded.

Form 5.7 (continued)

2. Painting frequency and methods
   a. How often is painting completed? every __________ years
   b. Is painting completed upon vacancy, if necessary?
      ______ Yes ______ No
   c. Who does the painting? _______Property Owner _______Residents
      (If residents, skip to Question 2)
   d. Is painting accompanied by scraping, sanding, or paint removal?
      ______ Yes ______ No
   e. How are paint dust/chips cleaned up? (check one)
      ______ Sweeping ______ Vacuum ______ Mopping ______ HEPA/wet wash/HEPA cycle
   f. Is the work area sealed off during painting?
      ______ Yes ______ No
   g. Is furniture removed from the work area?
      ______ Yes ______ No
   h. If no, is furniture covered with plastic during work?
      ______ Yes ______ No
3. Is there a preventive maintenance program?
   ______ Yes ______ No
4. Describe work order system (if applicable, attach copy of work order form).

   ____

   ____

   ____
5. How are resident complaints received and addressed? How are requests prioritized? If formal work orders are issued, is the presence or potential presence of lead-based paint considered in the work instructions?

   ____

   ____

   ____
6. Record location of dwellings recently prepared for reoccupancy.

   ________________ ________________ ________________

Chapter 6: Ongoing Monitoring

Ongoing Monitoring: How To Do It

1. Ongoing monitoring is required in all dwellings where lead-based paint is known or suspected to be present, regardless of the paint's present condition. Ongoing monitoring is not required in dwellings that are known to be free of lead-based paint.

2. Ongoing monitoring consists of reevaluations performed by certified risk assessors *and* visual surveys conducted by owners.

3. Reevaluations should be performed in accordance with the Standard Reevaluation Schedules contained in this chapter. The schedules differ based on the probability that lead-based paint hazards will reappear in a given dwelling. High-risk dwellings will require more frequent reevaluations.

4. When performing a reevaluation, risk assessors should do the following:

   - Review any previous risk assessment, paint inspection, clearance examination, or reevaluation report.
   - Conduct a visual examination of all existing lead-based paint hazard controls, *all* surfaces that are known or suspected to be coated with lead-based paint, and any soil. Any necessary repairs should be completed *before* dust sampling.
   - Collect at least two composite dust-wipe samples, one from the floors and the other from either the window troughs or the interior window sills. Each composite sample should contain no more than four subsamples. The sampling locations should be selected using the criteria in Chapter 5 and based on the professional judgment of the risk assessor.
   - Document the presence or absence of lead-based paint hazards in the reevaluation report and indicate when the next reevaluation (if any) should be scheduled (based on Table 6.1).

5. Visual surveys should be conducted by owners or their representatives at the following times:

   - Whenever the owner receives a resident complaint.
   - Whenever the dwelling turns over or becomes vacant.
   - Whenever significant damage occurs (i.e., flooding, vandalism, fire, etc.).
   - At least once every year.

6. When conducting a visual survey, the owner should examine all painted surfaces, all lead-based paint hazard controls, and all ground cover. Chapter 5 contains information on how to recognize lead-based paint hazards. The results of the visual survey and any corrective measures being taken should be documented.

Chapter 6: Ongoing Monitoring

I. Purpose

If lead-based paint is not in a hazardous condition and dust and soil lead levels are below the levels listed in Table 5.7, no hazard is present and no active control measures are necessary. However, paint can deteriorate through normal use and maintenance activity, thereby releasing dust and contaminating soil. Therefore, ongoing monitoring is necessary in *all* dwellings in which lead-based paint is known or suspected to be present. This applies both to dwellings that pass clearance tests after hazard control, as well as dwellings where an initial risk assessment found no lead-based paint hazards, but where lead-based paint may be present. In both cases, the potential exists for lead-based paint hazards to develop since hazard control methods can fail, previously intact lead-based paint can become deteriorated, and leaded dust can reaccumulate through friction, impact, or the introduction of exterior dust and soil. This chapter describes recommended procedures for managing lead-based paint so that it remains controlled and in a nonhazardous condition.

The ongoing monitoring procedures described in this chapter generally do not apply to dwellings found to contain *no* lead-based paint and where the levels of lead in dust and soil are below applicable standards. While it is conceivable that dwellings that contain no lead-based paint could develop elevated levels of leaded dust from other sources, HUD does not believe that ongoing monitoring of dust lead levels in all dwellings is warranted at this time. In other words, dwellings that are not suspected of containing lead-based paint are thought to be at relatively low risk.

Ongoing monitoring includes two different activities:

- Reevaluation.
- Annual Visual Surveys.

A. Reevaluation

In general terms, a reevaluation is a risk assessment that includes more limited soil and dust sampling, and a detailed visual examination of paint films and any existing lead hazard controls (such as enclosures). The reevaluation should be conducted by a certified risk assessor and should include both a visual examination and environmental sampling for lead-contaminated dust (and sometimes soil). Reevaluations are performed only in dwellings where lead-based paint is known or expected to exist, or where lead-based paint *hazards* have been found to be nonexistent (i.e., where a previous risk assessment, risk assessment/inspection combination, or clearance examination have shown the dwelling to be free of lead-based paint hazards).

Reevaluation occurs at specific intervals, which are specified in Section II below. These schedules are based on the likelihood of lead-based paint hazards reappearing. For example, low-risk dwellings require only infrequent reevaluations while high-risk dwellings should be reevaluated more frequently. The schedules are based on dwelling-specific criteria (e.g., types of hazards found, control actions taken, prior reevaluation results). This chapter also includes a section on a Reevaluation Protocol.

B. Annual Visual Surveys

Reevaluations are supplemented with visual surveys by the owner (or owner's representative), which should be conducted at least once a year. Visual surveys do not replace reevaluations. The goal of visual surveys is to confirm that:

- Painted surfaces with known or suspected lead-based paint are not deteriorating.
- Control methods such as encapsulation and enclosure have not failed.
- Structural problems (e.g., water leaks) do not threaten the integrity of any remaining known or suspected lead-based paint.

Visual surveys should also be conducted whenever the owner receives complaints from residents about potential lead hazards, the dwelling turns over or becomes vacant, or significant damage occurs that could affect the integrity of control treatments (e.g., flooding, vandalism, fire). Property owners are responsible for ensuring that these annual visual surveys are completed. Owners need not use a certified risk assessor to conduct the visual survey, unless required by local law.

Chapter 5 contains information on how to visually evaluate the condition of paint. Only paint that is found to be in "poor" condition—using the surface area criteria in Table 5.4—needs to be addressed, although paint in "fair" condition will probably become "poor" if not stabilized promptly. In addition, Chapter 11 describes some of the structural problems that could cause premature paint failure.

If visual surveys are done with care, the subsequent reevaluation will not find any deteriorated paint or failed hazard control treatments, thereby substantially reducing the cost to the owner.

C. Ongoing Maintenance and Management Practices

Owners should maintain all dwellings in good condition by following the maintenance and management practices described in Chapters 11 and 17. Such practices include:

- High-efficiency particulate air (HEPA) vacuuming, wet mopping, and cleaning of floors, window troughs, and interior window sills at turnover.
- Providing lead-based paint hazard information to new residents.
- Installing a washable doormat inside the primary entrance to the unit or inside entrances to a multifamily building.
- Maintaining ground cover.
- Encouraging residents to report any signs of paint deterioration or failure of hazard control treatments.

D. Dwellings Exempt From Ongoing Monitoring

Monitoring can be discontinued when any one of the following has occurred:

- A combined risk assessment/inspection determines no lead-based paint is present in the unit, and soil and dust levels are below applicable limits.
- All building components with lead-based paint are removed and/or all lead-based paint is abated and a risk assessor or inspector technician determines that soil and dust lead levels are below applicable limits.
- All reevaluations specified in Table 6.1 are completed; such dwellings are then subject only to annual visual surveys. (Reevaluation exemptions cannot be transferred from one owner to another, since maintenance and management activities often change with new ownership.)

II. Standard Reevaluation Schedules

The Standard Reevaluation Schedules (SRS) describe how frequently a certified risk assessor should reevaluate a dwelling. If a property owner wants or needs written verification, such as a Statement of Compliance, this schedule may determine the expiration date of the Statement, depending upon applicable regulations.

The potential for the development of lead hazards varies from dwelling to dwelling, depending upon the nature of the hazards detected, the hazard controls implemented, and the risk assessment and reevaluation results. Different reevaluation strategies are needed to respond to each specific unit. Risk assessors should follow a Standard Reevaluation Schedule when making recommendations to owners.

A. How To Use the Schedules

Risk assessors conducting an initial evaluation should consult the SRS in Table 6.1 and inform the property owner of the reevaluation implications of different hazard control strategies, since this will provide the owner with important information on long-term costs. For each dwelling the risk assessor should determine which schedule applies by reviewing the "Evaluation Results" column and "Action Taken" column. For those situations where more than one schedule applies, the risk assessor should choose the most conservative schedule (i.e., the one that calls for the greatest number of reevaluations) or, if the number of reevaluations is the same, the risk assessor should choose the applicable schedule calling for reevaluation at the earliest date. For the purposes of Table 6.1, the term "evaluation" includes: (1) a risk assessment (or lead hazard screen) before hazard control, (2) a risk assessment conducted at the time of clearance (if the owner has bypassed a risk assessment before hazard control), (3) a reevaluation, or (4) an evaluation of a dwelling housing a child with an elevated blood lead level. The results of the visual assessment and soil and dust tests collected as part of this combined clearance/risk assessment evaluation should be used to determine the appropriate schedule in Table 6.1.

For example, consider a unit that falls into Schedule 3 (i.e., a risk assessor finds dust levels that are greater than the applicable standard, but by less than a factor of 10, and detects deteriorated paint that contains lead above the standard). The owner chooses to stabilize the paint and remove the dust using the procedures in Chapter 11. In this case, the unit should be reevaluated after 1 year. If the reevaluation detects no hazards, a final reevaluation should be performed 2 years later. If the unit successfully passes every reevaluation, only annual visual surveys are needed thereafter. If the unit fails any reevaluation (i.e., lead hazards are found), then the findings of the reevaluation combined with the action taken will dictate which schedule should be applied.

For a unit in Schedule 2, only one reevaluation at the end of 3 years is required; if no hazards are found, no further reevaluations are needed. Only annual surveys by the owner should be done.

B. Principles on Which the Schedules Are Based

The varying reevaluation intervals prescribed by the schedules have been determined by considering the likelihood that a dwelling contains or will contain lead-based paint hazards. Dwellings with a lower probability of developing lead-based paint hazards (either because no hazards were found or all hazards were dealt with through long-term abatement methods) are subject to fewer reevaluations and a less frequent reevaluation schedule than dwellings with a higher probability of developing such hazards. Dwellings in which short-term interim controls were instituted and/or where high levels of interior leaded dust have been found are subject to shorter reevaluation intervals and a greater number of reevaluations. Once the specified reevaluations are successfully completed, only visual monitoring is needed.

The schedules are based on the following principles:

- Explicit reevaluation intervals are needed to ensure consistency across dwellings and to provide clear criteria for risk assessors in determining when a unit should be reevaluated.
- Dwellings that pass a risk assessment or reevaluation require less frequent reevaluations than dwellings that fail.
- The presence of leaded dust in excess of applicable standards shortens the reevaluation interval since it indicates an immediately available source of exposure for occupants, especially children.
- The expected duration of hazard control actions affects the reevaluation interval; less frequent reevaluation is needed when more permanent abatement methods are implemented over interim controls that have a shorter lifespan. For example, a longer reevaluation interval is specified when windows with lead-based paint are replaced in order to provide an incentive for permanent abatement, since windows are thought to be significant sources of leaded dust.

- If all lead hazards are controlled through encapsulation or enclosure (and leaded dust levels prior to hazard control were below the standard), then only annual visual surveys are recommended because failure of these methods is usually obvious.
- Repeated reevaluation failures will result in the assignment of the shortest possible reevaluation interval and may be an indication that the selected hazard control measures are inadequate for the unit in question.
- Full removal of all lead-based paint requires no reevaluation or monitoring, since new hazards are very unlikely.

III. Reevaluation Protocol

This section discusses how reevaluations should be conducted. Reevaluations determine if the following conditions have reappeared:

- Leaded dust above applicable standards.
- Deteriorated paint films with known or suspected lead-based paint.
- Deteriorated or failed interim controls, or encapsulant or enclosure treatments.
- New bare soil with lead levels above applicable standards.

These conditions can be detected through a visual examination, as well as through the use of limited dust and soil sampling.

A. Visual Examination

The certified risk assessor conducting the reevaluation should begin by reviewing any past risk assessment, paint inspection, clearance, and reevaluation reports. If other information describing the lead hazard control actions in use is available, this information should also be reviewed. A careful visual examination of all control measures and any known or suspected lead-based paint should then be conducted to determine if the paint is still intact and the controls are well maintained. If any lead hazard control measure is failing (e.g., an encapsulant is peeling away from the wall, a painted surface is no longer stabilized, or an enclosure has been breached), the risk assessor conducting the reevaluation should identify acceptable options for controlling the hazard.

If a paint inspection was conducted previously, the risk assessor should use this information to discover whether any of the surfaces known to contain lead-based paint are now in a deteriorated condition. If no inspection has occurred, then the assessor should assume that all painted surfaces contain lead-based paint and should consider any deteriorated paint to be a newly identified lead hazard. Alternatively, the deteriorated paint can be measured by x-ray fluorescence (XRF) or paint-chip laboratory analysis as described in Chapters 5 and 7.

B. Dust Sampling

When all lead hazard controls appear to be in place from a visual examination, the risk assessor can begin dust sampling. If lead hazard controls are not in place, they should be repaired before any dust sampling occurs. Dust measurements are intended not only to determine the effectiveness of the control measures in use, but also to determine if leaded dust has reaccumulated from other sources.

For reevaluations, composite dust sampling is encouraged as a cost-effective measure. At least two composite samples should be taken, one from floors and the other from either interior window sills or window troughs. The rules on composite dust sampling can be found in Chapter 5.

Samples should be collected from the locations identified in Chapter 5, or from any other area that, in the professional judgment of the risk assessor, may contain elevated leaded dust levels.

C. Soil Sampling

Soil sampling is not usually conducted for reevaluation, since the visual examination will discover if previously covered areas are now bare or if the interim controls implemented to cover soil are not working. If bare spots are identified, the risk assessor should recommend that the owner cover the bare spots and conduct more frequent (e.g., monthly) visual surveys to ensure that the soil stays covered. If the visual surveys indicate that soil is not staying covered, more permanent soil treatments should be recommended (i.e., paving or removal).

D. Newly Identified Hazards

Since the risk assessor must document the presence or absence of any lead-based paint hazards, both new hazards and previously controlled hazards should be investigated. If deteriorated paint is discovered and no previous information exists about the lead content of the paint (or the information is inconclusive), the risk assessor should recommend that the spot either be tested or stabilized. If the paint contains lead above the applicable standard, the risk assessor should provide the owner with a range of interim control and abatement options.

E. Reevaluation Results

The risk assessor conducting the reevaluation should produce a report documenting the presence or absence of lead-based paint hazards. The report should identify any lead hazards previously detected and controlled and the efficacy of these interventions. Any new hazards should also be described and the risk assessor should present the owner with suggested control options and their accompanying reevaluation schedules. In all cases the report should identify when the next reevaluation should occur, if further monitoring is necessary.

F. Sampling in Multifamily Dwellings

Reevaluations in multifamily dwellings should target different units than those sampled previously. The criteria for worst-case sampling discussed in Chapter 5 should be used for this purpose.

IV. Compliance Verification

Some property owners may choose or be required (e.g., by an insurance company or State or local government) to obtain documentation that the housing unit remains in compliance with established standards. To document such compliance, every reevaluation should be performed on schedule by a licensed, independent risk assessor who should provide the owner with a Statement of Compliance. For those dwellings subject to periodic reevaluation (see Table 6.1) the duration of the Statement could be set according to the prescribed SRS interval, depending on local laws and the specific underwriting standard. Alternatively, after a record of compliance has been established, regulators or underwriters could simply require reevaluations at 10-year intervals.

Table 6.1 Standard Reevaluation Schedules

Schedule	Evaluation Results	Action Taken	Reevaluation Frequency and Duration	Visual Survey (by owner or owner's representative)
1	Combination risk assessment/inspection finds no leaded dust or soil and no lead-based paint.	None.	None.	None.
2	No lead-based paint hazards found during risk assessment conducted before hazard control or at clearance (hazards include dust and soil).	None.	3 Years.	Annually and whenever information indicates a possible problem .
3	The average of leaded dust levels on all floors, interior window sills, or window troughs sampled exceeds the applicable standard, but by less than a factor of 10.	A. Interim controls and/or hazard abatement (or mixture of the two), including, but not necessarily limited to, dust removal. This schedule does not include window replacement.	1 Year, 2 Years.	Same as Schedule 2, except for encapsulants. The first visual survey of encapsulants should be done one month after clearance; the second should be done 6 months later and annually thereafter.
		B. Treatments specified in section A plus replacement of all windows with lead hazards.	1 Year.	
		C. Abatement of all lead-based paint using encapsulation or enclosure.	None.	Same as Schedule 3 above.
		D. Removal of all lead-based paint.	None.	None.
4	The average of leaded dust levels on all floors, interior window sills, or window troughs sampled exceeds the applicable standard by a factor of 10 or more.	A. Interim controls and/or hazard abatement (or mixture of the two), including, but not necessarily limited to dust removal. This schedule does not include window replacement.	6 Months, 1 Year, 2 Years.	Same as Schedule 3.
		B. Treatments specified in section A plus replacement of all windows with lead hazards.	6 Months, 2 Years.	Same as Schedule 3.
		C. Abatement of all lead-based paint using encapsulation and enclosure.	None.	Same as Schedule 3.
		D. Removal of all lead-based paint.	None.	None.

Table 6.1 Standard Reevaluation Schedules (continued)

Schedule	Evaluation Results	Action Taken	Reevaluation Frequency and Duration	Visual Survey (by owner or owner's representative)
5	No leaded dust or leaded soil hazards identified, but lead-based paint or lead-based paint hazards are found.	A. Interim controls or mixture of interim controls and abatement (not including window replacement).	2 Years.	Same as Schedule 3.
		B. Mixture of interim controls and abatement, including window replacement.	3 Years.	Same as Schedule 3.
		C. Abatement of all lead-based paint *hazards*, but not all lead-based paint.	4 Years.	Same as Schedule 3.
		D. Abatement of all lead-based paint using encapsulation or enclosure.	None.	Same as Schedule 3.
		E. Removal of all lead-based paint.	None.	None.
6	Bare leaded soil exceeds standard, but less than 5,000 µg/g.	Interim controls.	None.	Three months to check new ground cover, then annually to identify new bare spots.
7	Bare leaded soil greater than or equal to 5,000 µg/g.	Abatement (paving or removal).	None.	None for removal, annually to identify new bare spots or deterioration of paving.

See notes to table 6.1 on following page.

Notes to Table 6.1:

1. When more than one schedule applies to a dwelling, use the one with the most stringent reevaluation schedule. Do not use the results of a reevaluation for Schedule 2.

2. A lead-based paint hazard includes, but is not limited to, deteriorated lead-based paint and leaded dust and soil above applicable standards. See the Glossary for a more complete definition.

3. The frequency of reevaluations and the interval between reevaluations depends on the findings at each reevaluation and the action taken. For example, a dwelling unit or common area falling under Schedule 3.A would be reevaluated 1 year after clearance. If no lead-based paint hazards are detected at that time, the unit or area would be reevaluated again 2 years after the first reevaluation. If no hazards are found in the second reevaluation, no further reevaluation is necessary, but annual visual monitoring should continue.

   If, on the other hand, the unit or common area fails a reevaluation, a new reevaluation schedule should be determined based on the results of the reevaluation and the action taken. For instance, if the re-evaluation finds deteriorated lead-based paint but no lead-contaminated dust, and the action taken is paint stabilization, Schedule 5.A would apply, which indicates that the next reevaluation should be in 2 years. If, however, the owner of this same property decides to abate all lead-based paint hazards instead of doing only paint stabilization, the property would move to Schedule 5.C, which calls for reevaluation 4 years from the date of clearance after the hazard abatement.

   Following another scenario, suppose a reevaluation of this same dwelling unit or common area finds that the average dust lead levels on sampled window troughs exceeds the applicable standard by a factor of 10 or more, but no other lead-based paint hazards. The owner conducts dust removal. In this case the next reevaluation would be 6 months after clearance followed by another a year later, followed by yet another 2 years later, as indicated by Schedule 4.A.

4. The initial evaluation results determine which reevaluation schedule should be applied. An initial evaluation can be a risk assessment, a risk assessment/ inspection combination, or, if the owner has opted to bypass the initial evaluation and proceed directly to controlling suspected hazards, a combination risk assessment/clearance examination. This type of clearance must be conducted by a certified risk assessor, who should determine if all hazards were in fact controlled. The results of the initial clearance dust tests, soil sampling and visual examination should be used to determine the appropriate schedule. If repeated cleaning was necessary to achieve clearance, use the results of the dust tests *before* repeated cleaning was performed for schedule determination.

5. If a unit fails two consecutive reevaluations, the reevaluation interval should be reduced by half and the number of reevaluations should be doubled. If deteriorated lead-based paint hazards continue to occur, then the offending components/surfaces should be abated. If dwellings with dust hazards but no paint-related hazards repeatedly fail reevaluations, the exterior source should be identified (if identification efforts fail, regular dust removal efforts are needed).

U.S. Department of Housing and Urban Development

Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing

Chapter 7: Lead-Based Paint Inspection

1997 Revision

Chapter 7: Lead-Based Paint Inspection
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Step-by-Step Summary

Lead-Based Paint Inspection:
How to Do It

Note: This 1997 Revision replaces Chapter 7 of the 1995 *HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*

1. See Chapters 3, 5 and 16 for guidance on when a lead-based paint inspection is appropriate. A lead-based paint inspection will determine:

   - Whether lead-based paint is present in a house, dwelling unit, residential building, or housing development, including common areas and exterior surfaces; and

   - If present, which building components contain lead-based paint.

   The U.S. Department of Housing and Urban Development (HUD) and the U.S. Environmental Protection Agency (EPA) define an inspection as a surface-by-surface investigation to determine the presence of lead-based paint (see 40 CFR part 745 and Title X of the 1992 Housing and Community Development Act). The sampling protocols in this chapter fulfill that definition.

2. The client should hire a certified (licensed) lead-based paint inspector or risk assessor (see 40 CFR part 745). Lists of inspectors and laboratories can be obtained by calling 1-888-LEADLIST or through the Internet at www.leadlisting.org. Lists are also available through State agencies (call 1-800-LEAD-FYI for the appropriate local contact). More than half of all States now require a license or certification to perform a lead-based paint inspection. If the State does not yet have a certification law, an inspector or risk assessor certified under another State's law should be used. By the fall of 1999, all lead-based paint inspections must be performed by a certified lead-based paint inspector or risk assessor in accordance with 40 CFR part 745, section 227.

3. The inspector should use the HUD/EPA standard for lead-based paint of 1.0 mg/cm^2 or 0.5% by weight, as defined by Title X of the 1992 Housing and Community Development Act. If the applicable standard in the jurisdiction is different, the procedures in this chapter will need to be modified. For the purposes of the HUD/EPA lead-based paint disclosure rule, 1.0 milligrams per square centimeter (mg/cm^2) or 0.5% by weight are the standards that must be used.

4. Obtain the *XRF Performance Characteristic Sheet* for the X-Ray Fluorescence (XRF) lead paint analyzer to be used in the inspection. It will specify the ranges where XRF results are positive, negative or inconclusive, the calibration check tolerances, and other important information. Contact the National Lead Information Center Clearinghouse (1-800-424-LEAD) to obtain the appropriate *XRF Performance Characteristic Sheet*, or download it from the Internet at www.hud.gov/lea/leahome.html. *XRF Performance Characteristic Sheets* have been developed by HUD and EPA for most commercially available XRFs (see Addendum 3 of this chapter).

5. Report lead paint amounts in mg/cm^2 because this unit of measurement does not depend on the number of layers of non-lead-based paint and can usually be obtained without damaging the painted surface. All measurements of

lead in paint should be in mg/cm², unless the surface area cannot be measured or if all paint cannot be removed from the measured surface area. In such cases, concentrations may be reported in weight percent (%) or parts per million by weight (ppm).

6. Follow the radiation safety procedures explained in this chapter, and as required by the U.S. Nuclear Regulatory Commission and applicable State and local regulations when using XRF instruments.

7. Take at least three calibration check readings before beginning the inspection. Additional calibration check readings should be made every 4 hours or after inspection work has been completed for the day, or according to the manufacturer's instructions, whichever is most frequent. Calibration checks should always be done before the instrument is turned off and again after it has been warmed up (calibration checks do not need to be done each time an instrument enters an automatic "sleep" state while still powered on).

8. When conducting an inspection in a multifamily housing development or building, obtain a complete list of all housing units, common areas, and exterior site areas. Determine which can be grouped together for inspection purposes based on similarity of construction materials and common painting histories. In each group of similar units, similar common areas, and similar exterior sites, determine the minimum number of each to be inspected from the tables in this chapter. Random selection procedures are explained in this chapter.

9. For each unit, common area, and exterior site to be inspected, identify all testing combinations in each room equivalent. A testing combination is characterized by the room equivalent, the component type, and the substrate. A room equivalent is an identifiable part of a residence (e.g., room, house exterior, foyer, etc.). Painted surfaces include any surface coated with paint, shellac, varnish, stain, paint covered by wallpaper, or any other coating. Wallpaper should be assumed to cover paint unless building records or physical evidence indicates no paint is present.

10. Take at least one individual XRF reading on each testing combination in each room equivalent. For walls, take at least four readings (one reading on each wall) in each room equivalent. A different visible color does not by itself result in a separate testing combination. It is not necessary to take multiple XRF readings on the same spot, as was recommended in the 1990 Interim Guidelines for Public and Indian Housing.

11. Determine whether to correct the XRF readings for substrate interference by consulting the *XRF Performance Characteristic Sheet*. If test results for a given substrate fall within the substrate correction range, take readings on that bare substrate scraped completely clean of paint, as explained in this chapter.

12. Classify XRF results for each testing combination. Readings above the upper limit of the inconclusive range are considered positive, while readings below the lower limit of the inconclusive range are considered negative. Readings within the inconclusive range (including its boundary values) are classified as inconclusive. Some instruments have a threshold value separating ranges of readings considered positive from readings considered negative for a given substrate. Readings at or above the threshold are considered positive, while readings below the threshold are considered negative.

13. In single-family housing inspections, all inconclusive readings must be confirmed in the laboratory, unless the client wishes to assume that all inconclusive results are positive. Such an assumption may reduce the cost of an inspection, but it will probably increase subsequent abatement, interim control, and maintenance costs, because laboratory analysis often shows that testing combinations with inconclusive readings do not in fact contain lead-based paint. Inconclusive readings cannot be assumed to be negative.

14. In multifamily dwelling inspections, XRF readings are aggregated across units and room equivalents by component type. Use the flowchart provided in this chapter (Figure 7.1) to make classifications of all testing combinations or component types in the development as a whole, based on the percentages of positive, negative, and inconclusive readings.

15. If the inspector collected paint-chip samples for analysis, they should be analyzed by a laboratory recognized under the EPA's National Lead Laboratory Accreditation Program (NLLAP). Paint-chip samples are collected when the overall results for a component type are inconclusive. They may be collected by a properly trained and certified inspector, client, or third party, if permitted by State law. Paint-chip samples should contain all layers of paint (not just peeled layers) and must always include the bottom layer. If results will be reported in mg/cm^2, including a small amount of substrate with the sample will not significantly bias results. Substrate material should not, however, be included in samples reported in weight percent. Paint from 4 square inches (25 square centimeters) should provide a sufficient quantity for laboratory analysis. Smaller surface areas may be used, if the laboratory indicates that a smaller sample is acceptable. In all cases, the surface area sampled must be recorded.

16. The client or client's representative should evaluate the quality of the inspection using the procedures in this chapter.

17. The inspector should write an inspection report indicating if and where lead-based paint is located in the unit or the housing development (or building). The report should include a statement that the presence of lead-based paint must be disclosed to potential new buyers (purchasers) and renters (lessees) prior to obligation under a sales contract or lease, based on Federal law (see 24 CFR part 35, subpart H or 40 CFR part 745, subpart F). The suggested language below may be used. The inspection report should contain detailed information on the following:

    - Who performed the inspection;
    - Date(s);
    - Inspector's certification number;
    - All XRF readings;
    - Classification of all surfaces into positive or negative (but not inconclusive) categories, based on XRF and laboratory analyses;
    - Specific information on the XRF and laboratory methodologies;
    - Housing unit and sampling location identifiers;
    - Results of any laboratory analyses; and
    - Additional information described in Section IV of this chapter.

This chapter also contains language that may be used in an inspection report in the case where no lead-based paint has been identified (see the suggested language below).

Recommended Report Language On Disclosure For Use In Lead-Based Paint Inspections

"A copy of this summary must be provided to new lessees (tenants) and purchasers of this property under Federal law (24 CFR part 35 and 40 CFR part 745) before they become obligated under a lease or sales contract. The complete report must also be provided to new purchasers and it must be made available to new tenants. Landlords (lessors) and sellers are also required to distribute an educational pamphlet approved by the U.S. Environmental Protection Agency and include standard warning language in their leases or sales contracts to ensure that parents have the information they need to protect their children from lead-based paint hazards."

(See Section IV of Chapter 7 of the HUD *Guidelines* for further details)

Recommended Report Language for Inspections Where No Lead-Based Paint Was Identified

"The results of this inspection indicate that no lead in amounts greater than or equal to 1.0 mg/cm² in paint was found on any building components, using the inspection protocol in Chapter 7 of the *HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing (1997 Revision)*. Therefore, this dwelling qualifies for the exemption in 24 CFR part 35 and 40 CFR part 745 for target housing being leased that is free of lead-based paint, as defined in the rule. However, some painted surfaces may contain levels of lead below 1.0 mg/cm², which could create lead dust or lead-contaminated soil hazards if the paint is turned into dust by abrasion, scraping, or sanding. This report should be kept by the inspector and should also be kept by the owner and all future owners for the life of the dwelling."

(See Section IV of Chapter 7 of the HUD *Guidelines* for further details)

Chapter 7: Lead-Based Paint Inspection

Note: This 1997 Revision replaces Chapter 7 of the 1995 *HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*

I. Introduction

A. Purpose

This chapter explains methods for performing lead-based paint inspections in housing to determine:

- Whether lead-based paint is present in a house, dwelling unit, residential building, or housing development, including common areas and exterior surfaces; and

- If present, which building components contain lead-based paint.

The information presented here is intended for both inspectors and persons who purchase inspection services (clients). Both an inspection protocol and methods for determining the quality of an inspection are provided. Means for locating certified lead inspectors are also described.

1. Disclosure of Inspections

Federal law now requires that the results of lead-based paint inspections and risk assessments be disclosed to prospective renters (lessees, tenants) entering into a new lease and renters renewing an old lease, and to prospective purchasers prior to obligation under a sales contract, if lead-based paint is found. If the inspection described in this chapter finds that lead-based paint is not present in units which are to be leased, the dwelling unit and, for multifamily housing, all other dwelling units characterized by the inspection are exempt from disclosure requirements. However, for dwelling units which are being sold (not leased), the owner still has certain legal responsibilities to fulfill under Federal law *even if no lead-based paint is identified*. See the HUD and EPA regulations in 24 CFR part 35 or 40 CFR part 745, respectively, for additional details.

You may contact the National Lead Information Center Clearinghouse (1-800-424-LEAD) to obtain HUD and EPA brochures, question-and-answer booklets, the regulations mentioned above (and the descriptive preamble to those regulations), and other information on lead-based paint disclosure. See Section IV for recommended inspection report language regarding these disclosure requirements.

2. Limitation of this Inspection Protocol

The protocol described here is not intended for investigating housing units where children with elevated blood lead levels are currently residing. Such a protocol can be found in Chapter 16 or may be available from a State or local health department.

3. Documentation of Results

The complete set of forms provided at the end of this chapter may be used in single-family and multifamily housing. Equivalent forms or computerized reports may also be used to document the results of inspections.

B. Qualifications of Inspectors and Laboratories

1. Where to Find Inspectors and Laboratories

Lists of State-licensed (certified) inspectors and accredited laboratories recognized under the U.S. Environmental Protection Agency (EPA) National Lead Laboratory Accreditation Program (NLLAP) are often available from State or local agencies. Call the National Lead Information Center Clearinghouse (1-800-424-LEAD) to locate the appropriate local contact.

A nationwide listing of certified inspectors, risk assessors, and accredited laboratories is also available on the Internet at www.leadlisting.org. The lists are also available through an automated telephone system by calling 1-888-LEADLIST (1-888-532-3547).

2. Qualifications of Inspectors

The inspector must be certified (licensed) in lead-based paint inspection by the State where the testing is to be done if it has an inspection certification program; if the State does not have such a program, the inspector should be certified by another State. Currently, more than half of all States have such licensing laws. By the fall of 1999, all lead-based paint inspections must be performed only by a certified lead-based paint inspector or risk assessor in accordance with the work practices of 40 CFR part 745, section 227 (see the regulation for specific effective dates for States and Indian Tribes).

C. Other Sources of Information Required to Use This Protocol

The other sources of information and materials needed for using this protocol include an *XRF Performance Characteristic Sheet*, U.S. Nuclear Regulatory Commission and State radiation protection regulations, and standards issued by the American Society for Testing and Materials (ASTM). The National Institute of Standards and Technology (NIST) produces Standard Reference Materials (SRMs) and provides supporting documentation for these materials.

1. XRF Performance Characteristic Sheet

An *XRF Performance Characteristic Sheet* defines acceptable operating specifications and procedures for each model of X-Ray Fluorescence (XRF) lead-based paint analyzer. An inspector should follow the *XRF Performance Characteristic Sheet* for all inspection activities. For most commercially available XRFs, *XRF Performance Characteristic Sheets* are available from the National Lead Information Center Clearinghouse or through the Internet at www.hud.gov/lea/leahome.html. They are also included in a new, easy-to-use format in Addendum 3 to this chapter.

2. XRF Radiation Protection Regulations

Regulations that govern radioactive sources used in XRFs are available from State radiation protection agencies, and the Nuclear Regulatory Commission (301-415-7000).

3. ASTM and NIST Standards

Other helpful information and standards are available from ASTM (610-832-9585), including:

- ASTM E 1583 on evaluating laboratories used to determine lead levels
- ASTM E 1605 on terminology
- ASTM E 1613 on determining lead by atomic emission or atomic absorption spectroscopy
- ASTM E 1645 on laboratory preparation of paint-chip samples
- ASTM E 1729 on collecting paint-chip samples
- ASTM E 1775 on-site extraction and field-portable stripping voltammetry analysis for lead
- ASTM PS 53 on identifying and managing lead in facilities
- ASTM PS 87 on ultrasonic extraction for later analysis for lead
- ASTM PS 88 on determining lead by portable electroanalysis

NIST (301-975-6776) has developed series of paint films that have known amounts of lead-based paint and can be used for calibration check purposes. NIST Standard Reference Material 2579 is available as of mid-1997; NIST is planning to release additional series of paint films in late 1997 or early 1998 (see Section IV.D, below).

D. Paint Testing for Inspections and Risk Assessments

Risk assessments determine the presence of lead-based paint *hazards*, while inspections determine the presence of lead-based paint. The paint-chip sampling and measurement techniques used for paint inspections are similar to the techniques used for risk assessment. However, the number of paint measurements or samples taken for a paint inspection is considerably greater than the number of paint samples required for a risk assessment, because risk assessments measure lead only in deteriorated paint (risk assessments also measure lead in dust and soil). Inspections measure lead in both deteriorated and intact paint, which involves many more surfaces. Risk assessments always note the condition of paint films; inspections may not. For dwellings in good condition, a full risk assessment may be unnecessary, and a lead hazard screen risk assessment may be conducted. In a lead hazard screen or risk assessment, the certified risk assessor tests only painted surfaces in "deteriorated" condition for their lead content, either by XRF or laboratory analysis. See Chapter 5 for methods to determine the condition of paint films when conducting a risk assessment.

E. Most Common Inspection Method

Portable XRF lead-based paint analyzers are the most common primary analytical method for inspections in housing because of their demonstrated abilities to determine if lead-based paint is present on many surfaces and to measure the paint without destructive sampling or paint removal, as well as their high speed and low cost per sample. Portable XRF instruments expose a building component to X rays or gamma radiation, which causes lead to emit X rays with a characteristic frequency or energy. The intensity of this radiation is measured by the instrument; the inspector must then compare this displayed value (reading) with the inconclusive range or threshold specified in the *XRF Performance Characteristic Sheet* for the specific XRF instrument being used, and the specific substrate beneath the painted surface (see Section IV.G, below). If the reading is less than the lower boundary of the inconclusive range, or less than the threshold, then the reading is considered negative. If the reading is greater than the upper boundary of the inconclusive range, or greater than or equal to the threshold, then the reading is considered positive. Readings within the inconclusive range, including its boundary values, are considered inconclusive. Because the inconclusive ranges and/or thresholds shown in the Performance Characteristic Sheet are based on 1.0 mg/cm², positive and negative readings are consistent with the HUD definition of lead-based paint for identification and disclosure purposes.

F. XRF Performance Characteristic Sheets and Manufacturer's Instructions

Only XRF instruments that have a HUD/EPA-issued or equivalent *XRF Performance Characteristic Sheet* should be used. XRFs must be used in accordance with the manufacturer's instructions and the *XRF Performance Characteristic Sheet*. The *XRF Performance Characteristic Sheet* contains information about XRF readings taken on specific substrates, calibration check tolerances, interpretation of XRF readings (see section I.E, above), and other aspects of the model's performance. If discrepancies exist between the *XRF Performance Characteristic Sheet*, the HUD *Guidelines* and the manufacturer's instructions, the most stringent guidelines should be followed. For example, if the *XRF Performance Characteristic Sheet* has a lower (more stringent) calibration check tolerance than the manufacturer’s instructions, the *XRF Performance Characteristic Sheet* should be followed. These *Guidelines* and the *XRF Performance Characteristic Sheets* are applicable to all XRF instruments that detect K X rays, L X rays, or both.[1]

G. Inspection by Paint Chip Analysis

Performing inspections by the sole use of laboratory paint chip analysis is not recommended because it is time-consuming, costly, and requires extensive repair of painted surfaces. Laboratory analysis of paint-chip samples *is* recommended for inaccessible areas or building components with irregular (non-flat) surfaces that cannot be tested using XRF instrumentation. Laboratory analysis is also recommended to confirm inconclusive XRF results, as specified on the applicable *XRF Performance Characteristic Sheet*. Some newer laboratory analytical methods can provide results within minutes (see section I.H, below). Only laboratories recognized under the EPA NLLAP should be used. Laboratory analysis is more accurate and precise than XRF but only if great care is used to collect and analyze the paint-chip sample. Laboratory results should be reported as mg/cm². Appendix 1 of these *Guidelines* explains why units of mg/cm² are not dependent on the number of overcoats of lead-free paint and why such units of measure are therefore more reliable than weight percent. The dimensions of the area from which a paint-chip sample is removed must be measured as accurately as possible (to the nearest millimeter or 1/16th of an inch).

Although laboratory results can also be reported as a percentage of lead by weight of the paint sample, percents should only be used when it is not feasible to use mg/cm². These two units of measure are not interchangeable. Laboratory results should be reported as mg/cm² if the surface area can be accurately measured and if all paint within that area is collected.

In mg/cm^2 measurements, collecting small amounts of substrate material with the sample does not bias the results significantly, although having any amount of substrate in the sample can result in less precise results. In weight percent measurements, however, no substrate may be included because the substrate will "dilute" the amount of lead reported. Regardless of the units of measurement selected, the bottom layer of paint must always be included in the sample. If a visual examination shows that the bottom layer of paint appears to have "bled" into the substrate, a very thin upper portion of the substrate should be included in the sample to ensure that all lead within the sample area has been included in the sample. In cases where significant amounts of substrate are included in the sample, the results should always be reported in mg/cm^2.

See Section VI for additional information on laboratory analysis.

H. Additional Means of Analyzing Paint

Methods of analyzing lead in paint are available in addition to XRF and laboratory paint chip analysis, including transportable instruments and chemical test kits. Because these methods involve paint removal or disturbance, repair is needed after sampling, unless the substrate will be removed, encapsulated, enclosed, or repainted before occupancy (see Section VI), or if analysis shows that the paint is not lead-based paint, and leaving the damage is acceptable to the client and/or the owner.

1. Mobile Laboratories

Portable instruments that employ anodic stripping voltammetry and potentiometric stripping voltammetry are now available. Their use is described in ASTM Provisional Standard Practice PS 88. Also, ASTM Standard Guide E 1775 may be used as a basis for evaluating the performance of on-site extraction and electrochemical and spectrophotometric analyses. If the organization using a portable instrument is recognized under the EPA NLLAP and used that type of instrument to obtain the laboratory's recognition, they can be used in the same way as any other NLLAP-recognized laboratory. In short, both fixed-site and mobile laboratories may be used, provided they are recognized under NLLAP.

2. Chemical Test Kits

Chemical test kits are intended to show a color change when a part of the kit makes contact with the lead in lead-based paint. One type of chemical test kit is based on the formation of lead sulfide, which is black, when lead in paint reacts with sodium sulfide. Another is based on the formation of a red or pink color when lead in paint reacts with sodium rhodizonate.

EPA did not find that chemical spot test kits are sufficiently reliable for use in lead-based paint inspection, and recommended that they not be used (EPA 1995). HUD and EPA may recommend them in the future for inspections if chemical test kit technology is demonstrated to be equivalent to XRF or laboratory paint chip analysis in its ability to properly classify painted surfaces into positive, negative, and inconclusive categories, with appropriate estimates of the magnitude of sampling and analytical error. *XRF Performance Characteristic Sheets* currently provide such estimates for XRFs, and analytical error is well-described for laboratory analysis. HUD is currently funding the National Institute for Standards and Technology (NIST) and other researchers to evaluate commercially available chemical test kits and provide the basis for improved chemical test kits. Information on test kits or other new technologies for testing for lead in paint can be obtained from the National Lead Information Center Clearinghouse (1-800-424-LEAD).

II. Summary of XRF Radiation Safety Issues

Radiation hazards associated with the use of XRFs are covered in detail in Section VII. The shutter of an XRF must never be pointed at anyone, even if the shutter is closed. Inspectors should wear radiation dosimeters to measure their exposure, although excessive exposures are highly unlikely if the instruments are used in accordance with the manufacturer's instructions. If feasible, persons should not be near the other side of a wall, floor, ceiling, or other surface being tested.

III. Definitions

Definitions of several key terms used in this chapter are provided here. Some additional definitions may be found in ASTM Standard E 1605, Standard Terminology Relating to Abatement of Hazards from Lead-based Paint on Buildings and Related Structures, and in other standard chemical, statistical, architectural and engineering dictionaries and texts. For terms discussed both here and in the ASTM document, the definitions and descriptions in this chapter should be used.

Lead-based paint - Lead-based paint means paint or other surface coatings that contain lead equal to or greater than 1.0 mg/cm^2 or 0.5 percent by weight (equivalent units are: 5,000 µg/g, 5,000 mg/kg, or 5,000 ppm by weight). Surface coatings include paint, shellac, varnish, or any other coating, including wallpaper which covers painted surfaces.

Lead loading - The mass of lead in a given surface area on a substrate. Lead loading is typically measured in units of milligrams per square centimeter (mg/cm^2). It is also called area concentration.

Room equivalent - A room equivalent is an identifiable part of a residence, such as a room, a house exterior, a foyer, staircase, hallway, or an exterior area (exterior areas contain items such as play areas, painted swing sets, painted sandboxes, etc.). Closets or other similar areas adjoining rooms should not be considered as separate room equivalents unless they are obviously dissimilar from the adjoining room equivalent. Most closets are not separate room equivalents. Exteriors should be included in all inspections. An individual side of an exterior is not considered to be a separate room equivalent, unless there is visual or other evidence that its paint history is different from that of the other sides. All sides of a building (typically two for row houses or four for freestanding houses) are generally treated as a single room equivalent if the paint history appears to be similar. For multifamily developments or apartment buildings, common areas and exterior sites are treated as separate types of units, not as room equivalents (see section V.C.1 for further guidance).

Substrate - The substrate is the material underneath the paint. Substrates should be classified into one of six types: brick, concrete, drywall, metal, plaster, or wood. These substrates cover almost all building materials that are painted and are linked to those used in the *XRF Performance Characteristic Sheets*. For example, the concrete substrate type includes poured concrete, precast concrete, and concrete block.

If a painted substrate is encountered that is different from the substrate categories shown on the *XRF Performance Characteristic Sheet*, select the substrate type that is most similar in density and composition to the substrate being tested. For example, for painted glass substrates, an inspector should select the concrete substrate, because it has about the same density (2.5 g/cm^3) and because the major element in both is silicon.

For components that have layers of different substrates, such as plaster over concrete, the substrate immediately adjacent to (underneath) the painted surface should be used. For example, plaster over concrete block is recorded as plaster.

Testing Combination - A testing combination is a unique combination of room equivalent, building component type, and substrate. Visible color may not be an accurate predictor of painting history and is not included in the definition of a testing combination. Table 7.1 lists common building component types that could make up distinct testing combinations within room equivalents. The list is not intended to be complete. Unlisted components that are coated with paint, varnish, shellac, wallpaper, stain, or other coating should also be considered as a separate testing combination.

Certain building components that are adjacent to each other and not likely to have different painting histories can be grouped together into a single testing combination, as follows:

- Window casings, stops, jambs and aprons are a single testing combination
- Interior window mullions and window sashes are a single testing combination--do not group interior mullions and sashes with exterior mullions and sashes
- Exterior window mullions and window sashes are a single testing combination
- Door jambs, stops, transoms, casings and other door frame parts are a single testing combination
- Door stiles, rails, panels, mullions and other door parts are a single testing combination

- Baseboards and associated trim (such as quarter-round or other caps) are a single testing combination (do not group chair rails, crown molding or walls with baseboards)
- Painted electrical sockets, switches or plates can be grouped with walls

Each of these building parts should be tested separately if there is some specific reason to believe that they have a different painting history. In most cases, separate testing will not be necessary.

Table 7.1: Examples of Interior and Exterior Building Component Types

Commonly Encountered Interior Painted Components That Should Be Tested Include:	
Air Conditioners	Fireplaces
Balustrades	Floors
Baseboards	Handrails
Bathroom Vanities	Newel Posts
Beams	Other Heating Units
Cabinets	Radiators
Ceilings	Shelf Supports
Chair Rails	Shelves
Columns	Stair Stringers
Counter Tops	Stair Treads and Risers
Crown Molding	Stools and Aprons
Doors and Trims	Walls
Painted Electrical Fixtures	Window Sashes and Trim

Exterior Painted Components That Should Be Tested Include:	
Air Conditioners	Handrails
Balustrades	Lattice Work
Bulkheads	Mailboxes
Ceilings	Painted Roofing
Chimneys	Railing Caps
Columns	Rake Boards
Corner boards	Sashes
Doors and Trim	Siding
Fascias	Soffits
Floors	Stair Risers and Treads
Gutters and Downspouts	Stair Stringers
Joists	Window and Trim

Other Exterior Painted Components Include:	
Fences	Storage Sheds & Garages
Laundry Line Posts	Swing sets and Other Play Equipment

Table 7.2 provides six examples of different testing combinations. The first example is a wooden bedroom door. This is a testing combination because it is described by a room equivalent (bedroom), component (door), and substrate (wood). If one of these variables is different for another component, that component is a different testing combination. For example, if a second door in the room equivalent is metal, two testing combinations, not one, would be present.

For doors separating rooms, each side of the door is assigned to the room equivalent it faces and is tested separately. The same is true of door casings. For prefabricated metal doors where it is apparent that both sides of the door have the same painting history, only one side needs to be tested.

Table 7.2: Examples of Distinct Testing Combinations

Room Equivalent	**Building Component**	**Substrate**
Master Bedroom (Room 5)	Door	Wood
Master Bedroom (Room 5)	Door	Metal
Kitchen (Room 3)	Wall	Plaster
Garage (Room 10)	Floor	Concrete
Exterior	Siding	Wood
Exterior	Swing set	Metal

Building Component Types - A building component type consists of doors, windows, walls, and so on that are repeated in more than one room equivalent in a unit and have a common substrate. If a unique building component is present in only one room, it is considered to be a testing combination. Each testing combination may be composed of more than one building component (such as two similar windows within a room equivalent). Component types can be located inside or outside the dwelling. For example, typical component types in a bedroom would be the ceiling, walls, a door and its casing, the window sash, window casings, and any other distinct surface, such as baseboards, crown molding, and chair rails. If trends or patterns of lead-based paint classifications are found among building component types in different room equivalents, an inspection report may summarize results by building component type, as long as all measurements are included in the report. For example, the inspection may find that all doors and door casings in a dwelling unit are positive.

Test Location - The test location is a specific area on a testing combination where either an XRF reading or a paint-chip sample will be taken.

IV. Inspections in Single-Family Housing

Single-family housing inspections should be conducted by a State- or EPA-certified (licensed) lead-based paint inspector using the following seven steps, some of which may be done at the same time:

- List all testing combinations, including those that are painted, stained, shellacked, varnished, coated, or wallpaper which covers painted surfaces.
- Select testing combinations.
- Perform XRF testing (including the calibration check readings).
- Collect and analyze paint-chip samples for testing combinations that cannot be tested with XRF or that had inconclusive XRF results.
- Classify XRF and paint-chip results.
- Evaluate the work and results to ensure the quality of the paint inspection.
- Document all findings in a plain language summary and a complete report; include language in both the summary and the report indicating that the information must be disclosed to tenants and prospective purchasers in accordance with Federal law (24 CFR part 35 or 40 CFR part 745).

A. Listing Testing Combinations

Develop a list of all testing combinations in all interior rooms, on all exterior building surfaces, and on surfaces in other exterior areas, such as fences, playground equipment, and garages. The "Single-Family Housing LBP Testing Data Sheet" (see Form 7.1 at the end of this chapter) or a comparable data collection instrument may be used for this purpose. An inventory of a house may be completed either before any testing or on a room-by-room basis during testing.

1. Number of Room Equivalents to Inspect

Test all room equivalents inside and outside the dwelling unit. The final report must include a final determination of the presence or absence of lead-based paint on each testing combination in each room equivalent.

For varnished, stained, or similar clear-coated floors, measurements in only one room equivalent are permissible if it appears that the floors in the other room equivalents have the same coating.

2. Number of Testing Combinations to Inspect

Inspect each testing combination in each room equivalent, unless similar building component types with identical substrates (such as windows) are all found to contain lead-based paint in the first five interior room equivalents. In that case, testing of that component type in the remaining room equivalents may be discontinued, *if and only if* the purchaser of the inspection services agrees beforehand to such a discontinuation. The inspector should then conclude that similar building component types in the rest of the dwelling unit also contain lead-based paint. See item 6 entitled, "Conditions for Abbreviation of Testing," later in this section for additional details.

Because it is highly unlikely that testing combinations *known* (and not just presumed) to have been replaced or added to the building after 1977 will contain lead-based paint, they need not be tested. If the age of the testing combination is in doubt, it should be tested.

Some testing combinations have multiple parts. For example, a window testing combination could theoretically be broken down into the interior sill (stool), exterior sill, trough, sash, apron, parting bead, stop bead, casing, and so on. Because it is highly unlikely that all these parts will have different painting histories, they should not usually be considered separate testing combinations. (Inspectors should regard parts of building components as separate testing combinations if they have evidence that different parts have separate, distinct painting histories). See the definition of testing combination (Section III, above) for guidance on which building component parts may and which may not be grouped together.

3. Painted Furniture

Painted furniture that is physically attached to the unit (for example, a desk or dresser that is built-in) should be included in the inspection as a testing combination. Other painted furniture may also be tested, depending on the client's wishes. Children's furniture (such as cribs or playpens), especially if built before 1978, may contain lead-based paint and can be tested, subject to the client's wishes.

4. Building Component Types

Results of an inspection may be summarized by classifying component types across room equivalents if patterns or trends are supported by the data.

5. Substrates

All substrates across all room equivalents should be grouped into one of the six substrate categories (brick, concrete, drywall, metal, plaster, or wood) shown on the *XRF Performance Characteristic Sheet* for the instrument being used. Substrate correction procedures can then be applied for all building component types with the same substrate. For example, the substrate correction procedure for wooden doors and wooden baseboards can use the same substrate correction value (see Section IV.E, below).

6. Conditions for Abbreviation of Testing

If lead-based paint is determined to be present (a "positive" finding) for a building component type with the same substrate in all of the first five room equivalents inspected, further testing of that component type may be discontinued in the remaining room equivalents within that dwelling unit, *if and only if* the purchaser of inspection services agrees beforehand to such a discontinuation. The inspector should then conclude that the similar building component types in the rest of the dwelling unit also contain lead-based paint. For example, if an inspector finds that baseboards in the first five room equivalents are all positive, the inspector -- with the client's permission -- may conclude that all remaining room equivalents in the unit contain positive baseboards.

B. Number and Location of XRF Readings

1. Number of XRF Readings for Each Testing Combination

XRF testing is required for at least one location per testing combination, except for interior and exterior walls, where four readings should be taken, one on each wall. Previous editions of this chapter stated that three readings for each testing combination were needed to control for spatial variation and other sources of error. Recent analysis[2] of EPA data show a median difference in spatial variation of only 0.1 mg/cm² and a change in classification (positive, negative, or inconclusive) occurs less than 5 percent of the time as a result of different test locations on the same testing combination. Multiple readings on the same testing combination or testing location are, therefore, unnecessary, except for interior and exterior walls.

Because of the large surface areas and quantities of paint involved, and the possibility of increased spatial variation, take at least four readings (one reading on each wall) in each room equivalent. (For room equivalents with fewer than four walls, test each wall.) For each set of walls with the same painting history in a room equivalent, test the four largest walls. Classify each wall based on its individual XRF reading. If a room equivalent has more than four walls, calculate the average of the readings, round the result to the same number of decimal places as the XRF instrument displays, and classify the remaining walls with the same painting history as the tested walls, based on this rounded average. When the remaining walls in a room equivalent clearly do not have the same painting history as that of the tested walls, test and classify the remaining walls individually. For exterior walls, select at least four sides and average the readings (rounding the result as described above) to obtain a result for any remaining sides. If there are more than four walls and the results of the tested walls do not follow a classification pattern (for example, one is positive and the other three are negative), test each wall individually.

2. Location of XRF Readings

The selection of the test location for a specific testing combination should be representative of the paint over the areas which are most likely to be coated with old paint or other lead-based coatings. Thus, locations where the paint appears to be thickest should be selected. Locations where paint has worn away or been scraped off should not be selected. Areas over pipes, electrical surfaces, nails, and other possible interferences should also be avoided if possible. All layers of paint should be included and the XRF probe faceplate should be able to lie flat against the surface of the test location.

If no acceptable location for XRF testing exists for a given testing combination, a paint-chip sample should be collected. The sample should include all paint layers and should be taken as unobtrusively as possible. Because paint chip sampling is destructive, a single sample may be collected from a wall and used to characterize the other walls in a room equivalent (see section VI for additional details on paint chip sampling).

3. Documentation of XRF Reading Locations

Descriptions of testing combinations should be sufficiently detailed to permit another individual to find them. While it is not necessary to document the *exact* spot or the *exact* building component on which the reading was taken, it is necessary to record the *exact* testing combination measured. Current room uses or colors can change and should not be the only way of identifying them. A numbering system, floor plan, sketch or other system may be used to document which testing combinations were tested. While HUD does not require a standard identification system, one that could be used is as follows:

a. Side identification

Identify perimeter wall sides with letters A, B, C, and D (or numbers or Roman numerals). Side A for single-family housing is the street side for the address. Side A in multifamily housing is the apartment entry door side.

Side B, C, and D are identified clockwise from Side A as one faces the dwelling; thus Wall B is to the left, Wall C is across from Side A, and Side D is to the right of Side A.

Each room equivalent's side identification follows the scheme for the whole housing unit. Because a room can have two or more entries, sides should not be allocated based on the entry point. For example, giving a closet a side allocation based on how the room is entered would make it difficult for another person to make an easy identification, especially if the room had two closets and two entryways.

b. Room Equivalent Identification

Room equivalents should be identified by both a number and a use pattern (for example, Room 5-Kitchen). Room 1 can always be the first room, at the A-D junction at the entryway, or it can be the exterior. Rooms are consecutively numbered clockwise. If multiple closets exist, they are given the <u>side allocation</u>: for example, Room 3, Side C Closet. The exterior is always assigned a separate room equivalent identifier.

c. Sides in a Room

Sides in an interior room equivalent follow the overall housing unit side allocation. Therefore, when standing in any four-sided room facing Side C, the room's Side A will always be to the rear, Side B will be to the left, and Side D will be to the right.

d. Building Component Identification

Individual building components are first identified by their room number and side allocation (for example, the radiator in Room 1, Side B is easily identified). If multiple similar component types are in a room (for example, three windows), they are differentiated from each other by side allocation. If multiple components are on the same wall side, they are differentiated by being numbered left to right when facing the components. For example, three windows on Wall D are identified as windows D1, D2, and D3, left to right. If window D3 has the only old original sash, it is considered a separate testing combination from the other two windows.

A sketch of the dwelling unit's floor plan is often helpful, but is not required by this protocol. Whatever documentation is used, a description of the room equivalent and testing combination identification system must be included in the final inspection report.

C. XRF Instrument Reading Time

The recommended time to open an XRF instrument's shutter to obtain a single XRF result for a testing location depends on the specific XRF instrument model and the mode in which the instrument is operating. The *XRF Performance Characteristic Sheet* provides information on this issue.

To ensure that a constant amount of radiation is delivered to the painted surface, the open-shutter time must be increased as the source ages and the radiation source weakens. Almost all commercially available XRF instruments automatically adjust for the age of the source. (Some instruments adjust for source decay in some but not all modes; operators should check with the manufacturers of their instruments to determine whether these differences need to be accommodated). The following formula should be employed for instruments requiring manual adjustment of the open-shutter time:

$$\text{Open-Shutter Time} = 2^{(\text{Age}/\text{Half-life})} \times \text{Nominal Time}$$

where:

> *Age* is the age (in days) of the radioactive source, starting from the date the manufacturer says the source had its full radiation strength;
>
> *Half-life* is the time (in days) it takes for the radioactive material's activity to decrease to one-half its initial level; and
>
> *Nominal Time* is the recommended nominal number of seconds for open-shutter time,

when the source is at its full radiation strength, and is obtained from the *XRF Performance Characteristic Sheet*.

For example, if the age of the source is equal to its half-life, the open-shutter time should be twice the nominal time. Thus, if the recommended nominal time is 15 seconds, the open-shutter time should be doubled to 30 seconds.

XRFs typically use Cobalt-57 (with a half life of 270 days) or Cadmium-109 (with a half life of 464 days).

XRF Performance Characteristic Sheets typically report different inconclusive ranges or thresholds (see section IV.G, below) for different nominal times and different substrates. This may affect the number of paint-chip samples that must be collected as well as the length of time required for the inspection. Some XRF devices have different modes of operation with different nominal reading times. Inspectors must use the appropriate inconclusive ranges and other criteria specified on the *XRF Performance Characteristic Sheet* for each XRF model, mode of operation and substrate. For example, inconclusive ranges specified for a 30-second nominal reading cannot be used for a 5-second nominal reading, even for the same instrument and the same substrate.

D. XRF Calibration Check Readings

In addition to the manufacturer's recommended warm up and quality control procedures, the XRF operator should take the quality control readings recommended below, unless these are less stringent than the manufacturer's instructions. Quality control for XRF instruments involves readings to check calibration. Most XRFs cannot be calibrated on-site; actual calibration can only be accomplished in the factory.

1. Frequency and Number of Calibration Checks

For each XRF instrument, two sets of XRF calibration check readings are recommended at least every 4 hours. The first is a set of three nominal-time XRF calibration check readings to be taken before the inspection begins. The second occurs either after the day's inspection work has been completed, or at least every 4 hours, whichever occurs first. To reduce the amount of data that would be lost if the instrument were to go out of calibration between checks, and/or if the manufacturer recommends more frequent calibration checks, the calibration check can be repeated more frequently than every 4 hours. If the XRF manufacturer recommends more frequent calibration checks, the manufacturer's instructions should be followed. Calibration should also be checked before the XRF is turned off (for example, to replace a battery or before a lunch break) and after it is turned on again. For example, if an inspection of a large house took 6 hours, there would be three calibration checks: one at the beginning of the inspection, another after 4 hours, and a third at the end of the inspection.

If the XRF is not turned off as the inspector travels from one dwelling unit to the next, calibration checks do not need to be done after each dwelling unit is completed. For example, in multifamily housing, calibration checks do not need to be done after each dwelling unit is inspected; once every 4 hours is usually adequate.

Some instruments automatically enter a "sleep" or "off" state when not being used continually to prolong battery life. It is not necessary to perform a calibration check before and after each "sleep" state episode, unless the manufacturer recommends otherwise.

2. Calibration Check Standard Materials

XRF calibration check readings are taken on the Standard Reference Material (SRM) paint film nearest to 1.0 mg/cm² within the National Institute of Standards and Technology (NIST) SRM used. These films can be obtained by calling (301) 975-6776 and referencing SRM 2579 (NIST is planning to release additional series of paint films in late 1997 or early 1998; the film nearest to 1.0 mg/cm² should be used for XRF calibration checks). The cost as of September 26, 1997, for the SRM 2579 set of five films, was $320, including 2-day delivery. Calibration checks should be taken through the SRM paint film with the film positioned at least 1 foot (0.3 meters) away from any potential source of lead. The NIST SRM film should not be placed on a tool box, suitcase, or surface coated with paint, shellac, or any other coating to take calibration check readings. Rather, the NIST SRM film should be attached to a solid (not plywood) wooden board or other nonmetal rigid substrate such as drywall, or attached directly to the XRF probe. The SRM should be positioned so that readings of it are taken when it is more than 1 foot (0.3 meters) away from a potential source of error. For example, the NIST SRM film can be placed on top of a 1 foot (0.3 meter) thick piece of Styrofoam or other lead-free material, as recommended by the manufacturer before taking readings.

3. Recording and Interpreting Calibration Check Readings

Each time calibration check readings are made, three readings should be taken. These readings should be taken using the nominal time which will be used during the inspection, selected from among those specified in the XRF's Performance Characteristic Sheet. The open shutter time should be adjusted, if necessary, to reflect the age of the radioactive source (see section IV.C, above). The readings can be recorded on the "Calibration Check Test Results" form (Form 7.2), on a comparable form, or stored in the instrument's memory, and printed out or transferred to a computer later. The average of the three calibration check readings should be calculated, rounded to the same number of decimal places as the XRF instrument displays, and recorded on the form.

Large deviations from the NIST SRM value will alert the inspector to problems in the instrument's performance. If the observed calibration check average is outside of the acceptable calibration check tolerance range specified in the instrument's *XRF Performance Characteristic Sheet*, the manufacturer's instructions should be followed to bring the instrument back into control. A successful calibration check should be obtained before additional XRF testing is conducted. Readings not accompanied by successful calibration checks at the beginning and end of the testing period are unreliable and should be repeated after a successful calibration check has been made. If a backup XRF instrument is used as a replacement, it must successfully pass the initial calibration check test before retesting the affected test locations.

This procedure assumes that the HUD/EPA lead-based paint standard of 1.0 mg/cm² is being used. If a different standard is being used, other NIST SRMs should be used to determine instrument performance against the different standard. At this time, however, no method for determining performance characteristics using different standards has been developed.

E. Substrate Correction

XRF readings are sometimes subject to systematic biases as a result of interference from substrate material beneath the paint. The magnitude and direction of bias depends on the substrate, the specific XRF instrument being used, and other factors such as temperature and humidity. Results can be biased in either the positive or negative direction and may be quite high.

1. When Substrate Correction Is Not Required

Some XRF instruments do not need to have their readings corrected for substrate bias. Other instruments may only need to apply substrate correction procedures on specific substrates and/or when XRF results are below a specific value. The *XRF Performance Characteristic Sheet* should be consulted to determine the requirements for a specific instrument and each mode of operation (e.g., nominal time, or time required for intended precision). XRF instruments which do not require correction for any substrate, or require corrections on only a few substrates, have an advantage in that they simplify and shorten the inspection process.

2. Substrate Correction Procedure

XRF results are corrected for substrate bias by subtracting a correction value determined separately in each house for each type of substrate where lead paint values are in the substrate correction range indicated on the *XRF Performance Characteristic Sheet*. In single-family housing, the substrate correction value is determined using the specific instrument(s) used in that house. The correction value (formerly called "Substrate Equivalent Lead" or "SEL") is an average of six XRF readings, with three taken from each of two test locations that have been scraped visually clean of their paint coating. The locations selected for removal of paint should have an initial XRF reading on the painted surface of less than 2.5 mg/cm², if possible. If all initial readings on a substrate type are greater than 2.5 mg/cm², the locations with the lowest initial reading should be chosen. Because available data indicate that surfaces with XRF readings in excess of about 3.0 mg/cm² or 4.0 mg/cm² are almost always coated with lead-based paint, and since bleed-through of lead into the substrate may occur, or pipes and similarly interfering building components may be behind the material being evaluated, locations with such high readings should be avoided for substrate correction.

After all XRF testing has been completed but before the final calibration check test has been conducted, XRF results for each substrate type should be reviewed. If any readings fall within the range for substrate correction for a particular substrate, obtain the substrate correction value.

On each selected substrate requiring correction, two different testing combinations must be chosen for paint removal and testing. For example, if the readings are inconclusive for some wooden baseboards, select two baseboards, each from a different room. If some wooden doors also require substrate correction, the inspector should take substrate correction readings on one door and one baseboard. Selecting the precise location of substrate correction should be based on the inspector's ability to remove paint thoroughly from the substrates, the similarity of the substrates, and their accessibility. The XRF probe faceplate must be able to be placed over the scraped area, which should be completely free of paint or other coatings.

The size of the area from which paint is taken depends on the size of the analytical area of the XRF probe faceplate; normally, the area is specified by the manufacturer. To ensure that no paint is included in the bare substrate measurement, the bare area on the substrate should be slightly larger than the analytical area on the XRF probe faceplate.

In all, six readings must be taken for each substrate type that requires correction. All six must be averaged together. Take three readings on the first *bare* substrate area. Record the substrate and XRF readings on the "Substrate Correction Values" form (Form 7.3) or a comparable form. Repeat this procedure for the second *bare* substrate area and record the three readings on the same form. Substrate correction values should be determined using the same instrument used to take readings on the painted surfaces. If more than one XRF model was used to take readings, apply the substrate correction values as specified on each instrument's *XRF Performance Characteristic Sheet*.

Compute the correction value for each substrate type that requires correction by computing the average of all six readings as shown below and recording the results on the "Substrate Correction Values" form. The formula given below should be used to compute the substrate bias correction value for XRF readings taken on a bare substrate that is not covered with NIST SRM film. A different formula should be used when SRM film must be placed over the bare substrate. The *XRF Performance Characteristic Sheet* specifies when this correction is necessary and provides the formula for computing the correction value.

For each substrate type requiring substrate correction, transfer the correction values to the "Single-Family Housing LBP Testing Data Sheet" (Form 7.1). Correct XRF readings for substrate interference by subtracting the correction value from each XRF reading.

Example: Suppose that a house has 50 testing combinations with wood substrates. The *XRF Performance Characteristic Sheet* states that a correction value for XRF results taken on those wood testing combinations that have values less than 4.0 mg/cm² must be computed. Select two test locations from the testing combinations that had uncorrected XRF results of less than 2.5 mg/cm².

Completely remove the paint from these two test locations and take three nominal-time XRF readings on the bare substrate at each location. The six XRF readings at the two random locations are:

Selected Location	**Reading (mg/cm^2)**		
	First	Second	Third
Wood Master Bedroom Door	1.32	0.91	1.14
Kitchen Wood Baseboard (Room 4)	1.21	1.03	1.43

The correction value is the average of the six values:

Correction value = (1.32 + 0.91 + 1.14 + 1.21 + 1.03 + 1.43) mg/cm^2 / 6 = 1.17 mg/cm^2

In this same house, three different wood testing combinations were inspected for lead-based paint and the XRF results are: 1.63 mg/cm^2, 3.19 mg/cm^2, and 1.14 mg/cm^2. Correcting these three XRF measurements for substrate bias produces the following results:

First corrected measurement =
1.63 mg/cm^2 - 1.17 mg/cm^2 = 0.46 mg/cm^2

Second corrected measurement =
3.19 mg/cm^2 - 1.17 mg/cm^2 = 2.02 mg/cm^2

Third corrected measurement =
1.14 mg/cm^2 - 1.17 mg/cm^2 =-0.03 mg/cm^2

The third corrected result shown above is an example of how random error in XRF measurements can cause the corrected result to be less than zero. (Random measurement error is present whenever measurements are taken). Note that correction values can be either positive or negative. In short, negative corrected XRF values should be reported if supported by the data.

Finally, suppose an XRF result of 1.24 mg/cm^2 has a correction value of negative 0.41 mg/cm^2. Subtracting a negative number is the same as adding its positive value. Therefore, the corrected measurement would be:

Corrected result = 1.24 mg/cm^2 - (-0.41 mg/cm^2) =
1.24 mg/cm^2 + 0.41 mg/cm^2 = 1.65 mg/cm^2

3. Negative Values

If more than 20 percent of the corrected values are negative, the instrument's lead paint readings and/or the substrate readings are probably in error. Calibration should be checked and substrate measurements should be repeated.

F. Discarding Readings

If the manufacturer's instructions call for the deletion of readings at specific times, *only* readings taken at those specific times should be deleted. Similarly, readings between a successful calibration check and a subsequent unsuccessful calibration check must be discarded. Readings should not be deleted based on any criteria other than what is specified by the manufacturer's instructions or the *HUD Guidelines*. For example, a manufacturer may instruct operators to discard the first XRF reading after a substrate change. If so, *only* the first reading should be discarded after a substrate change.

G. Classification of XRF Results

XRF results are classified as positive, negative, or inconclusive.

A *positive* classification indicates that lead is present on the testing combination at or above the HUD/EPA standard of 1.0 mg/cm^2. A positive XRF result is any value greater than the upper bound of the inconclusive range, or greater than or equal to the threshold, as specified on the applicable *XRF Performance Characteristic Sheet*.

A *negative* classification indicates that lead is not present on the testing combination at or above the HUD/EPA standard. A negative XRF result is any value less than the lower bound of the inconclusive range, or less than the threshold, specified on the performance characteristic sheet.

An *inconclusive* classification indicates that the XRF cannot determine with reasonable certainty whether lead is present on the testing combination at or above the HUD/EPA standard. An inconclusive XRF result is any value falling within the inconclusive range on the performance characteristic sheet (including the boundary values defining the range). In single-family housing, all inconclusive results should be confirmed by laboratory analysis, unless the client wishes to assume that all inconclusive results are positive.

Positive, negative, and inconclusive results apply to the actual testing combination and to any repetitions of the testing combination that were not tested in the room equivalents. Positive results also apply to similar component types in room equivalents that were not tested. For example, suppose that one baseboard in a room equivalent is tested, and that the inspector decided that all four baseboards are a single testing combination. The single XRF result applies to all four baseboards in that room equivalent.

When an inconclusive range is specified on the *XRF Performance Characteristic Sheet*, XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range on the *XRF Performance Characteristic Sheets* in Addendum 3 of these *Guidelines* includes its upper and lower bounds. Earlier editions of this guide and earlier *XRF Performance Characteristic Sheets* did not include the bounds of the inconclusive range as "inconclusive." This 1997 edition of Chapter 7 of the HUD Guidelines changes that system, but the specific XRF readings that are considered positive, negative, or inconclusive for a given XRF model and substrate remain unchanged, so previous inspection results are not affected.

For example, if the inconclusive range given in the *XRF Performance Characteristic Sheet* is 0.51 mg/cm² to 1.49 mg/cm², an XRF result of 0.50 mg/cm² is considered negative, because it is less than 0.51; a result of 0.6 mg/cm² is inconclusive; and a result of 1.5 mg/cm² is positive. A result of 0.51 mg/cm², 1.00 mg/cm², or 1.49 mg/cm² would be inconclusive.

Different XRF models have different inconclusive ranges, depending on the specific XRF model and the mode of operation. The inconclusive range may also be substrate-specific.

In some cases, the upper and lower limits of the inconclusive range are equal; that value is called the *threshold*. If the reading is less than the threshold, then the reading is considered negative. If the reading is equal to or greater than the threshold, then the reading is considered positive.

Use of the inconclusive range and threshold is detailed in the performance characteristic sheet. The categories include substrate-corrected results, if substrate correction is indicated. XRF's with *only* threshold values listed on the *XRF Performance Characteristic Sheet* are advantageous in that classifications of results are either positive or negative (no XRF readings are inconclusive).

H. Evaluation of the Quality of the Inspection

The person responsible for purchasing inspection services -- the homeowner, property owner, housing authority, prospective buyer, occupant, etc.; also known as the client -- should evaluate the quality of the work using one or more of the methods listed below. Evaluation methods include direct observation, immediate provision of results, repeated testing, and time-and-motion analysis. Direct observation of the inspection should be used whenever possible. The inspection contract should outline the financial penalties that will occur if an inspector fails to perform as contracted during any visit.

1. Direct Observation

An evaluation of a lead-based paint inspection is best made if a knowledgeable observer is present for as much of the XRF testing as possible. This is the only way to ensure that all painted, varnished, shellacked, wallpapered, stained, or other coated testing combinations are actually tested, and that all XRF readings are recorded correctly. If possible, employ as the observer someone who is trained in lead-based paint inspection and who is independent of the inspection firm.

If it is not feasible for the client or the client's representative to be present throughout the inspection, that person should conduct unannounced and unpredictable visits to observe the inspection process. The number of unannounced visits will depend on the results of prior visits. When observing ongoing XRF testing, review the test results for the room equivalent currently being tested and for the previously inspected room equivalent. Even if the first visit is fully satisfactory, follow-up visits should be conducted throughout the inspection.

2. Immediate Provision of Results

The client, or a representative, should ask the inspector to provide copies or printouts of results on completed data forms immediately following the completion of the inspection or on a daily basis. Alternatively, visually review the inspector's written results to ensure that they are properly recorded for all surfaces that require XRF testing. If surfaces have been overlooked or recorded incorrectly, the inspection process should be stopped and considered deficient. Clients should retain daily results to ensure that the data in the final report are the same as the data collected in the home.

3. Repeated Testing of 10 Surfaces

Data from HUD's private housing lead-based paint hazard control program show that it is possible to successfully retest painted surfaces without knowing the exact spot which was tested.

Select 10 testing combinations at random from the already compiled list in the "Single-Family Housing LBP Testing Data Sheet" for retesting (see forms in Addendum 2 of this chapter). Observe the inspector during the retesting. If possible, the same XRF instrument used in the original inspection should be used in the retesting. If the XRF instrument used in the original inspection is not available and cannot be returned to the site, use an XRF of the same model for retesting. Use the same procedures to retest the 10 testing combinations. The 10 repeat XRF results should be compared with the 10 XRF results previously made on the same testing combinations. The repeat readings and the original readings should not be corrected for substrate bias for the purpose of this comparison. The average of the 10 repeat XRF results should not differ from the 10 original XRF results by more than the retest tolerance limit. The procedure for calculating the retest tolerance limit is specified in the *XRF Performance Characteristic Sheet*. If the limit is exceeded, the procedure should be repeated using 10 different testing combinations. If the retest tolerance limit is exceeded again, the original inspection is considered deficient.

4. Time-and-Motion Analysis

Anyone who contracts for a lead-based paint inspection can also perform a simple check to determine if the inspector had sufficient time to complete the number of housing units reported as being tested in the time allotted. Usually, inspections require at least 1 to 2 hours per unit using existing technology. If the inspector's on-site time is significantly less than that, further investigation should be conducted to determine if the inspector actually completed the work in the report.

I. Documentation in Single-Family Housing

1. Data Forms

Data can be recorded on hand written forms, electronically, or by a combination of these two methods. XRF readings can be entered on handwritten forms, such as the set of forms (7.1, 7.1A, 7.2, and 7.3) provided at the end of this chapter (or comparable forms). Because handwriting can result in transcription errors, handwritten forms should be examined for missing data and copying errors.

2. Electronic Data Storage

Electronic data storage is recommended only if the data recorded are sufficient to allow another person to find the testing combination that corresponds to each XRF reading. Electronically stored data should be printed in hard copy either daily or at the completion of the inspection. The printout should be examined for extraneous symbols or missing data, including missing test location identification. In most cases, electronic data storage is supplemented by manual data recording of sampling location, operator name, and other information.

3. Final Report

The final report must include both a summary and complete information about the site, the inspector, the inspection firm, the inspection process, and the inspection results. The full report should include a complete data set, including:

- Housing unit identifiers;
- Date of the inspection;
- Identity of the inspector and the inspection firm and any relevant certifications or licenses held by the inspector and/or the firm;
- Building component and room equivalent identification or numbering system or sketches;
- All XRF readings (including calibration check readings);
- All paint chip analyses;
- Testing protocol used;
- Instrument manufacturer, model, serial number, mode(s) of operation and age of radioactive source;
- Information on the owner's legal obligation to disclose the inspection results to tenants and/or purchasers before obligation under 24 CFR part 35 and 40 CFR part 745 (published in the *Federal Register,* Volume 61, Number 45, March 6, 1996, starting on p. 9064; copies of the regulations and related materials can be obtained from the National Lead Information Center Clearinghouse, 1-800-424-LEAD); and
- Final classification of all testing combinations into positive or negative categories, including a list of testing combinations, or building component types and their substrates, that were classified but not individually tested. *(Note that the final report should not list inconclusive readings as a third category. If the client wishes to assume all inconclusive readings are positive, the report should state that assumption and present all readings and testing combinations for which the readings were inconclusive. It is not permissible to assume all inconclusive readings are negative. The report should include the actual readings for any testing combinations for which readings were inconclusive, but were classified as positive. Also note that final classifications are needed for building component types and their substrates that were not actually tested. For example, if the client wants to suspend testing on testing combinations that were found to be positive in the first five room equivalents and are assumed to be positive in the remaining rooms, the final report should list those testing combinations that are assumed to be positive).*

The report should also contain a summary that answers two questions:

(1) Is there lead-based paint in the house? *and*
(2) if lead-based paint is present, where is it located?

The summary report should also include the house address where the inspection was performed, the date(s) of the inspection, the name, address and phone numbers of the inspector and inspection firm, any appropriate license or certification numbers, and the starting and ending times for each day when XRF testing was done. The summary should also contain language regarding disclosure, such as:

> "A copy of this summary must be provided to new lessees (tenants) and purchasers of this property under Federal law (24 CFR part 35 and 40 CFR part 745) before they become obligated under a lease or sales contract. The complete report must also be provided to new purchasers and it must be made available to new tenants. Landlords (lessors) and sellers are also required to distribute an educational pamphlet and include standard warning language in their leases or sales contracts to ensure that parents have the information they need to protect their children from lead-based paint hazards."

Although 24 CFR part 35 and 40 CFR part 745 do not require that inspectors and owners keep copies of inspection reports for any specified period of time, future buyers are entitled to all available inspection reports, should the property be re-sold.

If no lead-based paint has been detected in the house, the summary should say so. The following language may be used:

"The results of this inspection indicate that no lead in amounts greater than or equal to 1.0 mg/cm² in paint was found on any building components, using the inspection protocol in Chapter 7 of the *HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing (1997)*. Therefore, this dwelling qualifies for the exemption in 24 CFR part 35 and 40 CFR part 745 for target housing being leased that is free of lead-based paint, as defined in the rule. However, some painted surfaces may contain levels of lead below 1.0 mg/cm², which could create lead dust or lead-contaminated soil hazards if the paint is turned into dust by abrasion, scraping, or sanding. This report should be kept by the inspector and should also be kept by the owner and all future owners for the life of the dwelling."

Detailed documentation of the XRF testing should also be provided in the full report, including the raw data upon which it was based. The single-family housing forms provided at the end of this chapter or comparable forms would serve this purpose.

For a leased home, where no lead-based paint is identified during an inspection, the building owner is exempt from the requirements of the disclosure rule. However, when a housing unit with no lead-based paint is being sold, the owner still has responsibilities under the disclosure rule (e.g., providing a lead hazard information pamphlet to potential buyers). For selling and leasing properties where no lead-based paint is identified, it is strongly recommended that owners and inspectors retain inspection reports for the life of the building.

V. Inspections in Multifamily Housing

This section emphasizes the differences between single-family and multifamily housing paint inspections. The protocols mentioned in earlier sections are not repeated here. It will be necessary to read Section IV on single-family housing to implement the protocol for multifamily housing.

Use of the multifamily protocol is less time-consuming and more cost effective than inspecting all units in a given housing development or building because in most instances a pattern can be determined after inspecting a fraction of the units. The number of units tested is based on the date of construction and the number of units in the housing development.

For purposes of this chapter only, multifamily housing is defined as any group of units that are similar in construction from unit to unit, with:

- 21 or more units, if any were built before 1960 or are of unknown age, or
- 10 or more units, if they were all built from 1960 through 1977.

Developments with fewer units should be treated as a series of single-family housing units.

A. Statistical Confidence in Dwelling Unit Sampling

The number of similar units, similar common areas or exterior sites to be tested (the sample size) is based on the total number units, similar common areas or exterior sites in the building(s), as specified in Table 7.3. Use the table for sampling each set of similar units, each set of similar common areas and each set of exterior sites. For pre-1960 or unknown-age buildings or developments with 1,040 or more similar units, similar common areas or exterior sites, test 5.8 percent of them, and round up any fraction to the next whole number. For 1960-77 buildings or developments with 1,000 or more units, test 2.9 percent of the units, and round up any fraction to the next whole number. For reference, the table shows entries from 1500 to 4000 in steps of 500. For example, in a development built in 1962, with 200 similar units, 20 similar common areas, and 9 similar exterior sites, sample 27 units, 16 common areas, and all 9 exterior sites.

If lead levels in *all* units, common areas or exterior sites tested are found to be below the 1.0 mg/cm² standard, these sample sizes provide 95 percent confidence that:

- For pre-1960 housing units, less than 5 percent or fewer than 50 (whichever is less) units, common areas or exterior sites, have lead at or above the standard; and

- For 1960 to 1977 housing units, less than 10 percent or fewer than 50 (whichever is less) units, common areas or exterior sites, have lead at or above the standard.

Refer to Appendix 12 of these Guidelines for the statistical rationale for this table. The Appendix shows the details of the calculation for pre-1960 housing; the calculation is the same for 1960-1977 housing, except for using the 10 percent criterion for 1960-1977 housing, rather than the 5 percent used for older housing.[3]

Table 7.3: Number of Units to be Tested in Multifamily Developments

Number of Similar Units, Similar Common Areas or Exterior Sites in a Building or Development	Pre-1960 or Unknown-Age Building or Development: Number to Test	1960-1977 Building or Development: Number to Test
1-9	All	All
10-13	All	10
14	All	11
15	All	12
16-17	All	13
18	All	14
19	All	15
20	All	16
21-26	20	16
27	21	17
28	22	18
29	23	18
30	23	19
31	24	19
32	25	19
33-34	26	19
35	27	19
36	28	19
37	29	19
38-39	30	20
40-48	31	21
49-50	31	22
51	32	22
52-53	33	22
54	34	22
55-56	35	22

Number of Similar Units, Similar Common Areas or Exterior Sites in a Building or Development	Pre-1960 or Unknown-Age Building or Development: Number to Test	1960-1977 Building or Development: Number to Test
57-58	36	22
59	37	23
60-69	38	23
70-73	38	24
74-75	39	24
76-77	40	24
78-79	41	24
80-88	42	24
89-95	42	25
96-97	43	25
98-99	44	25
100-109	45	25
110-117	45	26
118-119	46	26
120-138	47	26
139-157	48	26
158-159	49	26
160-177	49	27
178-197	50	27
198-218	51	27
219-258	52	27
259-279	53	27
280-299	53	28
300-279	54	28
380-499	55	28
500-776	56	28
777-939	57	28

Number of Similar Units, Similar Common Areas or Exterior Sites in a Building or Development	Pre-1960 or Unknown-Age Building or Development: Number to Test	1960-1977 Building or Development: Number to Test
940-1004	57	29
1005-1022	58	29
1023-1032	59	29
1033-1039	59	30
1500	87	44
2000	116	58
2500	145	73
3000	174	87
3500	203	102
4000	232	116

Although the data set used to develop sample sizes in multifamily housing[4] was not randomly selected from all multifamily housing developments in the nation (no such data set is available), analyses drawn from the data are likely to err on the side of safety and public health for at least two reasons: First, the prevalence and amounts of lead-based paint are highest in pre-1960 housing developments. The sampling approach used here focuses inspection efforts on buildings where a greater chance of lead-based paint hazards exist.

Second, and perhaps more important, none of the 65 developments had lead-based paint in 5 to 10 percent of the units. That indicates lead-based paint in this range is likely to be quite rare and that plausible increases in sampling to improve detection in this range will fail to improve confidence in the results significantly. Most painting follows a pattern: Property owners or managers often paint all surfaces, all components within a room, or similar components in all rooms in a unit when there is tenant turnover. It is unlikely that lead-based paint distributions are completely random, as assumed in the 1995 edition of the *Guidelines*. From the available data, there appears to be no significant benefit to increasing the number of units to be sampled to detect a prevalence rate of 5 to 10 percent, because few developments are likely to be in that range. In short, the sampling design presented here will yield a more targeted, cost-effective approach to identifying lead-based paint where it is most likely to exist.

B. Selection of Housing Units

The first step in selecting housing units is to identify buildings in the development with a common construction based on written documentation or visual evidence of construction type. Such buildings can be grouped together for sampling purposes. For example, if two buildings in the development were built at the same time by the same builder and appear to be of similar construction, all of the units in the two buildings can be grouped for sampling purposes. Units can have different sizes, floor plans, and number of bedrooms and still be grouped.

The specific units to be tested should be chosen *randomly* from a list of all units in each building or buildings. The "Selection of Units" form (Form 7.4) or a comparable form may be used to aid in the selection process. A complete list of all units in each group should be used and a separate identifying sequential number must be assigned to each unit. For example, if apartment addresses are shown as 1A, 1B, 2A, 2B etc., they must be given a sequence number (1, 2, 3, 4, etc.).

Obviously, units without identifiers could not be selected for inspection and would thus bias the sampling scheme. The list of units should be complete and verified by consulting building plans or by a physical inspection of the development.

Specific units to be tested should be selected randomly using the formula below, and a table of random numbers or the random number function on a calculator. Tables of random numbers are often included in statistics books. Calculators with a random number function key can be obtained for less than $20 and are easier to use than tables. Inspectors are, therefore, advised to use them to obtain the random numbers, which can then be used to select the specific numbered units. A unit number is selected by rounding up the product of the random number times the total number of units in the development to the *next* whole number. That is:

Housing Unit number = Random number *times* Total number, rounded *up*,

where:

Housing Unit number = the identification number for a unit in a list;

Random number = a random number between 0 and 1; *and*

Total number = the total number of units in a list of units.

The same unit may be selected more than once by this procedure. Because each unit should be tested only once, duplicate selection should be documented and then discarded. The procedure should be continued until an adequate number of units has been selected.

The "Selection of Units" form (Form 7.4) is completed by filling in as many random numbers as are needed in the appropriate column. Numbers for the third column are obtained by multiplying the total development size by each random number. Numbers for the fourth column are obtained by rounding up from the previous calculation to the next whole number. If the whole number in the fourth column has already been selected, that selection should not be entered again. The notation "DUP" should be entered to show that the selection was a duplicate. This process should continue until the required number of distinct sample numbers have been selected. Common areas and exterior room equivalents should be identified at this time, but they are not considered to be separate units.

C. Listing Testing Combinations

The "Multifamily Housing LBP Testing Data Sheet" form (Form 7.5) -- or a comparable form -- should be used to list the testing combinations in each unit, common area and exterior site that was selected for inspection. In multifamily housing, the inventory of testing combinations often will be similar for units that have the same number of bedrooms. The inspector should, however, list testing combinations that are unique to each tested unit. For example, some units may contain built-in cabinets while others do not. The selection of testing combinations should, therefore, be carried out independently in each inspected unit.

As in single family housing, take readings on all testing combinations in all room equivalents in each unit selected for testing.

1. Common Areas

Similar common areas and similar exterior sites must always be tested, but in some cases they can be sampled in much the same way that dwelling units are. Common areas and building exteriors typically have a similar painting history from one building to the next. In multifamily housing, each common area (such as a building lobby, laundry room, or hallway) can be treated like a dwelling unit. If there are multiple similar common areas, they may be grouped for sampling purposes in exactly the same way as regular dwelling units are. However, dwelling units, common areas and exterior sites cannot all be mixed together in a single group.

All testing combinations within each common area or on building exteriors selected for testing must be inspected. This includes playground equipment, benches and miscellaneous testing combinations located throughout the development. The specific common areas and building exteriors to test should be randomly selected, in much the same way as specific units are selected using random numbers. (See Section IV.B, above).

The number of common areas to test should be taken from Table 7.3. In this instance, common areas and building exteriors can be treated in the same way as housing units (although they are not to be confused with true housing units).

D. Number of Readings on Each Testing Combination

The method for collecting XRF readings is identical for multifamily and single-family housing (see Section IV).

E. XRF Calibration Check Readings

The method for collecting and evaluating XRF calibration check readings is identical for multifamily and single-family housing (see Section IV.D).

F. Substrate Correction in Multifamily Housing

The method for correcting XRF readings for substrate bias is identical for multifamily and single-family housing (see Section IV.E) with one exception: For multifamily housing, randomly select two housing units to be used to collect substrate measurements for all substrates within the development that need correction, and use the results from those two units to perform substrate correction calculations in all tested units within the development or building. If substrates exist in common areas or on exterior sites that do not exist in residential areas, select two locations from these areas for substrate correction. Otherwise, the same substrate correction readings can be applied to dwelling units, common areas and exterior sites.

G. Classification of XRF Results in Multifamily Housing

The inspector should record each XRF reading for each testing combination on the "Multifamily Housing LBP Testing Data Sheet," (Form 7.5) or a comparable form, and indicate whether that testing combination was classified as positive, negative, or inconclusive as described previously for single-family housing.

When the inspection is completed in all of the selected units and the classification rules have been applied to all XRF results, the "Multifamily Housing: Component Type Report" form (Form 7.6) or a comparable form should be completed. Building component types -- groups of like components constructed of the same substrate in the multifamily housing development -- are aggregated on this form. For example, grouping all interior walls would create an appropriate component type if all walls are plaster. Grouping all doors would not be appropriate, however, if some doors are metal and some are wood. At least 40 testing combinations of a given component type in a multifamily housing development must be tested to obtain the desired level of confidence in the results. (Refer to Appendix 12 of these *Guidelines* for the statistical rationale for this minimum number of component types to test.) If fewer than 40 testing combinations of a given component type were tested, test additional combinations of that component type. If less than 40 components of a given type exist in the units to be tested, test all of the components that do exist.

In some cases additional sampling of the specific component may not be necessary. If no lead at or above the standard is found on that component type, additional measurements should be taken in other units to increase the sample size to 40. However, if all or most of the sampled component types are positive, no further sampling is needed, provided that the building owner agrees with this reduction of testing. For example, if 20 out of 60 doors are tested, and the majority are positive for lead-based paint, all similar doors in the buildings may be presumed positive. Note, however, that all required XRF testing and laboratory analysis, if necessary, must be completed to conclude that all components included in a given component type are negative.

On the "Multifamily Housing: Component Type Report" form, the substrate, and component for each component type should be recorded under the heading “Description” (for example, wooden interior doors) as well as the total number of testing combinations included in the component type. In addition, for each component type, the aggregated positive, negative, and inconclusive classifications should be recorded as described below. Record the number and percentage of testing combinations classified as:

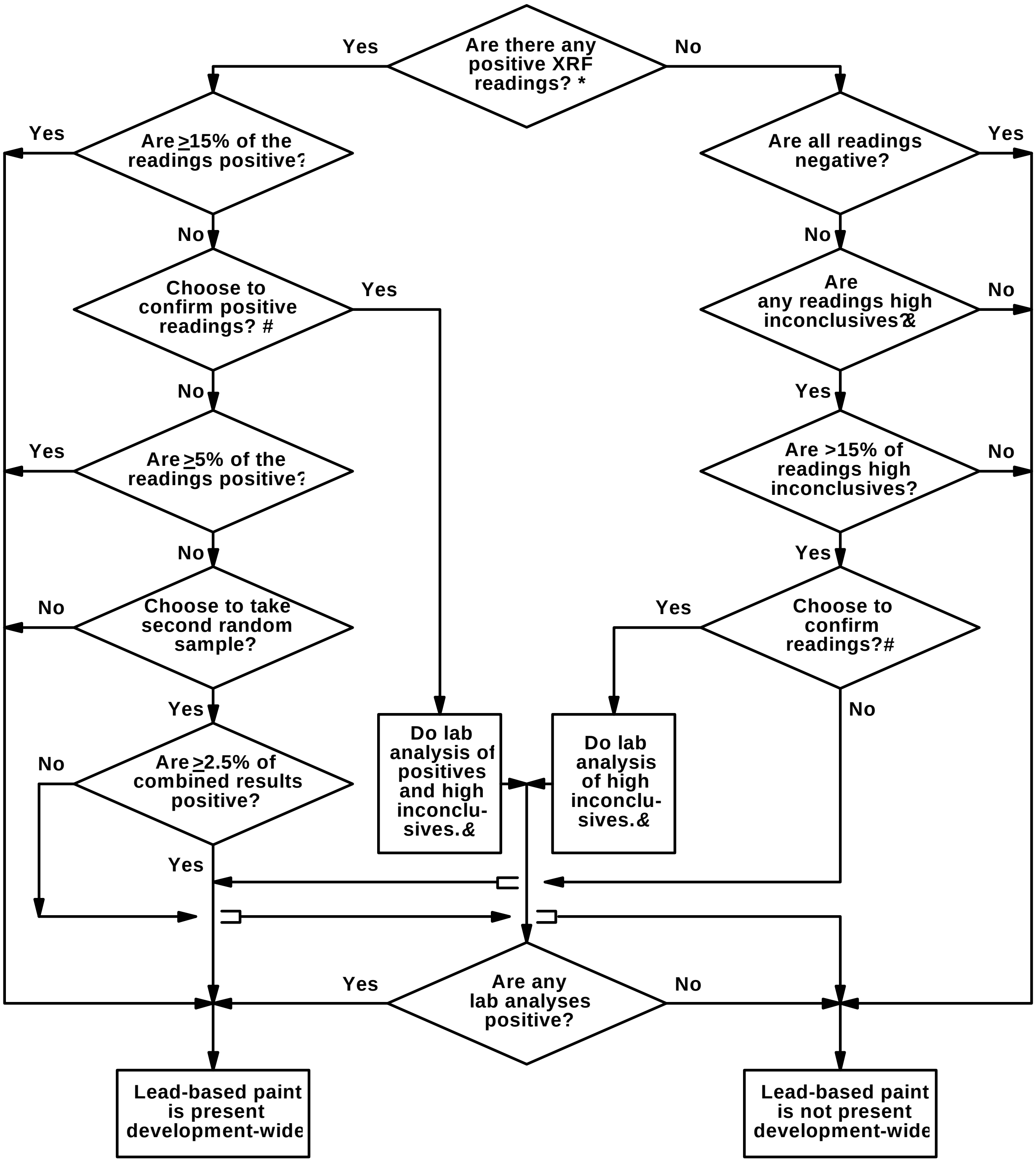
- Positive for lead-based paint. This is based upon a positive XRF reading in accordance with the XRF's Performance Characteristic Sheet;
- Inconclusive and having XRF readings less than the midpoint of the XRF's inconclusive range ("low inconclusive");
- Inconclusive and having XRF readings equal to or greater than the midpoint of the XRF's inconclusive range ("high inconclusive"); and
- Negative for lead-based paint.

The "Multifamily Decision Flowchart" (Figure 7.1) should be used to interpret the aggregated XRF testing results in the "Multifamily Housing: Component Type Report" form. The flowchart is applied separately to each component/substrate type (wood doors, metal window casings, etc.) and shows one of the following results:

- **Positive**: Lead based-paint is present on one or more of the components.
- **Negative**: Lead based-paint is not present on the components throughout the development. (Lead may still be present at lower loadings and hazardous leaded dust may be generated during modernization, renovation, remodeling, maintenance, or other disturbances of painted surfaces.)

These results are obtained by following the flowchart. The decision that lead-based paint is present is reached with 99 percent confidence if 15 percent or more of the components are positive. (Refer to Appendix 12 for the statistical rationale for this percentage.) The decision that lead-based paint is not present throughout the development is reached if: (1) 100 percent of the tested component types are negative, or (2) 100 percent of the tested component types are classified as either negative or inconclusive *and* all of the inconclusive classifications have XRF readings less than the midpoint of the inconclusive range for the XRF in use. Note that the midpoint of the inconclusive range is *not* a threshold; it is used only for classifying XRF readings in multifamily housing in conjunction with information about other XRF readings as described here. (See section 2 below for guidance on what to do when the percentage of positive readings is less than 5%). For cases with greater than or equal to 5% positives *and* less than 15% positives, as well as no positives but greater than 15% high inconclusives, some confirmatory laboratory testing may be needed to reach a final conclusion, unless the client wishes to assume the validity of the XRF results and that all inconclusives are positive. For each testing combination with an inconclusive XRF reading at or above the midpoint of the inconclusive range, a paint-chip sample should be analyzed by a laboratory recognized by the EPA National Lead Laboratory Accreditation Program. If all the laboratory-analyzed samples are negative, it is not necessary to test inconclusive XRF results below the midpoint of the inconclusive range. If, however, *any* laboratory results are positive on a component type, all inconclusives equal to or above the midpoint of the inconclusive range should be analyzed. Once all laboratory results have been reported, the "Multifamily Housing: Component Type Report" form should be updated to include the laboratory results and classifications (either positive or negative).

The "Multifamily Decision Flowchart" is based on data collected by EPA in a large field study of XRF instruments (EPA 1995). Percentages were chosen so that, for each component type, there is a 98 percent chance of correctly concluding that lead-based paint is either absent on all components or present on at least one component of a given



** "Positive," "negative," and "inconclusive" XRF readings are determined in accordance with the XRF instrument's Performance Characteristics Sheet as described in the HUD Guidelines for the Evaluation and Control of Lead Hazards in Housing, chapter 7.*

& A high inconclusive reading is an XRF reading at or above the midpoint of the inconclusive range. For example, if the inconclusive range is 0.41 to 1.39, its midpoint (average) is 0.90; a reading in the range from 0.90 to 1.39 would be a high inconclusive reading.

 # Any paint or coating may be assumed to be lead-based paint, even without XRF or laboratory analysis. Similarly, any XRF reading may be confirmed by laboratory analysis.

Figure 7.1 Multifamily Decision Flowchart

type. Thus, the probability that a tested component type will be correctly classified is very high.

Percentages of positive or inconclusive results are computed by dividing the number in each classification group by the total number of testing combinations of the component type that were tested. For example, if 245 wooden doors in a multifamily housing development were tested and 69 were classified as inconclusive with XRF readings less than the midpoint of the inconclusive range, 28 percent [(69 / 245) x 100 percent = 28.2 percent] should be recorded on the form in the "<1.0 percent" columns under the heading "Inconclusive."

1. Unsampled Housing Units

If a particular component type in the sampled units is classified as positive, that same component type in the unsampled units is also classified as positive. For those cases where the number of positive components is small, further analysis may determine if there is a systematic reason for the specific mixture of positive and negative results.

For example, suppose that a few porch railings tested negative, but most tested positive. Examination of the sample results in conjunction with the building records showed that the porch railings classified as positive were all original and the railings classified as negative were all recent replacements. The records did not reveal which units had replaced railings, and due to historic preservation requirements, the replacement railings were identical in appearance to the old railings. Thus, all unsampled original porch railings could be classified as positive, and all unsampled recently replaced porch railings could be classified as negative if at least 40 of the replaced porch railings had been tested.

2. Fewer than 5% Positive Results

Where a small fraction of XRF readings, less than 5 percent, of a particular component type are positive, several choices are available:

- First, the inspector may confirm the results by laboratory analysis, which is considered definitive when performed as described in Section VI, below; a laboratory lead result of 1.0 mg/cm² or greater (or 0.5 percent by weight or greater) is considered positive.

- Second, the inspector may select a second random sample (using unsampled units only) and test the component type in those units. If less than 2.5% of the combined set of results is positive, the component type may be considered as not having lead-based paint development-wide, but, rather, having lead-based paint in isolated locations, with a reasonable degree of confidence. Individual components that are classified positive should be considered as being lead-based painted and managed or abated appropriately.

- Finally, if the client chooses not to confirm the results by laboratory analysis and not to take a second set of measurements, then the component type should be considered as having lead-based painted development-wide.

The inspector may wish to advise the client that the cost of additional XRF testing or laboratory analysis is usually much less than the cost of lead abatement or interim control projects, and that this is of particular interest in the situation where few results are positive, because there is a significant chance that the paint, development-wide, may not be lead-based.

Whatever approaches are used, all painted individual surfaces found to be positive for lead must be included in the inspection report, regardless of development-wide conclusions.

H. Evaluation of the Inspection

The methods for evaluating inspection services in multifamily housing are identical to those described for single-family housing (see Section IV.H) except for the retesting option: In multifamily housing, a total of 10 testing combinations should be selected for retesting in two units.

I. Documentation in Multifamily Housing

The method for documentation is identical for multifamily and single-family housing (see Section IV.I), with the following exception: Use forms 7.2

through 7.6 for multifamily housing (see Addendum 2) or comparable forms, not the single-family housing forms.

When lead-based paint has been found in some units it must be managed or treated as such in those units, even if the inspection indicates that it is not present development wide.

VI. Laboratory Testing for Lead in Paint

For inconclusive XRF results and areas that cannot be tested using an XRF instrument, a paint-chip sample should be collected using the protocol outlined here and in Appendix 13.2 of these *Guidelines*. The sample should be analyzed by a laboratory recognized under the EPA National Lead Laboratory Accreditation Program (NLLAP) using the analytical method(s) it used to obtain the laboratory's recognition. If a paint chip sample cannot be collected, the inspection report should include a list of surfaces where paint chip samples were needed but not taken (in this case, the client would assume that inconclusives requiring confirmation by laboratory analysis are positive).

A. Number of Samples

Only one paint-chip needs to be taken for each testing combination. Additional samples can be collected as a quality control measure, if desired.

B. Size of Samples

The paint-chip sample should be taken from a 4-square-inch (25-square-centimeter) area that is representative of the paint on the testing combination, as close as possible to any XRF reading location and, if possible, unobtrusive. This area may be a 2 by 2 inch (5 by 5 centimeter) square, or a 1 by 4 inch (2½ by 10 centimeter) rectangle, or have any other dimensions that equal at least 4 square inches (25 square centimeters). Regardless of shape, the dimensions of the surface area must be accurately measured (to the nearest millimeter or 1/16th of an inch) so that laboratory results can be reported in mg/cm^2. Results should be reported as percent by weight if the dimensions of the surface area cannot be accurately measured or if all paint within the sampled area cannot be removed. In these cases, lead should be reported in ppm or percent by weight, _**not**_ in mg/cm^2. Smaller surface areas can be used if acceptable to the laboratory.

The 4-square-inch (25-square-centimeter) area practically guarantees that a sufficient amount of paint will be collected for laboratory analysis. As a result, samples will sometimes weigh more than required for some laboratory analysis methods. Smaller-sized paint chips may be collected if permitted by the laboratory. (See ASTM E 1729). In all cases, the inspector should consult with the NLLAP recognized laboratory selected regarding specific requirements for the submission of samples for lead-based paint analysis.

C. Inclusion of Substrate Material

Inclusion of small amounts of substrate material in the paint-chip sample will result in minimal error if results are reported in mg/cm^2, but including any amount of substrate can result in less precise results, with worse effect as the amount of substrate increases. Substrate material may not be included if results are to be reported in weight percent (or ppm).

D. Repair of Sampled Locations

Areas from which paint-chip samples are collected should be repaired and cleaned, unless the area will be removed, encapsulated, enclosed, or repainted before occupancy. Repairs can be completed by repainting, spackling, or any other method of covering that renders the bare surface inaccessible. Cleanup should be done with wet wiping and rinsing, and it should be done on both the surface and the floor underneath the surface sampled. The new covering or coating should have the same expected longevity as new paint or primer. Repair is not necessary if analysis shows that the paint is not lead-based paint and leaving the damage is acceptable to the client and/or the owner.

E. Classification of Paint-Chip Sample Results

Any paint inspections may be carried out using only paint-chip sampling and laboratory analysis at the option of the purchaser of the inspection services. This option is not recommended because it is time consuming, costly, and requires extensive repairs. Paint-chip sampling also has opportunities for errors, such as inclusion of substrate material (for results in weight percent), failure to remove all paint from an area (including paint that has bled into a substrate) and laboratory error. Nevertheless, paint-chip sampling generally has a smaller error than does XRF and is, therefore, appropriate as a final decisionmaking tool. Laboratory results of 1.0 mg/cm² or greater, or 0.5 percent or greater, are to be considered positive. If the laboratory reports both mg/cm² and weight percent for a sample, use whichever result is positive (if any) for final classification. In the rare situation where more than one paint-chip sample from a single testing combination is analyzed, the combination is considered positive if any of those samples is positive. All other results are negative. No inconclusive range is reported for laboratory measurements.

F. Units of Measure

Results should be reported in mg/cm², the primary unit of measure for lead-based paint analyses of surface coatings. Results should be reported as percent by weight only if the dimensions of the surface area cannot be accurately measured or if not all paint within the sampled area can be removed. In these cases, results should not be reported in mg/cm², but in weight percent.

Weight measurements are usually reported as micrograms per gram (μg/g), milligrams per kilogram (mg/kg), or parts per million (ppm) by weight. For example, a sample with 0.2 percent lead may also be reported as 2,000 μg/g lead, 2,000 mg/kg lead, or 2,000 ppm lead.

G. Sample Containers

Samples should be collected in sealable rigid containers such as screw-top plastic centrifuge tubes, rather than plastic bags which generate static electricity and make quantitative transfer of the entire paint sample in the laboratory impossible. Paint-chip collection should include collection of all the paint layers from the substrate, but collection of actual substrate should be minimized. Refer to ASTM E 1729 and Appendix 13 of these *Guidelines* for further details on collection of paint-chip samples.

H. Laboratory Analysis Methods

Several standard laboratory technologies are useful in quantifying lead levels in paint-chip samples. These methods include, but are not limited to, Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES), Anodic Stripping Voltammetry (ASV), and Potentiometric Stripping Voltammetry (PSV).

For analytical methods that require sample digestion, samples should be pulverized so that there is adequate surface area to dissolve the sample before laboratory instrument measurement. In some cases, the amount of paint collected from a 4-square-inch (25-square-centimeter) area may exceed the amount of paint that can be analyzed successfully. It is important that the actual sample mass analyzed not exceed the maximum mass the laboratory has successfully tested using the specified method. If subsampling is required to meet analytical method specifications, the laboratory must homogenize the paint-chip sample (unless the entire sample will eventually be analyzed and the results of the subsamples combined). Without homogenization, subsampling would likely result in biased, inaccurate lead results (see ASTM E 1645). See ASTM PS 87 for an ultrasonic extraction method for preparing paint samples for subsequent analysis for lead.

If the sample is properly homogenized and substrate inclusion is negligible, the result can be reported in either milligrams per square centimeter (mg/cm²; the preferred unit), percent by weight, or both. The following equation should be used to report the results in milligrams per square centimeter:

$$\text{mg/cm}^2 = \frac{\text{weight of lead from subsample (in mg)} \times \dfrac{\text{total sample weight (in g)}}{\text{subsample weight (in g)}}}{\text{sample area (in cm}^2\text{)}}$$

To report results in weight percent, the following equation should be used:

Weight percent = weight of lead in the subsample/weight of subsample x 100.

To report results in micrograms per gram ($\mu g/g$), the following equation should be used:

$$\mu g/g = \frac{\text{weight of lead from subsample (in } \mu g)}{\text{subsample weight (in g)}}$$

If the laboratory reports results in both mg/cm^2 and weight percent, and if one result is positive and the other negative, the sample is classified as positive.

Whatever the preparation techniques of paint-chip samples (including homogenization, grinding, and digestion), and instrument selection and operation selected, the inspector should verify, prior to the collection and submission of samples, that the laboratory is approved to perform the appropriate analytical methodologies. Methods should be applied to paint-chip materials of approximately the same mass and lead loading (also called area concentration, measured in mg/cm^2) as those samples anticipated from the field.

Because of the potential for sample mass to affect the precision of lead readings, laboratory analysis reference materials processed with field samples for quality assurance purposes should have close to the same mass as those used for paint-chip samples. Refer to ASTM E 1645 or equivalent methods for further details on laboratory preparation of paint-chip samples, and refer to ASTM E 1613, ASTM E 1775, ASTM PS 88, or equivalent methods on analysis of samples for lead.

I. Laboratory Selection

Only a laboratory recognized under EPA's National Lead Laboratory Accreditation Program (NLLAP) should be used for lead-based paint analysis. Such a laboratory is required to use the same analytical methods that it used to obtain accreditation. EPA established NLLAP to provide the public with laboratories that have a demonstrated capability for analyzing lead in paint chip, dust, and soil samples at the levels of concern stated in these *Guidelines*. In some states, an NLLAP laboratory *must* be used. To participate in NLLAP, a laboratory must:

- Participate successfully in the Environmental Lead Proficiency Analytical Testing Program (ELPAT). ELPAT is administered by the American Industrial Hygiene Association (AIHA) in cooperation with the Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH), and EPA. The proficiency testing samples used in ELPAT consist of variable levels of lead in paint, dust, and soil matrices.

- Undergo a systems audit, including an on-site visit. The systems audit must be conducted by an accrediting organization with a program recognized by EPA through a Memorandum of Understanding (MOU). Laboratory accrediting organizations participating in NLLAP have accrediting program requirements that meet or exceed NLLAP laboratory quality system requirements stated in the MOU.

An up-to-date list of fixed-site and mobile laboratories recognized by the EPA NLLAP for analysis of paint-chip samples may be obtained from the National Lead Information Center Clearinghouse by calling 1-800-424-LEAD or from the Lead Listing at http://www.leadlisting.org. Since December 1993, the American Association for Laboratory Accreditation (A2LA) and AIHA have been recognized as laboratory-accrediting organizations participating in NLLAP. NLLAP specifies quality control and data reporting requirements, as described in "Laboratory Quality System Requirements," which can be found in Appendix A of the NLLAP Model MOU. The MOU can also be obtained by calling the National Lead Information Center Clearinghouse, at the number above. The evaluation approach in ASTM E 1583 may be considered in selecting laboratories to use from among available NLLAP-recognized laboratories.

J. Laboratory Report

The laboratory report for analysis of paint samples for lead should include both identifying information and information about the analysis. At a minimum, this should include:

- Laboratory identifying information: including the laboratory's name, address, and phone number, and NLLAP and other applicable certification and accreditation information; similarly, the client and/or project's name and address should be provided.

- Analytical method information: including the information provided in accordance with NLLAP procedures, and ASTM E 1613, ASTM PS 88 or equivalent method(s) for analysis for lead.

- Sample information: including field sample number and any information (e.g., sample type and/or location) given to the laboratory about the sample, unique laboratory sample number, analytical method (including a description of any variations from the standard method), quality control/quality assurance results, date of analysis, operational or testing problems or unusual occurrences.

VII. Radiation Hazards

Portable XRF instruments used for lead-based paint inspections contain radioactive isotopes that emit X rays and gamma radiation. Proper training and handling of these instruments is required to protect the instrument operator and any other persons in the immediate vicinity during XRF usage. The XRF instrument should be in the operator's possession at all times. The operator should never defeat or override any safety mechanisms of XRF equipment.

A. XRF Use Licenses and Certification

In addition to training and certification in lead-based paint inspection, a person using a portable XRF instrument for inspection must have valid licenses or permits from the appropriate Federal, State, and local regulatory bodies to operate XRF instruments because of radioactive materials they contain. All portable XRF instrument operators should be trained by the instrument's manufacturer (or equivalent). XRF operators should provide related training, licensing, permitting, and certification information to the person who has contracted for their services before an inspection begins. Depending on the State, operators may be required to hold three forms of proof of competency: manufacturer's training certificate (or equivalent), a radiation safety license, and a State lead-based paint inspection certificate or license. To help ensure competency and safety, HUD and EPA recommend that clients hire only those inspectors who hold all three.

The regulatory body responsible for oversight of the radioactive materials contained in portable XRF instruments depends on the type of material being handled. Some radioactive materials are Federally regulated by the U.S. Nuclear Regulatory Commission (NRC); others are regulated at the State level. States are generally categorized as "agreement" and "non-agreement" States. An agreement State has an agreement with NRC to regulate radioactive materials that are generally used for medical or industrial applications. (Most radioactive materials found in XRF instruments are regulated by agreement States). For non-agreement States, NRC retains this regulatory responsibility directly. At a minimum, however, most State agencies require prior notification that a specific XRF instrument is to be used within the State. Fees and other details regarding the use of portable XRF instruments vary from State to State. Contractors who provide inspection services must hold current licenses or permits for handling XRF instruments, and must meet any applicable State or local laws or notification requirements.

Requirements for radiation dosimetry by the XRF instrument operator (wearing dosimeter badges to monitor exposure to radiation) are generally specified by State regulations, and vary from State to State. In some cases, for some isotopes, no radiation dosimetry is required. Because the cost of dosimetry is low, it should be conducted, even when not required, for the following four reasons:

- XRF instrument operators have a right to know the level of radiation to which they are exposed during the performance of the job. In virtually all cases, the exposure will be far below applicable exposure limits.

- Long-term collection of radiation exposure information can aid both the operator (employee) and the employer. The employee benefits by knowing when to avoid a hazardous situation; the employer benefits by having an exposure record that can be used in deciding possible health claims.

- The public benefits by having exposure records available to them.

- The need for equipment repair can be identified more quickly.

B. Safe Operating Distance

XRF instruments used in accordance with manufacturer's instructions will not cause significant exposure to ionizing radiation. But the instrument's shutter should never be pointed at anyone, even if the shutter is closed.

The safe operating distance between an XRF instrument and a person during inspections depends on the radiation source type, radiation intensity, quantity of radioactive material, and the density of the materials being surveyed. As the radiation source quantity and intensity increases, the required safe distance also increases. Placing materials, such as a wall, in the direct line of fire, reduces the required safe distance. According to NRC rules, a radiation dose to an individual in any unrestricted area must not exceed 2 millirems per hour. One of the most intense sources currently used in XRF instruments is a 40-millicurie ^{57}Co (Cobalt-57) radiation source. Other radiation sources in current use for XRF testing of lead-based paint generally produce lower levels of radiation. Generally, an XRF operator conducting inspections according to manufacturer's instructions would be exposed to radiation well below the regulatory level (State of Wisconsin 1994). Typically, XRF instruments with lower gamma radiation intensities can use a shorter safe distance provided that the potential exposure to an individual will not exceed the regulatory limit.

Persons should not be near the other side of a wall, floor, ceiling or other surface being tested. Verify that this is indeed the case prior to initiating XRF testing activities, and check on it during testing.

If these practices are observed, the risk of excessive exposure to ionizing radiation is extremely low and will not endanger any inspectors or occupants present in the dwelling.

VIII. REFERENCES

EPA 1995. "A Field Test of Lead-Based Paint Testing Technologies: Technical Report, EPA 747-R-95-002b, U.S. Environmental Protection Agency, Washington DC, May 1995.

EPA and HUD 1996. 24 CFR 35, subpart H, and 40 CFR 745, subpart F. Requirements for Disclosure of Known Lead-Based Paint and/or Lead-Based Paint Hazards in Housing. Published, along with their preamble, in the *Federal Register*, volume 61, pp. 9064-9088, March 6, 1996. Implements Section 1018 of Title X.

EPA 1996. 40 CFR 745, subparts L and Q. Requirements for Lead-Based Paint Activities in Target Housing and Child-Occupied Facilities. Published, along with its preamble, in *Federal Register*, volume 61, pp. 45777-45830, August 29, 1996. Implements Sections 402 and 404 of the Toxic Substances Control Act.

State of Wisconsin 1994. Wisconsin Department of Health and Social Services, memo from Mark Chamberlain dated April 28, 1994. Measurements showed that exposures to radiation during operation of a Scitec MAP 3 XRF were 132 µrem/day, which can be compared to about 1,400 µrem/day from natural background radiation.

Addendum 1

Examples of Lead-Based Paint Inspections

A. Example of a Single-Family Housing Inspection

The inspector completed the "Single-Family Housing LBP Testing Data Sheet," recording "bedroom (room 5)" as the room equivalent and listing "plaster" as the first substrate. The completed inventory of testing combinations in the bedroom indicated the presence of wood, plaster, metal, and drywall substrates. Brick and concrete substrates were not present in the bedroom. Descriptions of all testing combinations in the bedroom were recorded. Completed Form 7.1 shows the completed inventory for all testing combinations in the bedroom. (Completed Forms are found in Addendum 3, after the blank forms.)

Before any XRF testing, the inspector performed the manufacturer's recommended warm up procedures. The film was placed more than 12 inches (0.3 meters) away from a painted or other surface. The inspector then took three calibration check readings (1.18 mg/cm², 0.99 mg/cm², and 1.07 mg/cm²) on the NIST SRM with a lead level of 1.02 mg/cm². Results of the first calibration check readings were recorded on the "Calibration Check Test Results" form (see Completed Form 7.2).

The inspector then averaged the three readings (1.08 mg/cm²), and computed the calibration difference (1.08 mg/cm² - 1.02 mg/cm² = 0.06 mg/cm²) and compared this to the calibration check tolerance shown in the *XRF Performance Characteristic Sheet* (see Completed Form 7.2). The calibration difference was not greater than the 0.20 calibration check limits around the NIST SRM standard of 1.02 mg/cm², that is, the difference was within the range of 0.82 mg/cm² to 1.22 mg/cm², inclusive. The instrument was considered in calibration, and XRF testing could begin.

The inspector recorded the results from the XRF testing in the bedroom on the "Single-Family Housing LBP Testing Data Sheet." At that point, the inspector was able to complete this form only through the XRF Reading column (see Completed Form 7.1). The remainder of the form was completed after the testing combinations in the house were inspected and correction values for substrate bias were computed. The inspector then moved on to inspect the next room equivalent.

The other bedroom, the kitchen, a living room, and a bathroom were also inspected. Three substrates -- wood, drywall, and plaster -- were found in these room equivalents. XRF testing for lead-based paint was conducted, using the same methodology employed in the first bedroom (room 5). After these five room equivalents were tested, the inspector noticed that all baseboards and all crown molding of the same substrate had XRF values of more than 5.0 mg/cm². The client had agreed earlier that testing could be abbreviated in this situation, so no further baseboard and crown molding testing combinations were tested in the remaining room equivalents. All similar remaining untested baseboard and crown molding with identical substrates were classified as positive in the final report based on the results of those tested. The raw data for the tested baseboards and crown moldings were also included in the final report.

Four hours after the initial calibration check readings, the inspector took another set of three calibration check readings. (If the inspection had taken less than 4 hours, as is common, the second calibration check test would have been conducted at the end of the inspection.) The readings were 1.45 mg/cm², 1.21 mg/cm², and 1.10 mg/cm²; the inspector recorded the results on the "Calibration Check Test Results" form (Completed Form 7.2). The inspector then averaged the three readings (1.25 mg/cm²), and computed the calibration difference (1.25 mg/cm² - 1.02 mg/cm² = 0.23 mg/cm²) and compared this to the calibration check tolerance shown in the *XRF Performance Characteristic Sheet* on Completed Form 7.2. The calibration difference exceeded the 0.20 calibration check tolerance. The inspector then marked "Failed calibration check" on the data sheets for those room equivalents that had been inspected since the last successful calibration check test, and consulted the manufacturer's recommendations. After trying, the instrument could not be brought back into control. Consequently, the inspector began using a backup instrument, after performing a calibration check and manufacturer's warm up and quality control procedure. The calibration check test showed that the backup instrument was operating acceptably. The inspector used the backup instrument to reinspect the room equivalents checked with the first instrument, and then all the other room equivalents in the home. Next, because substrate correction was required for all results on wood and metal below 4.0 mg/cm² as specified in the *XRF Performance Characteristic Sheet* for the XRF model in use, the inspector prepared to take readings for use in the substrate correction computations. Using the random number function on a calculator and the list of sample location numbers, the inspector randomly selected two testing combinations each with wood and metal substrates where initial readings were less than 2.5 mg/cm², removed the paint from an area on each selected testing combination slightly larger than the faceplate of the XRF instrument, took three readings on the bare substrates, and recorded the readings on the "Substrate Correction Values" form (Completed Form 7.3). The inspector calculated the correction values for each substrate by averaging the six readings from the two test locations, rounded the result to the 2 places after the decimal point that the XRF instrument displayed, and recorded the information in the Correction Value row. The inspector then transferred the correction values to the "Single-Family Housing LBP Testing Data Sheet" for each corresponding substrate.

After the inspector had finished taking the readings needed to compute the substrate correction values, the inspector took another set of three calibration check readings. The inspector recorded the results on the "Calibration Check Test Results" form, under Second Calibration Check, for readings taken by the backup XRF instrument (Completed Form 7.2). The second (and final) calibration check average did not exceed the 0.20 calibration check tolerance. The inspector, therefore, deemed the XRF testing to be complete.

The inspector then calculated the corrected readings by subtracting the substrate correction value from each XRF result taken on a wood or metal substrate. The substrate correction value was obtained by averaging readings on bare surfaces that had initially measured less than 2.5 mg/cm² with the paint still on the surface (Completed Form 7.3). The inspector also used the inconclusive ranges obtained from the XRF Performance Characteristic Sheet (0.41 mg/cm² to 1.39 mg/cm²) for all substrates except plaster (inconclusive range 1.01 mg/cm² to 1.09 mg/cm²). Based on the valid window sill XRF readings, including substrate corrections for wood, there were initially 10 positive results, 2 inconclusive results, and 3 negative results in the bedroom. The two inconclusive results required paint-chip sampling with laboratory confirmation; this resulted in one positive and one negative result. The inspector then filled out the "Single-Family Housing: Component Type Report" (Completed Form 7.1A). A description of each component type was recorded in the first column, the total number of each tested component type was entered in the second column, and the number of testing combinations classified as positive for each component type from the "Single-Family Housing LBP Testing Data Sheet" (Completed Form 7.1) was calculated and entered in the third column. The inspector then did the same for the testing combinations classified as negative. Based upon the XRF results as modified by the laboratory confirmation of the two inconclusive samples, Completed Form 7.1A shows 11 positive and 4 negative results for wood window sills. The remaining component types were entered in a similar fashion.

B. Example of Multifamily Housing Inspection

This section presents a simple example of a multifamily housing development inspection. An actual inspection would have many more testing combinations than are provided here.

The inspector's first step was a visual examination of the development to be tested. During this pretesting review, buildings with a common construction and painting history were identified and the date of construction -- 1948 -- was determined. The construction and painting history of all the units was found to be similar, so that units in the development could be grouped together for sampling purposes. The inspector determined that the development had 55 units, and by consulting Table 7.3, determined that 35 units should be inspected.

The inspector used the "Selection of Housing Units" form (Completed Form 7.4) to randomly select units to inspect. The total number of units, 55, was entered into the first column of the form. The random numbers generated from a calculator were entered into the second column. The first random number, 0.583, was multiplied by 55 (the total number of units), and the product, 32.065, was entered in the third column. The product was rounded up from 32.065 to 33, and 33 was written in the fourth column, indicating that the 33rd unit would be tested. Other units were selected using the same procedure. When a previously selected unit was chosen again, the inspector crossed out the repeated unit number and wrote "DUP" (for duplicate) in the last column. The inspector continued generating random numbers until 35 distinct units had been selected for inspection. (In this case, it would have been faster to randomly determine the 20 units that would *not* be inspected (55 - 35 = 20) and then to select the remaining 35 units for inspection).

After identifying units to be inspected, the inspector conducted an inventory of all painted surfaces within the selected units. The inspector completed the "Multifamily Housing LBP Testing Data Sheet" for every testing combination found in each room equivalent within each unit. Completed Form 7.5 is an example of the completed inventory for the bedroom of the first unit to be inspected. The inventory showed that the bedroom was composed of four substrates and eight testing combinations of the following components: (1) one ceiling beam, (2) two doors, (3) four walls, (4) one window casing, (5) two door casings, (6) three shelves, (7) two support columns, and (8) one radiator. Where more than one of a particular component was present, except walls, one was randomly selected for XRF testing. Component location descriptions were recorded in the "Test Location" column. Drywall and brick substrates were not present in the bedroom.

Testing combinations not common to all units were added to the inventory list. The inspector also noted which types of common areas and exterior areas were associated with the selected units, identified each of these common and exterior areas as a room equivalent, and inventoried the corresponding testing combinations.

The inspector inventoried the remaining 34 units selected and their associated types of common areas and exterior areas before beginning XRF testing in the development. Alternatively, the inspector could have inventoried each room equivalent as XRF testing proceeded.

After completing the inventory, the inspector performed the XRF manufacturer's recommended warm up and quality control procedures successfully. Then the inspector took three calibration check readings on a 1.02 mg/cm² NIST SRM film. The calibration check was accomplished by attaching the film to a wooden board and placing the board on a flat wooden table. Readings were then taken with the probe at least 12 inches (0.3 meters) from any other potential source of lead. The following readings were obtained: 1.12, 1.00, and 1.08 mg/cm². These calibration check results were recorded on the "Calibration Check Test Results" form (Completed Form 7.2). The difference between the first calibration check average and 1.02 mg/cm² (NIST SRM) was not greater than the 0.3 mg/cm² calibration check tolerance limit obtained from the *XRF Performance Characteristic Sheet*, indicating that the XRF instrument was in calibration and that XRF testing could begin. (See the single-family housing example, in Section A, above, of this Addendum, for a description of what to do when the calibration check tolerance is exceeded).

The inspector began XRF testing in the bedroom by taking one reading on each testing combination listed on the inventory data sheet. XRF testing continued until all concrete, wood, and plaster component types were inspected in the bedroom. The XRF readings were recorded on the "Multifamily Housing LBP Testing Data Sheet" form (Completed Form 7.5). According to the *XRF Performance Characteristic Sheet*, the XRF instrument in use did not require correction for substrate bias for any of the substrates encountered in the development, so the XRF classification column was completed at that time. The inspector used single-family housing rules for classifying the XRF readings as positive, negative, or inconclusive. The inspector also used the inconclusive ranges obtained from the *XRF Performance Characteristic Sheet* (0.41 mg/cm² to 1.39 mg/cm²). The midpoint of the inconclusive range was then calculated to be 0.90 mg/cm² ([0.41 mg/cm² + 1.39 mg/cm²]/2 = 0.90 mg/cm²). The results of the classifications were recorded in the Classification column of the "Multifamily Housing LBP Testing Data Sheet" form. Classifications for all testing combinations within the unit were computed in the same manner as for the bedroom.

Once inspections were completed in all of the 35 selected units of the development, the inspector completed the "Multifamily Housing: Component Type Report" form (Completed Form 7.6). A description of each component type was recorded in the first column, the total number of each tested component type was entered in the second column, and the number of testing combinations classified as positive for each component type from the "Multifamily Housing LBP Testing Data Sheet" (Completed Form 7.5) was calculated and entered in the third column. The inspector then did the same for the testing combinations classified as negative, that is, XRF readings up to and including 0.40 mg/cm², and for inconclusive classifications with XRF readings less than the midpoint of the inconclusive range, that is, XRF readings from 0.41 mg/cm² to 0.89 mg/cm², and for inconclusive classifications with XRF readings equal to or greater than the midpoint of the inconclusive range, that is 0.90 mg/cm² to 1.39 mg/cm². Using these readings and the total number of the component type sampled, the inspector computed and recorded the percentages of positive, negative, and inconclusive classifications for each component type.

After entering the number of testing combinations for each component type in the "Multifamily Housing Component Type Report" form, the inspector noticed that only 34 wood door casings had been inspected. Because it is necessary to test at least 40 testing combinations of each component type, the inspector arranged with the client to test six more previously untested door casings. Additional units were randomly selected from the list of unsampled units. An initial calibration check test was successfully completed and the six door casings were tested for lead-based paint. Another calibration check test indicated that the XRF instrument remained within acceptable limits. The inspector then updated the "Multifamily Housing: Component Type Report" form by crossing out with one line the row of the form that showed the original, insufficient number of component types for testing; the inspector then wrote the information on the full 40 wood door casings in a new row.

The inspector used the "Multifamily Decision Flowchart" (Figure 7.1) to evaluate the component type results. Because 100 percent of the plaster walls and metals baseboards tested negative for lead, the inspector concluded that no lead-based paint had been detected on any walls or baseboards in the development, including those in uninspected units, and entered "NEG" in the Overall Classification column. The inspector also observed that shelves, hall cabinets, and window casings had no positive results. For all of the other component types, 15% or more of the readings for each type were positive; after choosing *not* to perform additional XRF readings or laboratory analysis on those components, that is, to rely on the XRF readings, the inspector entered "POS" in the Overall Classification column for them. For the shelves, all the XRF results were negative or inconclusive and less than 0.90 mg/cm² ("low inconclusive") so the inspector, in accordance with the flowchart, entered "NEG" in the Overall Classification column. The hall cabinets and window casings were classified as inconclusive with some readings greater than or equal to 0.90 mg/cm² ("high inconclusive"). The inspector determined that over 15 percent of the readings taken on these component types were high inconclusives. The inspector chose to take additional samples for laboratory analysis, to see if any or all of the samples would be determined to be negative by laboratory analysis.

The inspector collected paint-chip samples from the inconclusive component types, but only from testing combinations where XRF readings were equal to or greater than 0.90 mg/cm², the midpoint of the inconclusive range. Paint-chip samples were taken from 32 sampling locations: 12 hall cabinets, 7 window casings and 13 metal radiators. The paint-chip samples were collected from a 4-square-inch (25-square-centimeter) surface area on each component. Each paint-chip sample was placed in a hard-shelled plastic container, sealed, given a uniquely-numbered label, and sent to the laboratory for analysis.

The laboratory returned the results to the inspector, who entered the laboratory results and classifications on the appropriate "Multifamily Housing LBP Testing Data Sheet" (Form 7.5). Laboratory results of all 5 paint-chip samples taken from the window casings were classified as negative. The laboratory results of 5 samples from the hall cabinets were classified as positive, and 7 as negative. The metal radiator results were classified as 9 positives and 4 negatives.

The "Multifamily Decision Flowchart" was applied to the results shown in the "Multifamily Housing: Component Type Report" to determine the appropriate classification for each component type. The inspector classified all shelves and window casings as negative, based either on the XRF substrate-corrected readings or on laboratory confirmation analysis, respectively. Therefore, no further lead-based paint testing was required for the shelves and window casings. About 9.1 percent (none positive by XRF analysis and 5 positive by lab analysis of the 55 that were inspected) of all hall cabinets in the housing development had lead-based paint.

Final decisions made by the development client regarding the hall cabinets were based on various factors, including:

- The substantially lower cost of inspecting all hall cabinets in the development versus replacing all of those cabinets;
- Future plans, including renovating the buildings within three years; and
- The HUD/EPA disclosure rule requirements regarding the sale or rental of housing with lead-based paint.

In this case, the client arranged for testing hall cabinets in all of the unsampled units to determine which were positive, and which were negative. To verify the accuracy of the inspection services, the client asked the inspector to retest 10 testing combinations. The retest was performed according to instructions obtained from the *XRF Performance Characteristic Sheet*. The client appointed an employee to randomly select 10 testing combinations from the inventory list of 2 randomly selected units. The employee observed the inspector retesting the 10 selected testing combinations, using the same XRF instrument and procedures used for the initial inspection. A single XRF reading was taken from each of the 10 testing combinations. The average of the 10 repeat XRF results was calculated to be 0.674 mg/cm², and the average of the 10 previous XRF results was computed to be 0.872 mg/cm². The absolute difference between the two averages was computed to be 0.198 mg/cm² (0.872 mg/cm² minus 0.674 mg/cm²). The Retest Tolerance Limit, using the formula described in the *XRF Performance Characteristic Sheet* , was computed to be 0.231. Because 0.198 mg/cm² is less than 0.231 mg/cm², the inspector concluded that the inspection had been performed competently. The final summary report also included the address of the inspected units, the date(s) of inspection, the starting and ending times for each inspected unit, and other information described in Section V.I of Chapter 7.

At the end of the work shift, the inspector took a final set of three calibration check readings using the same procedure as for the initial calibration check. The following readings were obtained: 0.86, 1.07 and 0.94 mg/cm². The average of these readings is 0.97 mg/cm². The difference between 0.97 mg/cm² and the NIST SRM's 1.02 mg/cm² is -0.08 mg/cm², which is not greater in magnitude than the 0.30 mg/cm² calibration check tolerance for the instrument used. The inspector recorded that the XRF instrument was in calibration, and that the measurements taken between the first and second calibrations could be used.

Endnotes

1. Most XRF instruments detect K-shell fluorescence (X-ray energy), some L-shell fluorescence, and some K and L fluorescence. In general, L X rays released from greater depths of paint are less likely to reach the surface than are K X rays, which makes detection of lead in deeper paint layers by L X rays alone more difficult. However, L X rays are less likely to be influenced by substrate effects.

2. Westat, Inc. An Analysis and Discussion of the Single Family Inspection Protocol Under the 1995 HUD Guidelines: Draft Report. 1996.

3. Dixon, S., National Center for Lead-Safe Housing, Sample Size as a Function of Multifamily Development Size. 1997.

4. The statistical rationale and calculations used to develop sample sizes in multifamily housing is based on a data set which contains approximately 164,000 XRF readings from 23,000 room equivalents in 3,900 units located in 65 housing developments. Statistical and theoretical analyses completed for HUD are available through the Lead Clearinghouse and on HUD's World Wide Web Home Page.

Chapter 8: Resident Protection and Worksite Preparation

Resident Protection and Worksite Preparation: How To Do It

1. If possible, perform the work in a vacant unit. If residents must remain inside the dwelling during work, erect appropriate barrier systems as described in the tables in this chapter.

2. Permit residents to reenter the work area only after work is complete and visual inspection has been completed and dust samples collected. If the work is not completed at the end of the day, keep the barriers in place overnight and instruct residents not to enter the work area.

3. Determine if the dwelling will require precleaning before worksite containment. If the paint is severely deteriorated and there are paint chips present, the paint chips should be removed by HEPA vacuuming before plastic is laid down.

4. Determine requirements for relocation, isolation of work areas, and other worksite preparation measures based on the type and extent of the work and the amount of dust that will be generated.

5. Select an Interior Worksite Preparation Level, an Exterior Worksite Preparation Level, and/or a Window Worksite Preparation Level (depending on the work required) from the tables in this chapter.

6. Conduct daily cleanup.

7. Perform a visual examination daily.

8. Conduct dust sampling as specified in this chapter.

9. Never permit residents to enter a work area where lead hazard control work is under way. Entry should be denied until cleaning and clearance have been completed.

Chapter 8: Resident Protection and Worksite Preparation

I. Introduction

Lead hazard control methods generate varying amounts of leaded dust, paint chips, and other lead-contaminated materials. This chapter describes ways to protect residents and the environment from exposure to, or contamination from, these materials. Some processes require complete isolation of the work area and/or full evacuation of the residents and their belongings, while other methods require little or no containment. Containment refers to various methods of preventing leaded dust from migrating beyond the work area. It includes everything from the simple use of disposable plastic drop cloths to the sealing of openings with plastic sheeting. The required degree of containment depends upon a number of considerations (e.g., type of hazard control, resident relocation possibilities, size of work area, etc.). Generally speaking, significant lead hazard control work should be performed in vacant units, with only small-scale activity conducted in occupied units. Worksite preparation is needed for both interim control and abatement work.

This chapter describes the general principles behind resident protection and proper worksite preparation. Three tables are included: one for interior work, one for exterior work, and one for windows. Guidance is also offered for certified abatement supervisors, risk assessors, and project planners on the development of a written occupant protection plan, which may be required by some agencies.

II. Resident Entry Into Work Area Prohibited

Regardless of the extent of the work, *residents must never be permitted to enter the work area while work is under way, even if the work only disturbs a small area. Resident reentry into the work area is permitted only after the area has been cleaned and has passed clearance*. All of the work-site preparation strategies discussed in this chapter are based on this fundamental requirement. While residents may not be present inside the work area, it is possible for them to remain inside other parts of the dwelling during some types of work, or to leave for the day and return to the dwelling at night after cleaning and visual evaluation, and collection of dust samples. In cases of hardship where the resident *must* occupy the area prior to receiving laboratory results of clearance dust samples, occupancy should not occur until visual inspection has been completed and dust samples collected.

III. Site Assessment and Precleaning

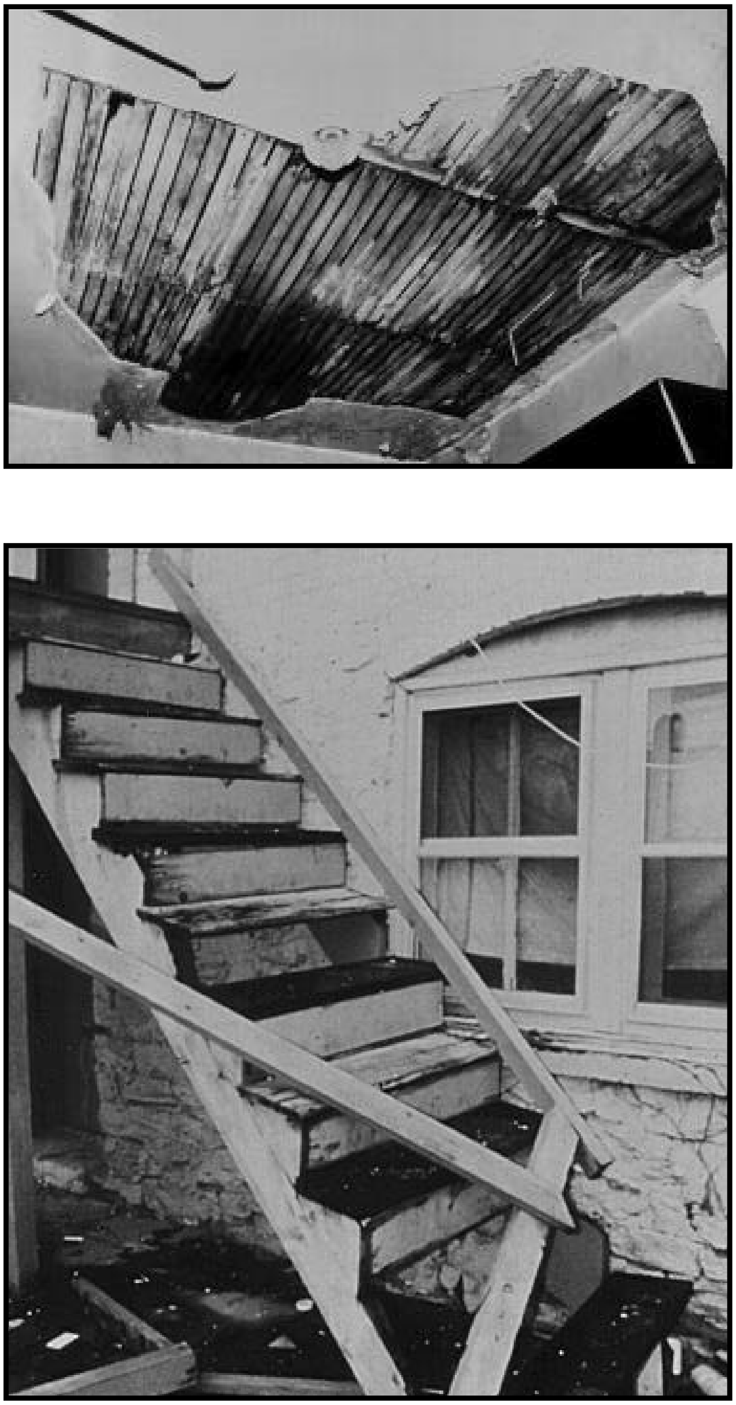
The certified lead hazard control supervisor should ensure that the dwelling is structurally sound. If structural deficiencies exist, they must be corrected before the site can be prepared for lead hazard control (see Figure 8.1). Environmental and worker protection must be provided if the structural repairs will involve disturbance of surfaces coated with lead-based paint.

If the paint is severely deteriorated and there are numerous paint chips on the floors, the paint chips should be removed by high-efficiency particulate air (HEPA) vacuuming before any plastic is laid down (see Figure 8.2). Vacuuming will prevent the paint chips from being ground into dust by the workers' feet. Wet washing usually is not required for precleaning.

IV. Debris Control

The only way that lead hazard control work can proceed safely in *occupied dwellings* is to ensure that cleaning is completed before residents reenter the unit. Cleaning is especially important when residents are present in the dwelling while

Figure 8.1 Repair Structural Deficiencies at the Beginning of Lead Hazard Control.



work is in progress, or when residents return in the evening after work has been completed for the day. Neither debris nor plastic sheeting may be left outside the dwelling overnight or in any area where passersby or children could come into contact with these materials. All debris must be handled in accordance with the standards outlined in Chapter10. When residents cannot be relocated and work must proceed room by room, clearance standards may be more difficult to meet, since dust from moved furniture may cause recontamination.

V. Worksite Preparation Levels

A. Worksite Preparation Level Selection

When planning a lead hazard control job, the worksite preparation levels listed in Tables8.1, 8.2, and 8.3 should be considered. Since each worksite is unique, it is necessary to pick the level that is the most cost-effective for each specific situation. This judgment should be made by a certified risk assessor, a certified abatement supervisor, or a trained lead-based paint planner/designer. The tables provide guidance on choosing the appropriate preparation level for each job.

The necessary worksite preparation level will depend on:

- The size of the surface(s) needing work.
- The type of hazard control methods to be used.
- The extent of existing contamination.
- The building layout.
- The vacancy status of the dwelling.
- The types of worker protection needed.
- The need for other construction or abatement work (e.g., renovation or asbestos abatement).

A certified individual should weigh all of these issues in determining which level of preparation is appropriate for a given situation. For example, the enclosure of walls will probably require a lower worksite preparation level than the wet scraping of a large area, since enclosure will generate less dust. Similarly, deteriorated component replacement (demolition work) will probably require a higher containment level than the wet scraping of a small area.

These *Guidelines* are performance-oriented and are not specifications. It is possible to select elements from different worksite preparation levels to devise a unique worksite preparation plan for an individual dwelling. Whatever combination of containment measures is selected, the levels of leaded dust outside the containment area must not rise above clearance levels. Containment measures should be designed to prevent the release of leaded dust, which can be spread by workers' shoes or by airborne dust. A previously conducted risk assessment will indicate if hazardous leaded dust levels exist outside the containment area. If such a problem was identified and if leaded dust levels rise in the course of the work, it is reasonable to conclude that the dust was released from the containment area and that the containment system is ineffective. Dust sampling is usually conducted no further than 10 feet away from the containment area. If deviations from the worksite preparation plans described below are contemplated, then the performance of the containment system should be determined by a certified risk assessment professional. This flexibility permits owners to select the most cost-effective strategy, while also protecting the public health and the environment.

B. Hazard Control Work in Occupied Dwellings

If bathrooms are not accessible, residents should always be relocated during the day (Table 8.1, Level2 at a minimum) unless alternative arrangements can be made (e.g., use of a neighbor's bathroom). In addition, if construction will result in other hazards (such as exposed electric wires), then residents should also be relocated.

Figure 8.2 Area Should Be Precleaned and Structural Deficiencies in Flooring Repaired Before Lead Hazard Control Begins.

Figure 8.3a Prepare the Worksite With Plastic Sheeting (interior).

Figure 8.3b Prepare the Worksite With Plastic Sheeting (exterior).

Figure 8.3c Prepare the Worksite (exterior).

If a worksite preparation level is selected that permits residents either to remain inside the dwelling while work is being conducted or return to the dwelling in the evening after work has been completed, then a dust sample should be collected from the living area at greatest risk of contamination (usually the living area adjacent to the work area) at the end of each work day. It is essential that the sample be collected *before* the work area is cleaned to determine if the containment system protected the occupants that day. If the leaded dust level is above clearance standards, residents must be relocated immediately and must not be allowed to reenter the dwelling until cleanup and documented compliance with clearance standards is achieved.

If the same work crew and supervisor can document compliance with these criteria for three or more consecutive dwelling units using the same hazard control techniques, then dust sampling frequency can be reduced to 1 in every 20 dwellings for that crew.

C. Worksite Preparation Level Definitions

Tables 8.1 and 8.2 define interior and exterior worksite preparation levels. There are four levels for the preparation of dwelling interiors and three levels for the preparation of dwelling exteriors. The lowest levels are primarily designed for interim control activities, while the highest levels are designed for the dustiest abatement methods. Table 8.3 describes worksite preparation as it applies specifically to windows (this technique could be performed from either the interior or exterior of the dwelling). The plastic sheeting in the tables refers to polyethylene plastic sheeting that is at least 6 mils thick (or equivalent). These recommendations represent the best guidance that can be offered at this time. Worksite preparation levels should be designed on a site-by-site basis.

VI. Relocation Dwellings

Relocation dwellings should be acceptable to residents so that they will not attempt to return to their own dwellings during lead hazard control work. Dwellings serving as temporary relocation units must be lead safe. In addition, these units should be adequately equipped with furniture, cooking facilities, refrigerators, televisions, and toys (unless these items will be moved with the resident). Relocation is usually a substantial undertaking, involving not only the movement of people and their possessions, but also the coordination of mail, phone, school, and community changes. Whenever possible, children should continue to attend the same school during the relocation period, even though this may involve finding special transportation. Due to their complex nature, relocation considerations may dictate the scheduling of the project.

VII. Negative Pressure Zones ("Negative Air" Machines)

In asbestos abatement work and lead-based paint removal work on structural steel, it is common to create work sites that are under negative pressure in comparison to the outside of the containment structure. A negative pressure zone is usually created by blowing air out of the work area through a HEPA filter, while air intake is restricted to a lower flow rate than exhaust. This process causes air to leak *into* the containment area instead of *out* of the containment area, and reduces dust fall and worker exposure by removing contaminants from the airstream through constant filtration.

Due to the different aerodynamics of leaded dust particles and asbestos fibers, negative pressure zones do not appear to be necessary for most forms of residential lead hazard control work. No effect on airborne lead levels, either inside or outside the containment area, has been associated with the use of an air filtration device commonly known as a "negative air" machine (NIOSH, 1993a). In addition, no effect on cleanup efficiency was noted. Most lead-based paint abatement projects in the public housing program have not found it necessary to use negative air machines. Therefore, the added expense of requiring negative pressure zones for general residential lead-based paint hazard control work does not appear to be justified. However, there are two specific situations where the use of a negative pressure zone would be appropriate in a residential setting.

The first case involves floor sanding. Even if the paint has already been removed, leaded dust generation is likely to be quite high due to residual dust in the flooring. Enclosing old

Figure 8.4 Apply a Second Layer of Plastic.

flooring with new flooring is the recommended course of action. However, if old flooring must be restored, then negative pressure zones should be established. At least 10 air changes per hour should be provided and all exhaust air must be passed through a HEPA filter.

Secondly, the practice of abrasive blasting is likely to produce extremely high levels of airborne leaded dust (NIOSH, 1992a) and should not be permitted in housing since other methods are readily available. One report indicated that the exterior sandblasting of a school resulted in 27,100 µg/g of lead in the soil at a nearby residence, and nearly 100,000 µg/g in the soil at the school (Peace, 1983). If for

Figure 8.5 Cover the Air Vents With Plastic After Turning Off the HVAC System.

Figure 8.6 Install a Simple Airlock Over a Doorway to Minimize Lead Dust Migration.

some reason abrasive blasting without local exhaust ventilation is performed on the interior of a dwelling, a full containment structure with HEPA filtration and adequate airflow should be required. Such a containment system would also be necessary if the exterior of a dwelling was blasted, usually resulting in "tenting" an entire building (i.e., erecting a temporary tent-like structure around a building or one face of a building).

For nearly all types of lead hazard control work, windows should be kept closed to prevent dust and chips from leaving the unit. If volatile chemicals will be used, adequate ventilation must be provided, either by opening windows during the use of the chemicals or by supplying air through a HEPA air handling machine.

Table 8.1 Interior Worksite Preparation Levels (Not Including Windows)

Description	Level 1	Level 2	Level 3	Level 4
Typical Applications (Hazard Controls)	Dust removal and any abatement or interim control method disturbing no more than 2 square feet of painted surface per room.	Any interim control or abatement method disturbing between 2 and 10 square feet of painted surface per room.	Same as Level 2.	Any interim control or abatement method disturbing more than 10 square feet per room.
Time Limit Per Dwelling	One work day.	One work day.	Five work days.	None.
Resident Location	Inside dwelling, but outside work area. Resident must have lead-safe passage to bathroom, at least one living area, and entry/egress pathways. Alternatively, resident can leave the dwelling during the work day.	Same as Level 1.	Outside the dwelling; but can return in evening after day's work and cleanup are completed. Resident must have safe passage to bathroom, at least one living area, and entry/egress pathways upon return. Alternatively, resident can leave until all work is completed.	Outside the dwelling for duration of project; cannot return until clearance has been achieved.
Containment and Barrier System	Single layer of plastic sheeting on floor extending 5 feet beyond the perimeter of the treated area in all directions. No plastic sheeting on doorways is required, but a low physical barrier (furniture, wood planking) to prevent inadvertent access by resident is recommended. Children should not have access to plastic sheeting (suffocation hazard).	Two layers of plastic on entire floor. Plastic sheet with primitive airlock flap on all doorways. Doors secured from inside the work area need not be sealed. Children should not have access to plastic sheeting (suffocation hazard).	Two layers of plastic on entire floor. Plastic sheet with primitive airlock flap on all doorways to work areas. Doors secured from inside the work area need not be sealed. Overnight barrier should be locked or firmly secured. Children should not have access to plastic sheeting (suffocation hazard).	Two layers of plastic on entire floor. If entire unit is being treated, cleaned, and cleared, individual room doorways need not be sealed. If only a few rooms are being treated, seal all doorways with primitive airlock flap to avoid cleaning entire dwelling. Doors secured from inside the work area need not be sealed.
Warning Signs	Required at entry to room but not on building (unless exterior work is also under way).	Same as Level 1.	Posted at main and secondary entryways, since resident will not be present to answer the door.	Posted at building exterior near main and secondary entryways.

(This table continues on the next page.)

Table 8.1 Interior Worksite Preparation Levels (Not Including Windows) (continued)

Description	Level 1	Level 2	Level 3	Level 4
Ventilation System	Dwelling ventilation system turned off, but vents need not be sealed with plastic if they are more than 5 feet away from the surface being treated. Negative pressure zones (with "negative air" machines) are not required, unless large supplies of fresh air must be admitted into the work area to control exposures to other hazardous substances (for example, solvent vapors).	Turned off and all vents in room sealed with plastic. Negative pressure zones (with "negative air" machines) are not required, unless large supplies of fresh air must be admitted into the work area to control exposure to other hazardous substances (for example, solvent vapors).	Same as Level 2.	Same as Level 2.
Furniture	Left in place uncovered if furniture is more than 5 feet from working surface. If within 5 feet, furniture should be sealed with a single layer of plastic or moved for paint treatment. No covering is required for dust removal.	Removed from work area. Large items that cannot be moved can be sealed with a single layer of plastic sheeting and left in work area.	Same as Level 2.	Same as Level 2.
Cleanup (See Chapter 14 for further discussion of cleanup methods)	HEPA vacuum, wet wash, and HEPA vacuum all surfaces and floors extending 5 feet in all directions from the treated surface. For dust removal work alone, a HEPA vacuum and wet wash cycle is adequate (i.e., no second pass with a HEPA vacuum is needed). Also wet wash and HEPA vacuum floor in adjacent area(s) used as pathway to work area. Do not store debris inside dwelling overnight; transfer to a locked secure area at the end of each day.	HEPA vacuum, wet wash, and HEPA vacuum *all* surfaces in room. Also wet wash and HEPA vacuum floor in adjacent area(s) used as pathway to work area. Do not store de bris inside dwelling overnight; use a secure locked area.	Remove top layer of plastic from floor and discard. Keep bottom layer of plastic on floor for use on the next day. HEPA vacuum, wet wash, and HEPA vacuum *all* surfaces in room. Also wet wash and HEPA vacuum floor in adjacent area(s) used as pathway to work area. Do not store debris inside dwelling overnight; use a secure locked area.	Full HEPA vacuum, wet wash, and HEPA vacuum cycle, as detailed in Chapter 14.
Dust Sampling	Clearance only.	Clearance only.	One sample collected outside work area every few jobs plus clearance.	Clearance only.

Note: Primitive air locks are constructed using two sheets of plastic. The first one is taped on the top, the floor, and two sides of doorway. Next, cut a slit about 6 feet high down the middle of the plastic; do not cut the slit all the way down to the floor. Tape the second sheet of plastic across the top of the door only, so that it acts as a flap. The flap should open *into* the work area. See Figure 8.6.

Table 8.2 Exterior Worksite Preparation Levels (Not Including Windows)

Description	Level 1	Level 2	Level 3
Typical Applications	Any interim control or abatement method disturbing less than 10 square feet of exterior painted surface per dwelling. Also includes soil control work.	Any interim control or abatement method disturbing 10 to 50 square feet of exterior painted surface per dwelling. Also includes soil control work.	Any interim control or abatement method disturbing more than 50 square feet of exterior painted surface per dwelling. Also includes soil control work.
Time Limit Per Dwelling	One day.	None.	None.
Resident Location	Inside dwelling but outside work area for duration of project until cleanup has been completed. Alternatively, resident can leave until all work has been completed Resident must have lead-safe access to entry/egress pathways.	Relocated from dwelling during workday, but may return after daily cleanup has been completed.	Relocated from dwelling for duration of project until final clearance is achieved.
Containment and Barrier System	One layer of plastic on ground extending 10 feet beyond the perimeter of working surfaces. Do not anchor ladder feet on top of plastic (puncture the plastic to anchor ladders securely to ground). For all other exterior plastic surfaces, protect plastic with boards to prevent puncture from falling debris, nails, etc., if necessary. Raise edges of plastic to create a basin to prevent contaminated runoff in the event of unexpected precipitation. Secure plastic to side of building with tape or other anchoring system (no gaps between plastic and building). Weight all plastic sheets down with two-by-fours or similar objects. Keep all windows within 20 feet of working surfaces closed, including windows of adjacent structures.	Same as Level 1.	Same as Level 1.
Playground Equipment, Toys, Sandbox	Remove all movable items to a 20-foot distance from working surfaces. Items that cannot be readily moved to a 20-foot distance can be sealed with taped plastic sheeting.	Same as Level 1.	Same as Level 1.

(This table continues on the next page.)

Table 8.2 Exterior Worksite Preparation Levels (Not Including Windows) (continued)

Description	Level 1	Level 2	Level 3
Security	Erect temporary fencing or barrier tape at a 20-foot perimeter around working surfaces (or less if distance to next building or sidewalk is less than 20 feet). If an entryway is within 10 feet of working surfaces, require use of alternative entryway. If practical install vertical containment to prevent exposure. Use a locked dumpster, covered truck, or locked room to store debris before disposal.	Same as Level 1.	Same as Level 1.
Signs	Post warning signs on the building and at a 20-foot perimeter around building (or less if distance to next building or sidewalk is less than 20 feet).	Same as Level 1.	Same as Level 1.
Weather	Do not conduct work if wind speeds are greater than 20 miles per hour. Work must stop and cleanup must occur before rain begins.	Same as Level 1.	Same as Level 1.
Cleanup (See Chapter 14)	Do not leave debris or plastic out overnight if work is not completed. Keep all debris in secured area until final disposal.	Same as Level 1.	Same as Level 1.
Porches	One lead-safe entryway must be made available to residents at all times. Do not treat front and rear porches at the same time if there is not a third doorway.	Front and rear porches can be treated at the same time, unless unprotected workers must use the entryway.	Same as Level 2.

Table 8.3 Window Treatment or Replacement Worksite Preparation

Appropriate Applications	**Any Window Treatment or Replacement**
Resident Location	Remain inside dwelling but outside work area until project has been completed. Alternatively, can leave until all work has been completed. Resident must have access to lead-safe entry/egress pathway.
Time Limit Per Dwelling	None.
Containment and Barrier System	One layer of plastic sheeting on ground or floor extending 5 feet beyond perimeter of window being treated/replaced. Two layers of plastic taped to interior wall if working on window from outside; if working from the inside, tape two layers of plastic to exterior wall. If working from inside, implement a minimum Interior Worksite Preparation Level 2. Children cannot be present in an interior room where plastic sheeting is located due to suffocation hazard. Do not anchor ladder feet on top of plastic (puncture the plastic to anchor ladders securely to ground). For all other exterior plastic surfaces, protect plastic with boards to prevent puncture from falling debris, nails, etc. (if necessary). Secure plastic to side of building with tape or other anchoring system (no gaps between plastic and building). Weigh all plastic sheets down with two-by-fours or similar objects. All windows in dwelling should be kept closed. All windows in adjacent dwellings that are closer than 20 feet to the work area should be kept closed.
Signs	Post warning signs on the building and at a 20-foot perimeter around building (or less if distance to next building or sidewalk is less than 20 feet). If window is to be removed from inside, no exterior sign is necessary.
Security	Erect temporary fencing or barrier tape at a 20-foot perimeter around building (or less if distance to next building or sidewalk is less than 20 feet). Use a locked dumpster, covered truck, or locked room to store debris before disposal.
Weather	Do not conduct work if wind speeds are greater than 20 miles per hour. Work must stop and cleanup must occur before rain begins, or work should proceed from the inside only.
Playground Equipment, Toys, Sandbox	Removed from work area and adjacent areas. Remove all items to a 20-foot distance from dwelling. Large, unmovable items can be sealed with taped plastic sheeting.
Cleaning	If working from inside, HEPA vacuum, wet wash, and HEPA vacuum all interior surfaces within 10 feet of work area in all directions. If working from the exterior, no cleaning of the interior is needed, unless the containment is breached. Similarly, no cleaning is needed on the exterior if all work is done on the interior and the containment is not breached. If containment is breached, then cleaning on both sides of the window should be performed. No debris or plastic should be left out overnight if work is not completed. All debris must be kept in a secure area until final disposal.

CHAPTER 9: WORKER PROTECTION

Worker Protection: How To Do It

1. Since worker exposure to lead during residential lead abatement work may be greater than the permissible exposure limit (PEL) set by the Occupational Safety and Health Administration (OSHA), develop a written compliance plan and designate a competent person to oversee worker protection efforts (usually an industrial hygienist or a certified lead abatement supervisor). [See the OSHA Lead in Construction Standard for complete details (29 CFR 1926.62). Call your local OSHA office for a copy (see Appendix 4 for a listing).] A model written compliance plan is provided at the end of this chapter.

2. Conduct an exposure assessment for each job classification in each work area. Monitoring current work is the best means of conducting exposure assessments. Perform air sampling in 1 dwelling unit out of every 20 being treated, with an emphasis on sampling "worst-case" dwellings. Alternatively, if working conditions are similar to previous jobs by the same employer, previously collected exposure data can be used to estimate worker exposures. Finally, objective data (as defined by OSHA) may be used to determine worker lead exposures in some cases. Exposures to airborne leaded dust greater than 30 $\mu g/m^3$ (8-hour, time-weighted average) trigger protective requirements that are enforced by OSHA.

3. If lead hazard control will include manual demolition, manual scraping, manual sanding, heat gun use, or use of power tools such as needle guns, then specific worker protection measures (outlined in this chapter) are required until an initial exposure assessment is completed. If the initial exposure assessment indicates exposures are less than 30 $\mu g/m^3$, the requirements do not legally apply, although exposure to lead should be kept as low as possible at all times.

4. Implement engineering, work practice, and administrative controls to bring worker exposure levels below the PEL. Examples of such controls include the use of wet abatement methods and the selection of other work methods that generate little dust.

5. Where needed, supplement the use of engineering and work practice controls with appropriate respirators (at a minimum, use a half-mask, air-purifying respirator approved by the National Institute for Occupational Safety and Health (NIOSH)) and implement a respiratory protection program. Provide a respirator to any employee who requests one, regardless of the degree of exposure. Most residential lead hazard control projects will involve the use of a half-mask, air-purifying respirator with high-efficiency particulate air (HEPA) cartridges.

6. Arrange for a medical exam before work begins for each worker who will be required to wear a respirator. The exam will indicate whether the worker is physically capable of wearing a respirator safely. Conduct fit testing for all workers who will be required to wear respirators. Workers with beards, scars, or unusual facial shapes may not be able to wear certain kinds of fitted respirators.

7. Provide protective clothing and arrange for proper disposal or laundering of work clothing.

8. Provide handwashing facilities, preferably with showers.

9. Implement a medical surveillance program that includes blood lead monitoring under the supervision of a qualified physician pursuant to OSHA regulations. Initial blood testing for lead exposure is required by OSHA for workers performing certain tasks, such as manual scraping, and for any worker who may be exposed to greater than 30 $\mu g/m^3$ of lead on any day.

10. Ensure that workers are properly trained in the hazards of lead exposure, the location of lead-containing materials, the use of job-specific exposure control methods (such as respirators), the use of hygiene facilities, and the signs and symptoms of lead poisoning. See Appendix 15 for a Worker Fact Sheet on the OSHA Standard that can be used for training purposes. OSHA and the U.S. Environmental Protection Agency require all lead hazard control workers to be trained, even if exposures are very low.

11. Post lead hazard warning signs around work areas. Also, post an emergency telephone number in case an on-the-job injury occurs.

12. Conduct work as specified.

13. Conduct worker decontamination before all breaks, before lunch, and at the end of the shift. Decontamination usually consists of:

    - Cleaning all tools (end of the shift only).
    - HEPA vacuuming all protective clothing if visibly contaminated with paint chips or dust before entering the decontamination area.
    - Entering the decontamination area (dirty side).
    - Removing protective clothing by rolling inward (do not remove respirator yet); removing work shoes and putting in plastic bag.
    - Entering shower or washing facility.
    - Washing hands and then removing respirator.
    - Taking a shower using plenty of soap and water; washing hair, hands, underneath fingernails, and face especially well (hand and face washing only is permitted for lunch and breaks).
    - Entering the clean area and putting on street clothing and shoes.

14. Maintain exposure assessment and medical surveillance records for 30 years. Notify workers within 5 days after receiving air sampling and blood lead level results.

Chapter 9: Worker Protection

I. Introduction

The potential for worker exposure to lead (as well as to other hazardous substances, safety hazards, and physical agents) exists during all lead hazard control projects. This chapter provides recommendations to:

- Assist contractors and facility owners in establishing programs to control employee lead exposures.
- Help employers and facility owners understand and meet the requirements of the Occupational Safety and Health Administration (OSHA) interim final rule for lead exposure in construction as it applies to residential work (29 CFR 1926.62) (OSHA, 1993).

A model written compliance plan is provided at the end of this chapter to help employers comply with the standard. A summary of the standard for workers prepared by the Alice Hamilton Occupational Health Center is found in Appendix15.

Due to the recognized adverse health effects of lead, employers should minimize worker lead exposures as much as possible. The OSHA construction lead standard is the minimum level of protection that employers must legally provide to workers during all lead hazard control projects. Employers should refer directly to the OSHA construction lead standard for complete requirements.

Where To Get the OSHA Standard

The OSHA standard can be obtained by writing or calling OSHA, Office of Publications, Room N–3101, United States Department of Labor, Washington, DC 20210; (202) 219–4667, or by contacting any local OSHA office (see Appendix 4).

II. Adult Occupational Exposure to Lead

Inhalation of dust and fumes, and ingestion resulting from contact with lead-contaminated food, cigarettes, clothing, or other objects, are the major routes of worker exposure to lead. Once absorbed, lead accumulates in the blood, soft tissues, and bones, with the highest accumulation initially in the liver and kidneys (NIOSH, 1992a). Lead is stored in the bones for decades, and may cause toxic effects in adults as it is slowly released over time (Silbergeld, 1992). Chronic overexposure to lead results in damage to the kidneys, the gastrointestinal tract, the peripheral and central nervous systems, the reproductive system, and the blood-forming organs. Adverse effects in adults include:

- Abdominal discomfort.
- Anemia.
- Colic.
- Constipation.
- Excessive tiredness.
- Fine tremors.
- Headache.
- High blood pressure.
- Irritability or anxiety.
- Loss of appetite.
- Muscle and joint pain.
- Pallor.
- Pigmentation on the gums (“lead line”).
- Sexual impotence.

- Weakness.
- Inability to keep the hand and arm fully extended ("wrist drop").

The frequency and severity of symptoms associated with lead exposure increase as blood lead levels increase. The signs and symptoms of chronic lead poisoning are well recognized (Hernberg, 1988; Landrigan, 1985; Proctor, 1988).

Overt symptoms of lead poisoning in adults generally become apparent when blood lead levels are between 60 and 120 micrograms per deciliter (µg/dL) (Figure 9.1). Neurologic, hematologic, and reproductive effects, however, may be detectable at much lower levels. OSHA recommends a blood lead level no greater than 30 µg/dL to prevent reproductive problems, although the medical removal provisions do not take effect until the level reaches 50µg/dL. In 1990, the U.S. Public Health Service established the national goal of eliminating, by the year 2000, all occupational exposures that result in worker blood lead levels greater than 25 µg/dL (DHHS, 1990). The mean blood lead level for men in the United States during the period from 1976 to 1980 was 16 µg/dL (Mahaffey, 1982; Annest, 1983). In addition, the American Conference of Governmental Industrial Hygienists (ACGIH) has proposed that worker blood lead levels be controlled to 20 µg/dL (ACGIH, 1993).

Recent studies suggest that adverse health effects can be detected when blood lead levels are *below* the current OSHA standard for occupational exposure (50 µg/dL). Therefore, the OSHA standard may not sufficiently protect workers' health. OSHA is currently developing a final rule to address this issue (the current rule is an interim final standard).

In males, increased blood lead levels are associated with increased blood pressure, with no apparent blood lead threshold (less than 10 µg/dL). A number of studies have found neurological symptoms in workers with blood lead levels as low as 40 µg/dL. In addition, decreased fertility in men (low sperm count, low sperm motility, and abnormal sperm shape) has been identified at blood lead levels as low as 40 µg/dL.

In women, exposure to lead (as low as 10 to 15 µg/dL) before and during pregnancy is associated with preterm delivery, low birth weight, an increased frequency of miscarriage and stillbirth, and problems in early mental development of the fetus (ATSDR, 1990; National Academy of Sciences, 1993).

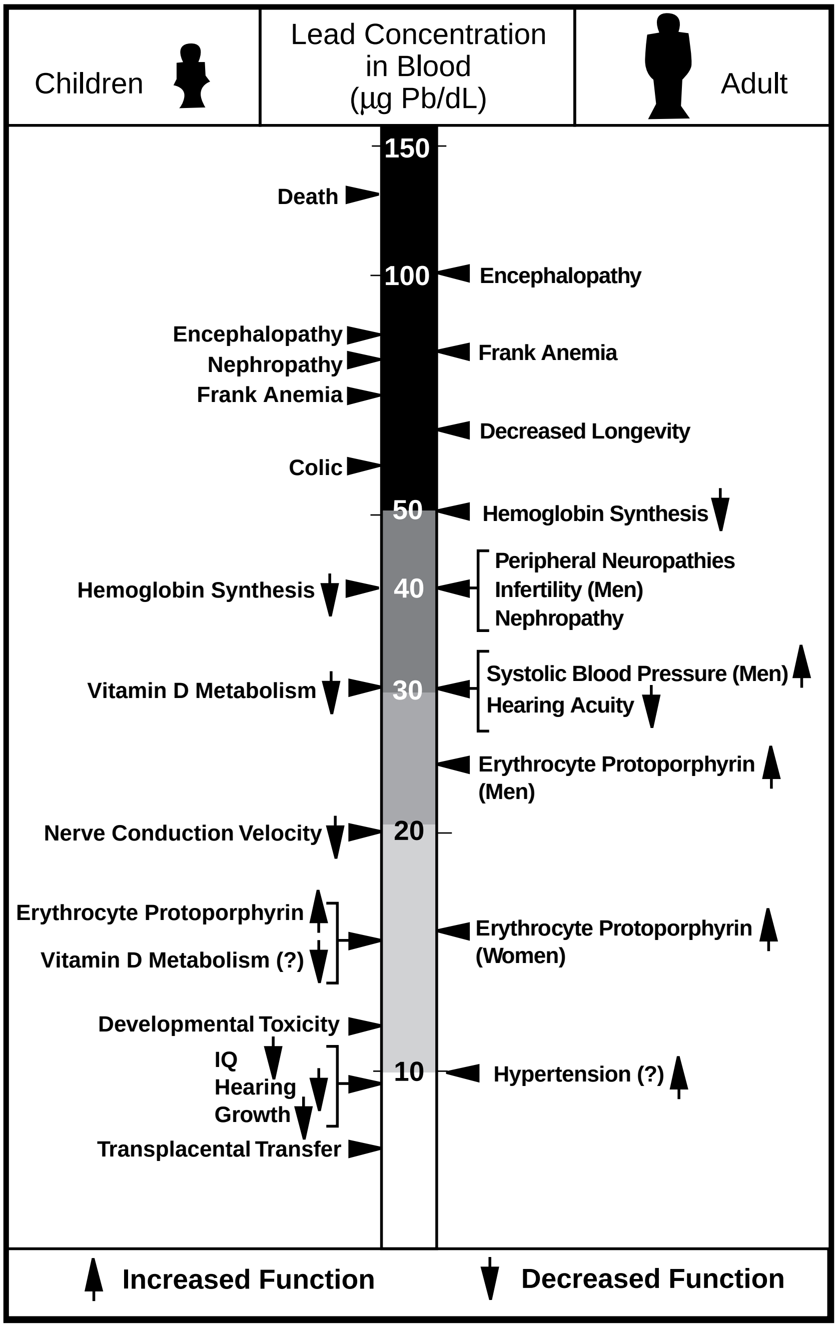
When a family member is occupationally exposed to lead, leaded dust may be carried home on clothing, on skin and hair, and in vehicles. High blood lead levels in resident children and elevated concentrations of lead in house dust have been found in the homes of workers employed in industries associated with high lead exposure (Grandjean, 1986). Children of workers with lead poisoning or children of any worker exposed to high lead levels should be tested for lead exposure by a qualified health-care provider.

III. Background on Federal Worker Protection Standards for Lead

For many years, there was a large disparity between OSHA's requirements for lead-exposed workers in general industry and those in construction. In 1978, OSHA promulgated a final lead standard for general industry (29 CFR 1910.1025). This comprehensive standard established a permissible exposure limit (PEL) of 50 micrograms of lead per cubic meter of air (µg/m^3) (8-hour, time-weighted average) and included requirements for engineering controls, personal protective equipment, air monitoring, medical surveillance, and employee training. Medical removal, with economic protection of wages and benefits, was specified for employees with an average blood lead level at or above 50 µg/dL.

The construction industry was exempted from the 1978 lead standard, primarily due to concerns regarding feasibility, the short duration of many exposures, and the relatively high number of temporary employees (OSHA, 1978). Prior to 1993, worker exposures to lead in the

Figure 9.1 Adverse Health Effects of Lead In Adults and Children.



Adapted from: ATSDR, *Toxicological Profile for Lead* (1989)

- ❑ Effects in children generally occur at lower blood lead levels than in adults.
- ❑ The developing nervous system in children can be affected adversely at blood lead levels of less than 10 µg/dL.

construction industry were regulated by several sections of the 1971 construction industry standards (29 CFR 1926), which included a PEL for lead of 200 µg/m^3, and did not include requirements for medical monitoring, removal of exposed workers, or other specific protective measures regarding lead.

The *HUD Interim Guidelines for Lead-Based Paint Abatement in Public and Indian Housing* (Revised Chapter 8, 55 FR 39973, August 1991) recommended that the requirements of the OSHA general industry lead standard be established as a minimum level of protection for workers performing lead-based paint abatement, and that additional medical monitoring and respiratory protection be provided. Both OSHA and the National Institute for Occupational Safety and Health (NIOSH) have recently published recommendations that exposures to lead in construction be minimized through the use of engineering controls and work practices, and that comprehensive worker protection programs be provided for lead-exposed workers (OSHA/NIOSH, 1991; NIOSH, 1992a).

In 1990, OSHA began to develop a comprehensive standard regulating lead exposure in the construction industry. Since no proposed final rule was forthcoming by late 1992, Congress required in Title X of the Housing and Community Development Act of 1992 (October 28, 1992) that OSHA issue an interim final rule for the construction industry within 180 days. Congress required that the standard be as protective as the worker protection requirements contained in the 1991 *HUD Interim Guidelines for Lead-Based Paint Abatement in Public and Indian Housing* (i.e., PEL of 50 µg/m^3). OSHA complied with this mandate, issuing an interim final rule for lead exposure in construction on May 4, 1993 (OSHA, 1993).

Workers engaged in routine maintenance work are covered by the general industry standard. Maintenance workers engaged in interim control or abatement work are covered by the construction standard.

Generally speaking, the new lead in construction standard requires employers to do the following:

- Evaluate workers' exposures.
- If exposures cannot be assessed before a job begins, determine if the job will involve manual demolition, manual scraping, or heat gun or power tool use.
- Implement engineering, work practice, and administrative controls.
- If these controls do not reduce exposures below the PEL, implement a respiratory protection program.
- Provide protective clothing.
- Provide handwashing or shower facilities.
- Provide a medical surveillance and blood lead monitoring program.
- Ensure that workers are trained adequately.
- Post warning signs.

IV. Previous Evaluations of Worker Exposures During Residential Lead Hazard Control Work

Prior to the initiation of lead hazard control work, employers should review the results of previous exposure assessments to help select proper methods, engineering controls, personal protective equipment, and work practices. In general, the data collected to date indicate that workers are occasionally exposed to lead levels greater than 50 µg/m^3 in most types of lead hazard control work, and that exposures are highly variable. Practically speaking, this means that *most* lead hazard control workers will need protective measures, such as respirators and medical surveillance. Some forms of lead hazard control (such as wet cleaning) may require only minor worker protection measures while others may require more substantial measures.

OSHA has recently collected exposure data that are representative of employees' lead exposure levels (8-hour, time-weighted average) for various construction activities, and are summarized in a table in the *Federal Register* (58 FR, No. 84, May4, 1993, Table 4, p.26612).

While *average* exposures in housing are generally below the PEL, it is important to understand that worker exposures at a given site may vary widely from previous exposure assessments (even for the same activity) due to variations in environmental conditions, work practices, the lead concentration in paint, and the total quantity of lead-based paint abated. Results from two relevant NIOSH studies of abatement activities are summarized below to illustrate how variable exposures can be.

A. The HUD Lead-Based Paint Abatement Demonstration

NIOSH investigators evaluated exposures and analyzed the exposure data collected by HUD contractors during the 1990 HUD Lead-Based Paint Abatement Demonstration that took place in single-family Federal Housing Authority (FHA) homes (NIOSH, 1992). During the demonstration, HUD prohibited certain abatement methods with high exposure potential (such as torch burning) and required the use of competent persons (as defined in the OSHA Lead Exposure in Construction standard), engineering and work practice controls, worker training, protective clothing and equipment, medical surveillance, and exposure monitoring.

Table 9.1 Personal Breathing Zone Air Sampling for Lead by Method or Activity*

	Personal Breathing Zone Lead Concentrations				
Abatement Method/Activity	**Number of Samples**	**Minimum ($\mu g/m^3$)**	**Maximum ($\mu g/m^3$)**	**Geometric Mean ($\mu g/m^3$)**	**Geometric Standard Deviation**
Abrasive	28	0.4	399	8.8	7.6
Chemical removal	291	0.4	476	3.3	4.1
Cleaning	138	0.4	588	1.9	3.6
Encapsulation	83	0.4	26	1.4	2.8
Enclosure	50	0.4	72	1.7	3.2
Final cleaning	56	0.9	36	2.1	2.8
Heat gun	360	0.4	916	6.4	4.7
Precleaning	31	0.9	11	1.5	2.2
Replacement	110	0.4	46	2.5	3.9
Setup	153	0.4	137	1.5	3.1
Other[1]	15	0.4	207	1.9	5.1
Missing[2]	87	—	—	—	—

NOTE: Underlined methods resulted in maximum exposures above the OSHA PEL.

OSHA PEL (8-hour, time-weighted average) = 50 $\mu g/m^3$

* Data collected by HUD Industrial Hygiene Contractors.

[1] Other abatement activities.

[2] Samples with no identified method/activity are not reported.

Laboratory-assigned Limit of Quantitation (LOQ): 0.4 $\mu g/m^3$

Understanding Worker Exposure Variability: Why Every Contractor Needs to Monitor Worker Exposure

Worker lead exposures during lead hazard control activities have been found to be highly variable. Due to differences in individual work practices and environmental variations, personal airborne lead exposures even among workers in the same job category and work area can vary significantly. Therefore, it is recommended that employers sample each type of worker on the job, preferably over several shifts (days) that are representative of the entire job. This recommendation is based on the NIOSH determination that estimating the exposures of a group of workers with similar exposure risk (e.g., same job category) by sampling only a few workers in the group is reasonably accurate (within 20 percent) *only* if the geometric standard deviation (GSD) of the group's exposures is less than 1.15 (McDermott, 1985). In the vast majority of occupational groups, and particularly in the construction industry, this condition will *not* be met; therefore, employers should monitor every type of employee at the worksite. For example, NIOSH investigators found that GSDs for residential lead-based paint abatement during the HUD demonstration ranged from 2.2 to 7.6 by method (see Table 9.1). However, it is *not* necessary for employers to conduct monitoring on each and every residence where work is proceeding. If the work is similar, monitoring may be performed in 1 of every 20 dwellings.

The NIOSH summary of the personal monitoring results is presented in Table 9.1. This personal breathing zone sampling was conducted primarily to examine exposures during different methods and activities. Sampling periods were generally less than a full shift, making it impossible to compare these results to typical lead hazard control jobs. While the average personal exposures to lead were generally low, the variability of exposures was very high. The geometric mean exposures were 3.1 $\mu g/m^3$, but the geometric standard deviation was 4.4. NIOSH recommends that generalizing the results from a limited sample, such as the HUD demonstration, to an entire population of workers is reasonable only if the variability is low and if the geometric standard deviation is less than 1.15. According to the maximum exposure levels, workers were exposed to lead above the OSHA PEL in 7 of the 11 NIOSH-assigned method categories, which would indicate that most types of lead hazard control can produce exposures above the PEL.

Personal lead exposures were found to vary significantly for different abatement methods, contractors (with significant method-contractor interaction), and housing units. Paint lead concentration alone was found to be a poor predictor of personal breathing zone exposures during abatement.

The HUD data should be useful for initial planning purposes. However, when reviewing the exposures, it is important to recognize that exposures during the HUD demonstration will not be representative of other contractors, work locations, or types of buildings.

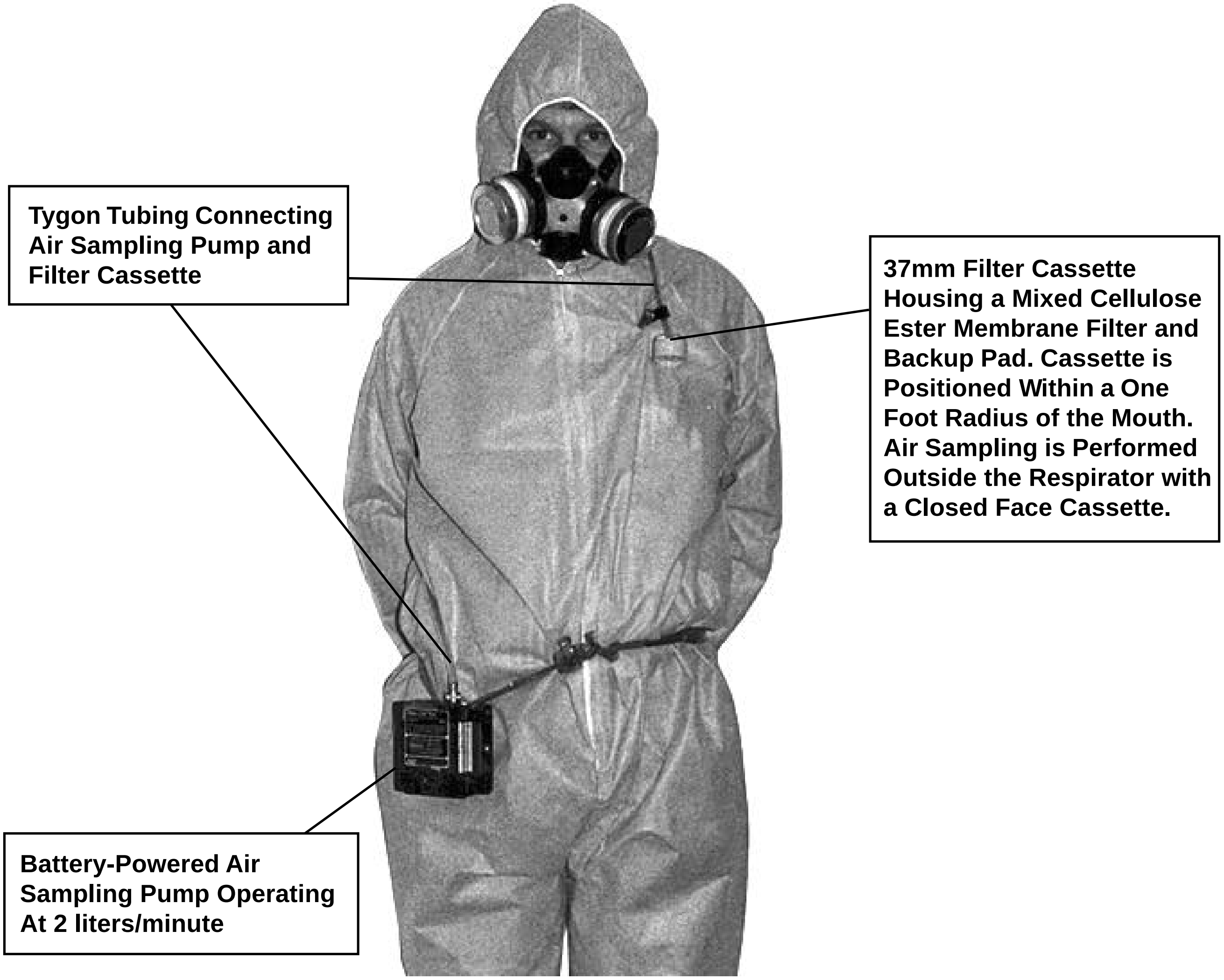
Limited air sampling for at least a few job sites for each contractor is therefore recommended, although it is *not* necessary to perform air sampling on every job.

B. Lead-Based Paint Removal

NIOSH investigators conducted an evaluation of worker exposures during a lead-based paint removal and cleaning pilot project (NIOSH, 1993). The project was designed to evaluate the following removal methods:

- Dry scraping followed by broom sweeping (dry sweeping)—this was selected to demonstrate exposures with no use of engineering or work practice controls.
- Wet scraping (painted surfaces were wetted with water mist) followed by high-efficiency particulate air (HEPA) vacuuming (wet HEPA).
- Wet scraping followed by HEPA vacuuming, with an air-filtration device (AFD) that is

Figure 9.2 Personal Breathing Zone Air Sampling.



Personal Breathing Zone Air Sampling involves drawing air through a 0.8µ Mixed Cellulose Ester Filter in a closed-face 37mm filter cassette using an air sampling pump running at 2 liters/minute.

equipped with a HEPA filter (wet HEPA/AFD) to pump air out of the work area (i.e., "negative air").

The final step for each of the methods was the wet mopping of floors.

In this study, workers were potentially overexposed to lead when using each of the removal methods. Short-term exposures ranged from 5 to 360 µg/m^3, with a geometric standard deviation of 2.9 overall. Of the methods evaluated, the wet HEPA method appeared to offer the best control for worker exposures and area airborne lead concentrations. Extrapolated 8-hour exposures for workers who used all three methods during a shift (which should be considered minimum values) ranged from 6 to 73 µg/m^3.

The method, mean paint lead concentration, precleaning surface lead concentration, and work crew practices were all found to be related to average worker exposures.

V. OSHA Requirements for Residential Lead Hazard Control Work

The preceding NIOSH data indicate that the OSHA standard will apply to most forms of residential lead hazard abatement work. The OSHA interim final rule for construction applies a level of protection (generally equivalent to the lead standard for general industry) to all occupational exposures to lead in construction, including lead abatement, repair or renovation of structures containing lead, cleaning and disposal of lead-contaminated materials, and maintenance operations.

The OSHA standard covers the following work:

- Demolition or salvage of structures containing lead.
- Removal, enclosure, or encapsulation.
- Renovation, alteration, repair, or construction of structures or substrates that are coated with lead-based paint.
- Lead cleanup.
- Transportation, storage, disposal, or containment of lead debris at the site of lead hazard control activities.
- Any maintenance work.

Various provisions of the standard are triggered by an action level of 30 $\mu g/m^3$ (the same as the general industry standard) and a PEL of 50 $\mu g/m^3$ (both measures are expressed as 8-hour, time-weighted averages). Employers may use a combination of engineering controls, work practices, and respiratory protection to comply with the PEL. However, engineering and work practice controls must be used first. As a practical matter, engineering and work practice controls in residential lead hazard control work are limited largely to the use of low dust-generating hazard control methods, such as enclosure and wet methods. This means that respirators will be needed for most types of lead hazard control work in housing, since the variability of exposures is quite high.

As in the general industry standard, OSHA requires adjustment of the PEL to ensure that employees who work longer than 8 hours are not exposed to a greater daily dose of airborne lead. For work shifts longer than 8 hours, the PEL is reduced according to the following formula:

$$\text{Adjusted PEL} = \frac{400}{\text{number of hours worked}}$$

For example, if the work shift is 10 hours, the PEL becomes 40 $\mu g/m^3$.

$$\frac{400}{10 \text{ hours}} = 40\ \mu g/m^3$$

A trigger for worker protection requirements based on paint lead concentration was considered by OSHA, but rejected. Given the variability of work practices and methods, OSHA concluded that no useful correlation between surface concentrations and occupational exposures could be established.

In recognition of the difficulties of conducting exposure assessments during construction jobs, the interim final rule establishes task-related triggers. Certain protective measures are triggered by tasks (listed in Table 9.4) that commonly produce exposures greater than the PEL, even with prescribed protective measures. Performance of any task on one of the lists triggers specific interim protective requirements that will remain in effect until results of an exposure assessment demonstrate that such protection is not necessary.

The interim final rule requires that the following provisions be made:

- Written compliance plan and competent person(s).
- Initial exposure assessment and periodic exposure monitoring.
- Task-related triggers, with interim protection during assessment.
- Engineering, work practice, and administrative controls.
- Respiratory protection program.

Table 9.2 Worker Exposure Limits and Guidelines

Air lead	
OSHA Permissible Exposure Limit (PEL)	50 µg/m^3
OSHA action level	30 µg/m^3
Blood lead	
OSHA medical removal limit	50 µg/dL
OSHA recommended level to prevent reproductive problems	30 µg/dL
ACGIH proposed Threshold Limit Value	20 µg/dL

Table 9.3 Required Action Under the OSHA Standard by Exposure Level

CATEGORY I	CATEGORY II	CATEGORY III
30 µg/m^3* and under (below the action level)	30–50 µg/m^3 (above the action level, but below the PEL).	50 µg/m^3 and over (above the PEL).
Train employees. Conduct exposure monitoring. Maintain records.	Same as category I, plus: Provide respirator at employee request. Conduct exposure monitoring every 3 months. Conduct blood lead monitoring.	Same as category II, plus: Enforce respirator use. Enforce use of protective clothing. Develop monitoring every 6 months. Enforce housekeeping. Provide hygiene facilities and enforce washing.

* All exposure levels are 8-hour, time-weighted averages.

- Protective clothing and equipment.
- Housekeeping.
- Hygiene facilities and practices.
- Medical surveillance.
- Medical removal protection.
- Hazard communication programs and training on specific operations causing lead exposure.
- Signs.
- Recordkeeping.
- Observation of monitoring.

Individual States that have approved plans for OSHA enforcement may adopt their own lead standards for the construction industry, as long as their requirements are at least as stringent as the Federal OSHA standard. Employers will need to ensure that their programs for worker protection meet applicable State requirements.

The OSHA standard does not specify the methods for any given type of operation, such as lead-based paint removal. The method of removal is left to the discretion of the employer, and constitutes an important potential engineering control. In some cases, however, the method of abatement or interim control will have already been selected by a risk assessor and/or the property owner based on other considerations.

A. Written Compliance Plan and Competent Person(s)

For every job, OSHA requires employers to prepare a written compliance plan that specifically describes how the standard will be implemented and includes regular and frequent inspections of the job site by a competent person. The written compliance plan, in conjunction with frequent work area inspections by a competent person, should ensure the prevention of dangerous, unhealthy, or unsafe conditions.

1. Written Compliance Plan

An example of a written compliance plan appears at the end of this chapter. Prior to the start of every job in which employee exposure will potentially exceed the OSHA PEL, employers must develop and implement a written compliance plan. (Providing respirators does *not* make a written plan unnecessary.) The written plan should be an organized strategy for protecting workers and should account for potential exposure problems, control alternatives, and a schedule for inspection of the job by the competent person(s). At a minimum, OSHA requires that written plans include:

- A description of equipment and materials, controls, crew size, job responsibilities, and operations and maintenance procedures for each activity in which lead is emitted.
- A description of specific control methods (e.g., abatement process selection, wet methods). For engineering controls, include supporting engineering plans and studies used to select methods.
- Technology considered in meeting the PEL.
- Air monitoring data documenting sources of lead emissions.
- A detailed implementation schedule for the compliance plan, including the schedule for inspections by a competent person.
- A description of the lead work practice program that will be used to control worker exposures. (This includes the use of protective work clothing and equipment, hygiene facilities and practices, and housekeeping practices.)
- A description of arrangements made among contractors on multicontractor worksites to inform affected employees (including bystanders) of potential lead exposures, and to clarify responsibilities with regard to control of those exposures.

For those hazard control jobs that proceed over an extended period in multifamily housing, OSHA requires that the written compliance plan be updated at least every 6 months. Single-family housing will require a separate plan for each dwelling. The plan must be available at the worksite for representatives of OSHA or NIOSH, and at the request of any affected employee or employee representative. (See the end of this chapter for copies of blank and completed written compliance plans.)

2. Competent Person(s)

As defined by OSHA, a “competent person” is one who is capable of identifying existing and predictable hazards at the worksite, and who has the authority to ensure prompt corrective measures are taken to eliminate them. The employer must utilize a competent person (or persons) to ensure that the worker protection program is effective. The definition of a competent person and the requirement for regular and frequent inspections of job sites, materials, and equipment by a competent person are identical to those already required by OSHA’s general safety and health provisions for construction work (29 CFR 1926.32 and 29 CFR 1926.20). In the context of a lead-based paint abatement job, the competent person should have knowledge of the lead exposures for each abatement method in use; the potential hazards from lead and other substances or physical agents in the worksite; the appropriate engineering controls, work practices, and personal protective equipment for the job; the requirements of OSHA construction standards (29 CFR, Part 1926); and the recommendations of these *Guidelines* and other general sources of information. The competent person's worksite inspection frequency should be based on the magnitude of potential lead exposures, the number of workers at each site, and the employer's past experience. Duties of the competent person include:

- Determining whether lead is present before work begins.
- Ensuring that employee exposure assessment is performed.
- Ensuring that workers use required protective clothing and respirators.
- Ensuring that up-to-date copies of respirator fit tests and medical examination results are available.
- Ensuring that proper hygiene facilities are available and in use.
- Ensuring that engineering controls are operating properly and are effective.
- Posting lead hazard work areas with warning signs.

B. Exposure Assessment

1. Initial Exposure Assessment

The OSHA standard requires all employers to conduct initial exposure assessments for all jobs involving the use or removal of lead or lead-containing materials. The purpose of the initial assessment is to determine if *any* workers are being exposed to lead equal to or greater than the action level of 30 µg/m^3. The exposure assessment can include current results from exposure monitoring of employees, previous monitoring results, or other objective data demonstrating that the specific product, process, operation, or activity involving lead cannot result in exposures above the action level under any circumstances. Each of these methods for exposure assessment is discussed in more detail below.

The initial exposure assessment may be limited to workers that are believed to have the greatest exposures to airborne lead. When planning which employees to include in the initial exposure assessment, the following should be considered: any information, observations, or calculations that would indicate potential airborne exposure to lead, including previous measurements of airborne lead; and any employee complaints of symptoms consistent with exposure to lead. Additional factors that should be considered include the worker's distance from airborne lead sources; employee movement, ventilation, and airflow patterns; and individual work practices. If no information is available for assessing maximum-risk employees, then all workers should be assumed to be at risk. NIOSH has published recommendations for selecting maximum-risk employees (NIOSH, 1977).

Positive initial determination

When the initial assessment shows the potential for any employee to be exposed to lead at or above the action level (for 1 day or more), the determination is *positive* and exposure monitoring (or assessment with existing data) for each individual on the job must be conducted during representative work shifts.

Negative initial determination

When the determination shows that no employee is potentially exposed to lead at or above the action level (for 1 day or more), the determination is *negative* and further exposure assessment is not necessary until there is a change in the workplace (see Monitoring frequency below).

2. Exposure Monitoring

Personal monitoring

"Exposure monitoring" refers to the measurement of a worker's exposure to an airborne contaminant, regardless of any respiratory protection worn. An air sample is collected outside of any respirator worn, as close to the worker's mouth and nose as is practical (often the collection device is located on the shirt collar).

OSHA requires that exposure monitoring consist of full-shift samples (at a minimum, one sample for each job classification in each work area). In the case of multiple shifts, each shift or the shift with the highest expected exposure level should be monitored. Since the degree of worker protection provided may depend on the results of exposure monitoring, it is critical that the sampling be representative of the employees' regular, daily, and highest exposure to lead. It is not necessary to perform sampling in each dwelling where work is performed.

Number of samples

There is no formula for determining the total number of samples to be collected during each job. The sampling protocol should be developed on a case-by-case basis by an industrial hygienist or other qualified occupational safety and health professional.

Sampling methods

NIOSH and OSHA have published laboratory-based sampling methods for personal airborne lead, with guidelines for acceptable precision and accuracy (OSHA, 1985; NIOSH, 1984). The sampling method used for monitoring must have an accuracy rate not less than ±25 percent for the action level of 30 $\mu g/m^3$. Employers should use laboratories that are accredited for environmental lead analyses. Requirements for a National Lead Laboratory Accreditation Program (NLLAP) have been developed by the U.S. Environmental Protection Agency's (EPA's) Office of Pollution Prevention and Toxics for the recognition of private and/or State laboratory accreditation systems. A complete list of EPA NLLAP-recognized laboratories is available to the public from NIOSH (1–800–35–NIOSH) or the National Lead Information Center Clearinghouse (1–800–424–LEAD).

Monitoring frequency

Employers do not need to perform air sampling in each dwelling treated. A reasonable approach would be to conduct air sampling in 1 dwelling out of every 20 treated, with an emphasis on sampling worst-case dwellings. This approach can be used for both large, multifamily and small, single-family jobs.

If employee exposures to lead are at or above the action level, but not exceeding the PEL, then employers must perform monitoring at least every 6 months. If employee exposures are above the PEL, then monitoring must be performed at least every 3 months. The monitoring must be continued every 6 months (or every 3 months) until at least two consecutive measurements that are taken at least 1 week apart are below the action level (or PEL).

Employee notification

Employees must be provided with written results of their exposure within 5 (working) days of the completion of the exposure assessment. This concludes the exposure assessment requirement.

Other air sampling

Samples collected inside a worker's respirator may be used to determine the effectiveness of a respiratory protection program, although such sampling is often quite difficult for most types of respirators. "Area" samples (those collected in the general area of the work activity or at the perimeter of the lead hazard work area) may be used to assess potential bystander exposures. While inside-respirator and area samples are potentially useful, neither can be used to meet OSHA monitoring requirements and they should not be considered a substitute for personal sampling.

3. Previous Monitoring Results

To use previous monitoring results for exposure assessment of employees, the data must have been collected within the past 12 months, and the work operations and work conditions should closely resemble the processes and types of materials, control and containment methods, work practices, and environmental conditions in the current workplace, including the condition of the lead-based paint, the concentration of lead in paint, and the degree of employee training and supervision. Employers must have this data in their possession to present to an OSHA compliance officer.

4. Objective Data

Objective data may not be used for exposure assessment for any of the activities listed in OSHA's task-related triggers (see below). Examples of objective data that OSHA would allow are the results of laboratory product test results from manufacturers of lead-containing products or materials, or results of an industry-wide study. (The HUD demonstration project described earlier does not constitute an industrywide study since project conditions were different from ordinary conditions.) Since manufacturers' data are of varying quality, employers should determine whether the data have been collected in a sound and objective manner.

Additional requirements for the use of objective data are:

- The data must show that the product, process, or material cannot result in employee exposure to lead that is equal to or greater than 30 µg/m^3 during any aspect of the job.
- The employer must establish and maintain accurate records of the objective data and its relevancy (see the information on recordkeeping below).

C. Task-Related Triggers

Until exposure assessments have been completed, employers must rely on OSHA's task-related triggers to determine appropriate controls and work practices. OSHA's task-related triggers are based on three categories of exposure (see Table 9.4). If lead is present when any of these tasks are performed, interim protective provisions are required prior to and during assessment of employee exposures.

Required interim protection during initial exposure assessment includes respiratory protection, protective work clothing and equipment, change areas, handwashing facilities, training, and initial blood sampling and analysis. Requirements for the three lists of tasks are identical except for the minimum respiratory protection, which depends on the assumed exposure range. For example, for airborne concentrations of lead less than 500 µg/m^3, the required minimum respiratory protection is a half-mask, air-purifying respirator with HEPA filters (see Figure9.3).

The employer can discontinue the interim protection for any employee performing one of these tasks only after it is documented that the employee's exposure is below the PEL. Respiratory protection can be reduced only after it is documented that the exposure is below the assumed range for the task. It is unlikely that risk assessors or inspector technicians, who scrape limited surface areas, will require respiratory protection. It is not necessary for such individuals to wear respirators, unless a large number of samples will be collected on a single day.

Table 9.4 Residential Lead Hazard Control Assumed Exposures for OSHA's Task-Related Triggers (adapted from 29 CFR 1926.62)

50 µg/m^3 to 500 µg/m^3	500 µg/m^3 to 2,500 µg/m^3	Greater than 2,500 µg/m^3
Manual demolition Manual scraping Manual sanding Heat gun use Power tool paint removal in the HEPA vacuum-assist dust collection system	Cleanup on dry, abrasive blasting jobs Abrasive blasting enclosure movement/removal	Abrasive blasting

Note: Abrasive blasting without a HEPA local exhaust system is not permitted in residential dwellings.

Figure 9.3 How to Inspect Your Respirator.

A Half-Mask, Air-Purifying Respirator with HEPA Cartridges Is Appropriate for Many Residential Lead Hazard Control Jobs. Paper Dust Masks are NOT Adequate.

STRAPS—hold the respirator on your head. One goes over the crown of your head. Another headband has two plastic straps, which go straight up and straight back on your head.

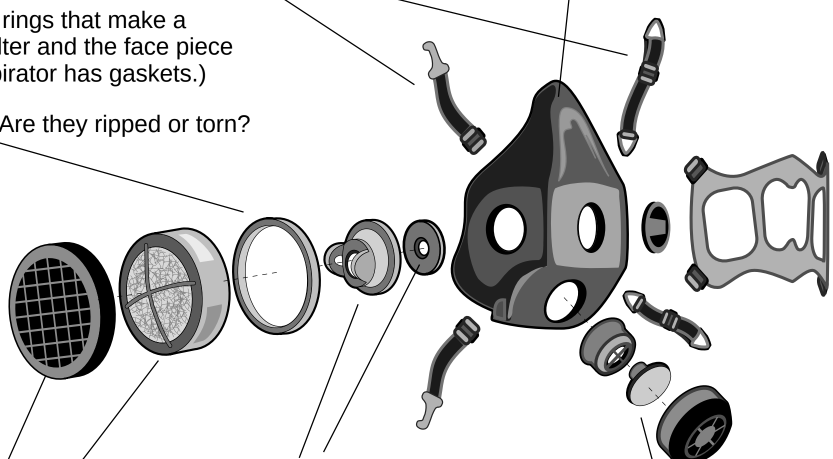
Check: Are they elastic? Are they torn? Do the buckles and snaps work?

FACE PIECE—is made of rubber, silicon, or other materials.

Check: Is it ripped or worn? Is the face piece bent? Is it clean?

GASKETS—are rubber rings that make a tight seal between the filter and the face piece present. (Not every respirator has gaskets.)

Check: Are they there? Are they ripped or torn?



INHALATION VALVES—are where you breathe in. There are two small rubber flaps behind the filters.

Check: Are both there? Are they ripped or bent? Are they dirty?

Filters—filter the air. They are also called "cartridges."

Check: Do you have the right one for the job? When you work with lead, you need HEPA filters. When you use solvents or caustic paste, you will need other filters, too. Change filters regularly, especially when it becomes harder to breathe.

EXHALATION VALVE—is where you breathe out. It is a small rubber flap about the size of a quarter. It is underneath a cover.

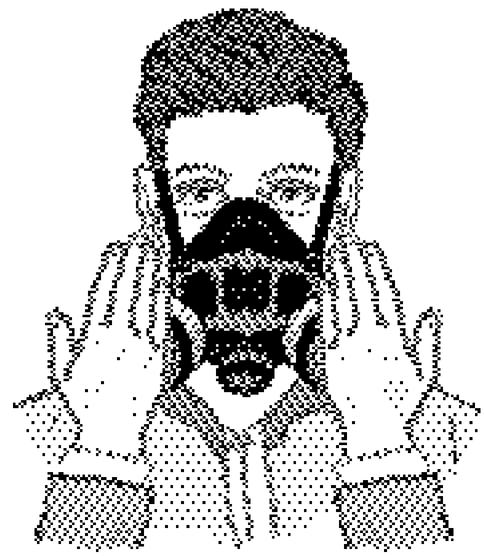
Check: Take off the cover. Is the valve there? Is it ripped or bent? Is it dirty?

Courtesy: Alice Hamilton Occupational Health Center

Figure 9.4 Qualitative Respirator Fit Checks.

Negative-pressure fit check

Cover the two filters or the air hose with your hands and inhale gently. Hold for a count of ten. You will feel the respirator pull against your face. You can feel the area of the seal tightening to your face. If there is a leak, air will rush in through the leak instead of pulling the mask against your face. You will feel air move against your cheeks. It may feel like a feather brushing across your face. The air will move toward your mouth. You may hear the air flow. If someone is watching you, they should see the respirator suck in a little at your nose.



Negative-pressure fit check

Positive-pressure fit check

Cover the rubber flap exhalation valve with one hand and puff out gently. You should feel the force of your breath balloon the respirator out a tiny bit. This is like the feeling you get when you first blow up a balloon. You have to blow harder to get over the resistance of the balloon. As the mask moves out, you will feel the seal of the respirator tighten on your face. If there is a leak in the mask, air will rush out of the leak instead of making the mask balloon out. If there is a leak, you will feel air rush out against your cheeks. You will not feel the seal tightening to your face. Don't blow too hard, or you can blow out your intake valves and break a good seal.

Positive-pressure fit check

Courtesy: Alice Hamilton Occupational Health Center

D. Engineering and Work Practice Controls

OSHA requires employers to institute engineering and work practice controls to the extent feasible to reduce worker exposures so they are at or below the PEL. The Society for Occupational and Environmental Health (SOEH) has published recommendations on engineering and work practice controls (SOEH, 1993).

Some examples of good engineering controls are:

- ❖ Providing HEPA-filtered local exhaust ventilation for devices and abrasive power tools, including all blasting equipment, needle guns, sanders, and grinders.
- ❖ Using HEPA vacuums for cleanup instead of dry sweeping or compressed air.
- ❖ Providing adequate ventilation during indoor heat gun use to prevent buildup of lead and volatile organic compounds.
- ❖ Using wet methods to reduce airborne dust generation; for example, a water sprayer to hold down settled leaded dust on the plastic sheeting covering the floor or ground.

Some examples of good work practices are:

- ❖ Wetting of surfaces with water mist prior to scraping, sweeping, or sawing.
- ❖ Providing onsite washing facilities, and following good hygiene practices.
- ❖ Daily cleanup of work area and equipment to prevent leaded dust accumulations.
- ❖ Whenever feasible, avoiding methods with known high exposure potential, such as machine sanding without local exhaust ventilation.

E. Respiratory Protection Program

Even with implementation of engineering and work practice controls, respiratory protection will probably be necessary for most abatement methods, such as lead-based paint removal by chemicals, heat gun, or abrasive techniques, and some other operations, including setup, cleaning, many forms of interim control, and maintenance. Due to the variability of exposures in construction, contractors may need to use more than one type of respirator at a given job. Respirator selection for each job should be determined by an industrial hygienist or other trained health and safety professional.

OSHA requires the use of respirators:

- ❖ When an employee's exposure exceeds the PEL and as interim protection for tasks specified in the task-related triggers.
- ❖ In work situations where engineering and work practice controls are not sufficient to reduce employee exposures below the PEL.
- ❖ Whenever an employee requests a respirator.

Because there are recognized health effects at blood lead levels below what is allowed by OSHA, employees may wish to use respirators even when their exposures are below the PEL.

Whenever respirators are used, either on a voluntary or mandatory basis, employers must establish a respiratory protection program. Respirators are devices that must be used carefully (29 CFR 1910.134, OSHA respirator standard). A minimally acceptable respiratory protection program must include selection of respirators on the basis of worker exposures; written standard operating procedures; training of workers in the proper use of respirators; fitting, regular cleaning, maintenance, and inspection of equipment; and storage in a clean and sanitary location. Workers must not be assigned to tasks requiring the use of respirators unless it has been determined by a physician that they are physically able to perform the work and use the respirator. Under the OSHA Lead Exposure in Construction standard, employers are required to:

- ❖ Provide respirators approved by NIOSH and the Mine Safety and Health Administration (MSHA) for protection against leaded dust, fume, and mist at no cost to the employee.

- Select required respirators for employees based on the maximum airborne concentrations of lead, expected or measured, according to Table 1, 29 CFR 1926.62.
- Upon employee request, provide a powered air-purifying respirator (PAPR) to any employee in lieu of the selected respirator if this will provide sufficient protection.
- Ensure that the respirator issued to each employee fits properly and exhibits minimum face piece leakage.
- Perform qualitative or quantitative fit tests at the time of the initial fitting and at least every 6 months thereafter for employees wearing negative-pressure respirators.
- If an employee exhibits difficulty during fit testing or subsequent use, provide an appropriate medical examination to determine whether the employee can wear a respirator while performing the job.
- If filter respirators are used, maintain an adequate supply of filters, and instruct each employee to change the filter elements whenever an increase in breathing resistance is detected.

1. Respirator Selection

If a respirator is required, it is the employer's duty to enforce its use.

Employers should refer to the OSHA interim construction lead standard (Table 1, 29 CFR 1926.62) for the proper selection of respirators. In the absence of hazardous contaminants other than lead, the half-mask, air-purifying respirator with HEPA filters should be adequate for most lead hazard control jobs, since most exposures are usually less than 500 $\mu g/m^3$.

Respirators specified for higher concentrations can also be used at lower concentrations of lead. For example, PAPRs may be preferred over half-mask, negative-pressure respirators because they are more protective, produce less cardiovascular stress, and are generally more comfortable to wear. PAPRs include a small, battery-powered blower that provides clean air to the worker, thus reducing breathing resistance.

If an initial determination or exposure monitoring indicates potential airborne exposure to contaminants other than lead, such as solvents used during chemical stripping or heat gun use, reevaluation of the respirator selection is warranted. It would be prudent to select a respirator (or filter) that protects against *both* lead particulate and organic vapors. If a worker has an increase in blood lead level, reevaluation of the respirator program, personal hygiene, and work practices is needed.

F. Protective Clothing and Equipment

OSHA requires that employers provide and enforce the use of protective clothing whenever employees are exposed to airborne lead above the PEL (irrespective of respirator use) and as interim protection for employees performing tasks listed in the task-related triggers. Hardhats, goggles, safety shoes, and other personal protective equipment may also be required by other OSHA standards, depending on the type of work performed. These materials must be supplied at no cost to employees.

Leaded dust is not absorbed directly through the skin; however, lead contamination of workers' clothing and person has resulted in lead exposure for workers and their families in the past. The use of protective equipment, in conjunction with good hygiene practices and washing facilities, should prevent contamination of workers' personal clothing and prevent the transfer of lead contamination from the work area to lunch and break areas, personal vehicles, and workers' homes. Workers should be equipped with disposable or reusable coveralls or similar full-body work clothing, gloves, hardhats, safety shoes, disposable shoe covers, chemical-resistant clothing (for skin-contact hazards), safety glasses, face shields, and goggles (in conjunction with portable eyewash equipment).

Since workers may spend most of their time on abatement jobs wearing protective clothing, it should be selected to prevent heat stress. For

Figure 9.5 Types of Respirators Used in Residential Lead Hazard Control Work.

Half-Mask, Air Purifying Respirator

Adequate for Atmospheres Up To 500 $\mu g/m^3$ Lead

Full-Face, Air Purifying Respirator

Adequate for Atmospheres Up To 2500 $\mu g/m^3$ Lead

Powered Air Purifying Respirator

Adequate for Atmospheres Up To 2500 $\mu g/m^3$ Lead
(Filter and Battery-Powered Blower are worn on Belt)

example, the use of breathable clothing (cotton or paper fabric) is appropriate during most abatement work to reduce the potential for employee heat stress. Shoes or disposable shoe covers should have nonskid soles, particularly for work on plastic-covered surfaces. Shoe covers should *not* be used when workers need to climb ladders and scaffolding because they may cause slips and falls; nonskid work boots should be used instead. Work boots or shoes should be removed from the work area only in a sealed plastic bag. Torn shoe coverings also present a serious hazard and should be replaced as often as necessary. Chemical-resistant protective clothing will be necessary for any work involving caustic or solvent-based strippers and other substances that are hazardous upon skin contact. For example, caustic paint strippers require special clothing and gloves (see the Manufacturer's Material Safety Data Sheet). Paper suits and shoe covers are not appropriate for chemical processes.

The possibility of heat stress and its signs and symptoms while wearing protective clothing should be included in worker training. Contractors should consult an industrial hygienist or other qualified health and safety professional for the proper selection of protective clothing.

OSHA requires that employers supply clean work clothing at least weekly to employees with personal exposures above the PEL, and daily to those with levels greater than 200 $\mu g/m^3$ as an 8-hour, time-weighted average.

Employers are responsible for cleaning, laundering, and disposing of protective clothing and equipment; repairing or replacing protective clothing and equipment to maintain its effectiveness; ensuring that all protective clothing is removed at the end of a work shift only in designated change areas; ensuring that contaminated clothing is placed in a closed container in the change area to prevent the spread of lead contamination; and notifying in writing anyone who cleans or launders the protective clothing that the clothing is contaminated with lead.

Removal of lead from clothing by blowing, shaking, or any other means that disperses lead into the air is prohibited. HEPA vacuuming heavily contaminated protective work clothing as an initial cleaning method is recommended.

G. Housekeeping

Employers must keep all surfaces in the worksite as free as practicable from lead accumulations. This is important to prevent dispersal of leaded dust into the air during work activities, thus reducing employee exposure to lead. Cleanup of floors and other surfaces must be completed by vacuuming (using vacuums equipped with HEPA filters and/or wet washing methods) or other methods that minimize airborne lead during cleaning.

Shoveling, wet sweeping, and brushing may only be used for cleanup where vacuuming or other equally effective methods have been tried and proven ineffective. For example, shoveling and sweeping may be necessary to pick up large debris. In such cases, the debris should be misted with water prior to cleanup to minimize leaded dust generation.

OSHA prohibits the use of compressed air to clean leaded dust from any surface.

H. Hygiene Facilities and Practices

OSHA requires that employers provide hygiene facilities and ensure good hygiene practices for all employees performing work that is covered by the task-related triggers or for workers who are exposed to airborne lead above the PEL (irrespective of respirator use). Employers must ensure that no food, beverage, or tobacco product be present or consumed, and that cosmetic products not be applied in work areas. Employers must also provide change areas, showers (where feasible), eating areas, and handwashing areas. Good hygiene facilities and practices will minimize additional employee exposure to lead from ingestion or inhalation, and prevent contamination of workers' vehicles and homes. Wipe sampling of designated "clean" areas during abatement jobs longer than 2 weeks should be conducted. Even if exposures are less than 50 $\mu g/m^3$, contamination of workers' automobiles, clothes, and homes with settled leaded dust can be a serious problem. Good personal hygiene is essential even if airborne dust exposures appear to be low.

Specific hygiene requirements for employees exposed above the PEL (without regard to respirators) are listed below. Change areas and handwashing facilities are also required as interim protection during exposure assessment for the task-related triggers.

1. Decontamination Procedures

Conduct worker decontamination before all breaks, before lunch, and at the end of the shift. Decontamination consists of:

- Cleaning all tools (at the end of the shift).
- HEPA vacuuming all protective clothing before entering the decontamination area.
- Entering the decontamination area (dirty side).
- Removing protective clothing by rolling inward (do not remove respirator yet); removing work shoes and putting in plastic bag.
- Entering shower or washing facility.
- Removing respirator after washing hands.
- Taking a shower, if available, using plenty of soap and water; washing hair, hands, fingernails, and face thoroughly (before lunch and at the end of the shift only).
- Entering the clean area and putting on street clothing and street shoes.

2. Change Areas

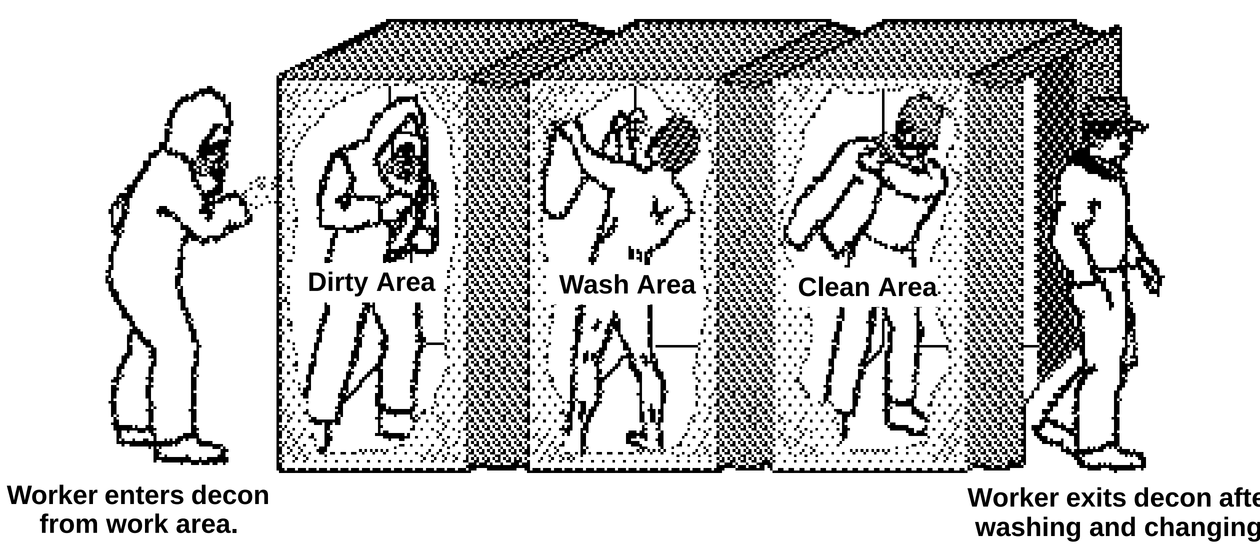
To prevent cross-contamination, change areas must have separate storage facilities for protective work clothing and equipment and workers' street clothes. The employer is responsible for ensuring that employees do not leave the worksite wearing protective work clothing. Change areas and clean areas should be cleaned on a regular basis.

In those worksites where a decontamination zone is not feasible, workers can wear two layers of protective clothing, if heat stress is not a problem. The first layer is removed at the work area exit; the second is removed in the clean area.

3. Showers

Wherever feasible, employers should provide shower facilities onsite. Employers must make soap and towels available, and make sure that

Figure 9.6a Worker Decontamination.



employees shower before lunch and at the end of their shifts to remove lead from skin and hair.

4. Eating Facilities

Employers must provide clean, accessible eating areas for employees. The dwelling and work area should not be used as eating areas.

Employers must ensure that workers wash their hands and face prior to eating, drinking, smoking, or applying cosmetics. Also, workers may not enter eating areas with contaminated protective work clothing or equipment unless surface leaded dust has been removed by vacuuming or another cleaning method that controls leaded dust dispersion.

Although not specifically addressed by OSHA Lead Exposure in Construction standard, if workers voluntarily leave the worksite for lunch, they should be required to wash or shower, and change into street clothing to prevent contamination of their personal vehicles. Showering is not needed for other breaks, although workers should always wash their hands and face before eating, drinking, or smoking.

5. Handwashing Facilities

Employers must provide adequate handwashing facilities for employees exposed to lead. Handwashing facilities must be in accordance with general construction health and safety requirements (29 CFR 1926.51 (f)). The facilities should be located near the worksite and be sufficiently equipped so that workers can remove lead effectively. Where showers are not provided, employers must ensure that workers wash their hands and face at the end of their work shift.

I. Medical Surveillance

Workers must undergo both initial and routine medical surveillance, depending on the level and duration of their airborne exposures to lead. Employers and physicians should consult AppendixC in 29 CFR 1926.62 for detailed guidelines on medical surveillance of lead-exposed workers. All medical examination procedures must be under the supervision of

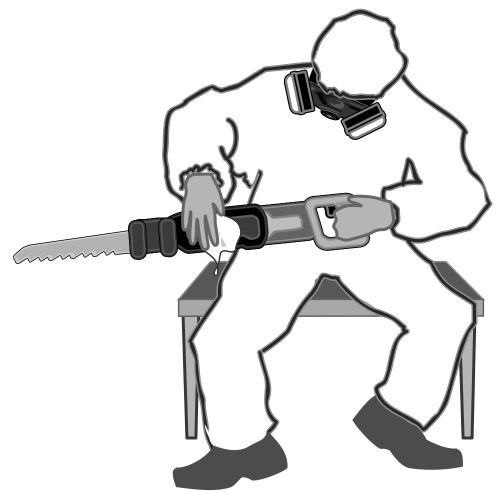
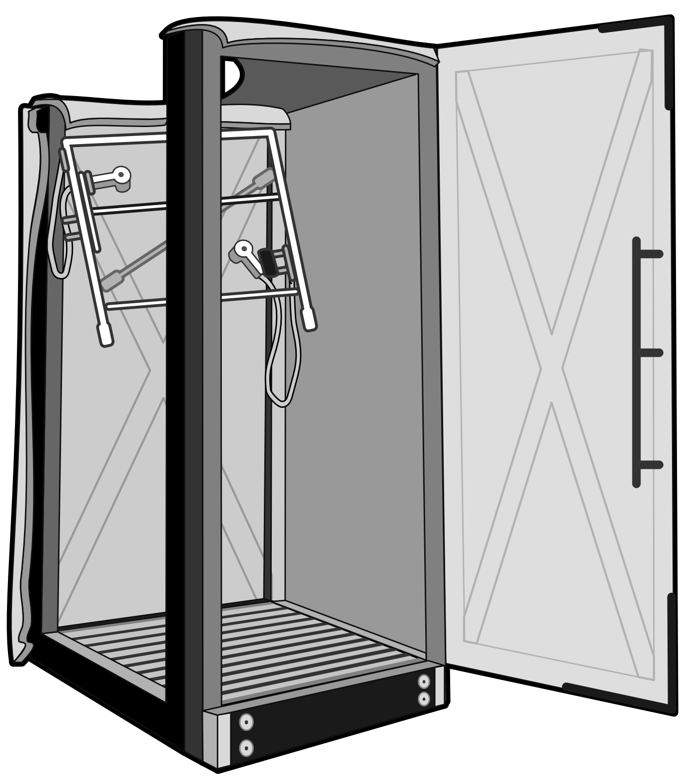


Figure 9.6b Decontamination of Tools.

Figure 9.7 Portable Showers Make Worker Decontamination More Effective and Feasible.



a licensed physician, preferably one who is board-certified in occupational health.

Lead abatement contractors should use medical surveillance to measure the effectiveness of their worker protection programs. For example, significant increases in blood lead levels of 10 µg/dL or greater or blood lead levels exceeding 20 µg/dL should trigger timely investigations of exposures, work practices, respirators, and personal hygiene practices.

1. Initial Surveillance

One purpose of initial medical (or biological) monitoring is to establish baseline blood lead levels and to allow early detection of increases in worker blood lead levels. Another purpose is to detect workers who have already been overexposed to lead on previous jobs. OSHA requires employers to:

- Make initial biological monitoring available to all employees who are exposed *on any single day* to lead levels equal to or greater than 30 µg/m^3.
- Provide initial biological monitoring to all employees who will be performing task-related trigger activities (see Table9.4).
- Conduct biological monitoring of workers' blood lead levels *and* zinc protoporphyrin levels (zinc protoporphyrin levels are one way of measuring long-term exposures).
- When an employee's initial blood lead level is equal to or greater than 40 µg/dL, provide continued biological monitoring at least every 2 months, until two consecutive blood lead level results are less than 40 µg/dL.

2. Routine Surveillance

Generally, most lead hazard control workers in the residential setting should have their blood lead levels checked every month or two and a baseline level determined before beginning work. An ongoing medical surveillance program, including biological monitoring of blood lead and zinc protoporphyrin levels and medical examinations, must be provided for all employees who *are or may be* exposed to lead levels greater than 30 µg/m^3 for more than 30 days in any consecutive 12-month period. OSHA requires employers to pay for biological monitoring and medical examinations.

Biological monitoring requirements

The employer must make available the following:

- Biological monitoring for blood lead and zinc protoporphyrin levels at least every 2 months for the first 6 months, and every 6 months thereafter.
- When an employee's blood lead level is equal to or greater than 40 µg/dL, biological monitoring at least every 2 months, until two consecutive blood lead level results are less than 40 µg/dL.
- When an employee's blood lead level meets the criterion for removal from the worksite (equal to or greater than 50 µg/dL), followup blood testing within 2 weeks.
- Monthly blood lead level testing during the removal period for any employee medically removed due to an elevated blood lead level (EBL).
- Blood lead sample analysis by an OSHA-approved laboratory (call 1–800–35–NIOSH for a list of OSHA-approved laboratories).

The employer must notify all employees of their individual blood lead level in writing within 5 working days after receipt of results. In addition, each employee with a blood lead level greater than 40 µg/dL must be informed that temporary medical removal from the worksite (with benefits) is required when periodic and followup blood testing indicate a blood lead level equal to or greater than 50 µg/dL. Medical removal means that a worker is not permitted to continue to work in a leaded environment. If no other equivalent work is available from the employer, wages and benefits must be maintained in full. A worker cannot be penalized for having an elevated blood lead level.

Medical examinations

The employer must:

- Provide medical examinations prior to assignment for workers whose exposures will be equal to or greater than 30 µg/m^3 for more than 30 days per year.
- Make medical examinations available at least annually for any employee who had a blood lead level equal to or greater than 40 µg/dL any time during the past 12 months.
- Provide a medical examination as recommended by the treating physician for any employee who either has reported symptoms consistent with lead intoxication or upon employee request. Reasons that an employee may request a medical examination include medical advice related to conceiving a healthy baby, pregnancy, and difficulty in breathing during respirator fit test or use.
- Furnish employees with written medical opinions from examining physicians.
- Make available medical examinations for employees medically removed from the job due to exposure to lead.
- Provide a multiple-physician review mechanism as specified in the standard 29 CFR 1926.62(j)(3)(iii) to give workers the opportunity to obtain a second and possibly a third medical opinion.

At termination of employment, an employer would be well advised to have an exit medical examination performed for each worker, due to workers' compensation considerations.

Medical examinations provided to employees must include detailed work history; medical history; physical examination; pulmonary status to determine if respirator can be worn; blood pressure check; blood sampling and analysis for blood lead level, zinc protoporphyrin level, and other specified parameters (hematocrit, hemoglobin, peripheral smear morphology, and red cell indices); routine urinalysis with microscopic examination (checking levels of urea nitrogen and serum creatinine); pregnancy testing or laboratory evaluation of male fertility, if requested by the worker; and any other test relevant to lead exposure recommended by the examining physician. Prophylactic chelation (routine use of drugs to keep blood lead levels low) of any employee at any time is prohibited.

J. Medical Removal Protection

Medical removal protection is designed to give employees time away from lead exposure to reduce blood lead levels. The trigger for required medical removal protection is either a blood lead level equal to or greater than 50 µg/dL, or a "final medical determination," which is the examining physician's written opinion on the employee's health or the outcome of the multiple-physician review mechanism (see Medical examinations above).

Since medical removal protection includes retention of salary and benefits for employees removed from work, employers have a strong economic incentive to prevent excess lead exposure. With effective controls very few employees should reach the trigger levels requiring removal during lead hazard control work.

The following are OSHA's basic medical-removal protection requirements for construction employers:

- Remove employee on each occasion that a worker's periodic and followup blood lead levels are equal to or greater than 50 µg/dL; employee can return to work when two consecutive blood lead levels are less than 40 µg/dL.
- Remove employee on each occasion when a final medical determination indicates a medical condition that places the employee at "increased risk of material impairment to health" due to lead exposure.
- Implement protective recommendations for the employee that are included in the results of final medical determinations.
- Provide medical-removal protection benefits for up to 18 months, or as long as the job continues, each time an employee is removed.

- Maintain employee's normal earnings, seniority, and other employment benefits during removal, including the right to return to the former job.

- Provide the same medical-removal protection benefits to any employee who is removed even if not required under the standard.

K. Hazard Communication Programs and Training on Specific Operations Causing Lead Exposure

The employer must establish a hazard communication program for all potentially exposed workers (29 CFR 1926.59). This program should at a minimum include warning signs and labels, material safety data sheets, and the required employee information and training, including discussion of the Hazard Communication Standard. Employers must also have a written hazard communication program for their workplaces.

OSHA requires that employers provide a lead training program for all employees who are exposed to lead at or above the action level (30 µg/m^3) *on any single day*. The training program must be provided prior to the time of job assignment and at least annually for employees.

The employer must ensure that employees are trained in:

- The content of the OSHA interim lead standard for construction (29 CFR 1926.62) and its appendixes, including supplying a copy of the standard and appendixes to the employee.

- The specific nature of the operations that would result in lead exposure above the action level.

- The purpose, proper selection, fitting, use, and limitations of respirators.

- The purpose of the medical surveillance program and the medical-removal protection program.

- The adverse health effects of excessive exposure to lead, with particular attention to the adverse reproductive effects on both males and females.

- The hazards to the fetus and precautions for pregnant employees.

- The specific engineering controls and work practices associated with the employee's job assignment.

- Relevant good work practices described in Appendix B of the OSHA standard.

- The content of any compliance plan.

- The risks associated with chelating agents. They should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician.

- Their right of access to records under OSHA's Access to Exposure and Medical Records Standard (29 CFR 1910.20).

EPA Regional Lead Training Centers currently provide training courses for inspector technicians, project supervisors, and abatement workers. SOEH has also developed a training guide, which is referenced in the OSHA standards (SOEH, 1993). Other training providers also offer EPA training (see Chapter2). Appendix 15 contains a summary of the OSHA standard for workers. It is likely that EPA worker training will meet the OSHA training requirements as long as job-specific information is included.

L. Signs

Employers are required to post warning signs with the wording shown in Figure 9.8. This requirement does not preclude the employer from posting other appropriate hazard warnings, such as "Respirators required in this area." The signs must be posted in each work area where an employee's lead exposure is above the PEL, and illuminated and cleaned as necessary so that the legend is readily visible.

Figure 9.8 Example of Required Sign.

W A R N I N G
L E A D W O R K A R E A
P O I S O N
N O S M O K I N G O R E A T I N G

M. Recordkeeping

OSHA requires employers to maintain records of exposure assessments, medical surveillance, medical removals, and, if applicable, objective data used for exemption from the requirement for initial monitoring. Records must be made available upon request to affected employees, former employees, designated employee representatives, and OSHA and NIOSH. These records (except medical removals) must be kept for 30 years (29 CFR 1910.20). If an employer ceases to do business, the records must be transferred to a successive employer. If there is no successor, these records must be submitted to the Director of NIOSH. Employers should refer to 29 CFR 1926.62(n)(6) for additional requirements for transfer and disposal of records.

Employer records can provide a basis for assessment of regulatory compliance and the effectiveness of the employer's worker protection program. Additionally, records of exposures and health effects may be useful in epidemiologic studies.

1. Exposure Assessments

Exposure monitoring records must include the following information:

- Date(s), number, duration, location, and results of each of the samples taken.
- A description of the sampling procedure used to determine representative employee exposure, where applicable.
- A description of the sampling and analytical methods used and evidence of their accuracy.
- The type of respiratory protection worn by monitored employees.
- Name, social security number, and job classification of the monitored employee and all other representative employees.
- The environmental variables that could affect the measurement of exposure (for example, temperature and relative humidity).

It is also recommended that the name of the laboratory conducting the monitoring and a contact person be included in the records.

2. Medical Surveillance

The employer must establish and maintain an accurate record for each employee included in the medical surveillance program. Medical records must be kept for the duration of employment plus 30 years, in accordance with 29 CFR 1910.20. Some States may require blood lead levels to be reported to a central occupational health registry. The record for each employee must include:

- Name, social security number, and description of the duties of the employee.
- A copy of the examining physician's written opinions.

- Results of any airborne exposure monitoring done and provided to the physician.
- Any medical complaints related to lead exposure.
- Medical examination results, including medical and work history information.
- A description of laboratory procedures and standards or guidelines used to interpret test results (or references to that information).
- Results of biological monitoring.
- Name of physician and laboratory and date of examination.

3. Medical Removals

Records for each employee who is medically removed should be kept at least for the duration of employment and must include:

- An explanation of how removal was accomplished.
- A statement of whether or not the removal was due to an elevated blood lead level.

4. Objective Data

Limitations on the use of objective data for exemption from initial monitoring were discussed above (see Initial Determinations and Exposure Assessment). The employer must maintain a record of the objective data.

N. Observation of Monitoring

OSHA requires that employers provide affected employees or their designated representatives (e.g., union representatives) with an opportunity to observe any monitoring of employee lead exposures that is conducted as part of exposure assessments. The observers are entitled to receive an explanation of measurement procedures, observe all steps related to the monitoring of lead at the worksite, and either record the results or receive copies of the laboratory results of air sampling.

VI. Other Employer Requirements

In addition to the OSHA construction lead standard, there are many other applicable construction standards that employers must comply with during lead hazard control projects. OSHA standards for construction are found in 29 CFR, Part 1926. Some of these standards are:

- General safety and health provisions, 29 CFR 1926.20.
- Medical services and first aid, 29 CFR 1926.50.
- Sanitation, 29 CFR 1926.51.
- Occupational noise exposure, 29 CFR 1926.52.
- Gases, vapors, fumes, dusts, and mists, 29 CFR 1926.55.
- Hazard communication, 29CFR 1926.59.
- Ventilation: welding, cutting, or heating of toxic metals, 29 CFR 1926.353(c).
- Safety equipment, such as hardhats, safety shoes, eyewash stations, etc.

VII. Example of an OSHA Written Compliance Plan

Following is a model worker protection compliance plan that meets the requirements of the OSHA Lead Exposure in Construction standard as they apply to housing. The model plan should be completed by applying its general provisions to the specific lead hazard control job.

Form 9.1
Model OSHA Written Compliance Plan

Date: __/__/__

This plan has been developed to comply with the OSHA Construction Lead Standard, 29 CFR 1926.62.

1. *Location of Project:*

This job will take place at the residence located at ________________________________ (full address).

A previous lead inspection of this residence by ________________________________ (name and address of inspection or risk assessment firm) revealed that lead hazards or lead-based paint are present in the following locations:

_______________ (location and name of all building components to be treated)

____

____

____

These building components are coated with lead-based paint and represent a hazard to workers who may disturb it during lead hazard control, renovation, or maintenance activities.

2. *Brief Description of Job:*

This job will involve the following lead hazard reduction measures (complete all that apply):

Replacement of ________________________________ (name all components)

Enclosure of ________________________________ (name all components)

Paint removal of ________________________________ (name all components)

Encapsulation of ________________________________ (name all components)

Paint film stabilization of ________________________________ (name all components)

Friction surface treatments of ________________________________ (name all components)

Impact surface treatments of ________________________________ (name all components)

Dust removal in the following areas: ________________________________ (name all areas)

3. *Schedule:*

The job is expected to start on _______________ (date) and end on _______________(date). This compliance plan will take effect immediately on _______________(date). The competent person will conduct worksite visual inspections on a daily basis.

Work will proceed according to the following schedule:

Day 1: Initial setup, followed by:

_______________ (name all tasks to be completed)

____

____

Daily cleanup: wet mopping, HEPA vacuuming

Day 2: Tasks

Day 3: Tasks

Day 4: Final cleanup and clearance examination

4. Equipment and Materials:

HEPA vacuums, cleaning detergents, protective clothing, cotton work gloves, electric power saws, hammers, wrecking bars, pry bars, screwdrivers, plastic sheeting, metal scrapers, compressed air-powered water pumps, rollers, brushes, butyl rubber gloves, respirators, cutting shears, mops, plastic sheeting, paintbrushes, paint rollers.

5. Crew:

The work will be completed by a crew of _________________(insert number) workers. Crew assignments are as follows:

Crew 1 _________________(name) _________________ (task)

Crew 2 _________________(name) _________________ (task)

6. Competent Person:

_________________(Name), a certified lead abatement supervisor, will be onsite at all times and will act as the competent person for occupational health and safety issues. The lead supervisor license (or certificate) number is:_________________. The lead supervisor will conduct daily inspections of the work areas to ensure that control measures, work practices, personal protective equipment, and hygiene facilities are used as prescribed in this document.

7. Control Measures:

The primary control methods for this project are (check all that apply):

_____ method substitution (building component replacement, enclosure)

_____ wet methods

_____ wrapping materials to be discarded in plastic

_____ respiratory protection

_____ local exhaust ventilation (needle guns, vacuum blasting)

_____ general room ventilation

_____ on-the-job training

_____ HEPA vacuums

_____ containment (use of plastic barriers)

8. Technology Considered in Meeting the Permissible Exposure Limit:

The *HUD Guidelines for Evaluation and Control of Lead Hazards in Housing* and *Protecting Workers and Their Communities From Lead Hazards: A Guide for Protective Work Practices*, published by the Society of Occupational and Environmental Health, and other publications were reviewed to determine the appropriate engineering controls to be used in this project. The only specialized equipment that will be utilized for this project are HEPA-filtered vacuum cleaners and _________________ (name all special equipment).

9. Respirators:

All individuals in the work area will be provided with a NIOSH/MSHA-approved half-mask, air-purifying respirator equipped with HEPA cartridges or a powered air-purifying respirator (if so requested).

Respirators will be provided in the context of a complete respiratory protection program; the written respirator program is attached.

Respirators will be required during (name phases of job for which respirators will be required):

____

____

____

Respirator use during other activities, including initial setup (laying down plastic for containment), and enclosure and encapsulation after surface preparation is not necessary, *unless* other workers nearby (same interior room or outside wall) are performing activities for which respirators are required.

10. Protective Clothing:

Disposable protective clothing will be worn at all times inside the work area. Protective clothing will be made of breathable fabric to reduce the potential for worker heat stress. If visibly contaminated with dust or paint chips, protective clothing will be vacuumed before it is removed.

11. Hygiene Facilities:

Handwashing facilities will be used to decontaminate workers, since leaded dust levels are expected to be low. Showers are used on jobs that generate high leaded dust levels. The facilities will be located in a portable trailer, which will be parked in the driveway of the residence. The trailer will contain two sinks, a fresh water tank, hot water heater, wastewater collection tank, and easily cleanable floors and benches. Labeled plastic bins with covers will be used to separate disposable protective clothing from street clothing. Hot water, soap, and towels will be provided. Hands and face will be washed before all breaks and at the end of the day. Wastewater will be collected, pretreated onsite with filtration, and disposed of in accordance with prior arrangements made with ________________(name of local water and sewage authority).

12. Air Monitoring Data:

Previous data for lead hazard control projects conducted with similar controls, environmental conditions, personnel, and methods were reviewed. Air sampling will not be performed on this job, since typical exposures have already been established for these work crews by:

________________(name of person or firm completing air sampling).

Based on these results, the major exposures to lead will occur during ________________(name tasks during which substantial exposures are likely to occur).

In previous work conducted by the same contractor and work crew on similar houses in the same city, using the same methods, *maximum* personal exposures measured for various activities were:

Maximum Exposure ($\mu g/m^3$)	**Task**

The environmental conditions in the homes previously abated closely resemble the current location. These maximum exposures are expected to represent "worst-case" exposures because they did not include breaks or setup time; it is expected that 8-hour, time-weighted average exposures on this job will be lower than these figures. However, worker respiratory protection requirements will be based on the maximum exposures to allow for unexpected variations.

13. Medical Surveillance Program:

A medical surveillance program is already in place for this work crew. It is supervised by:

Dr. ____ (name, address, and phone number of physician and/or firm).

Worker blood lead levels are measured initially before the onset of work, each month for the first 6 months of employment, and every 6 months thereafter.

Blood lead levels for current employees who will be assigned to this job are between:

______ µg/dL to ____________ µg/dL (list range of blood lead levels) based on the report dated _____________ (add date for latest medical monitoring report). Worker blood lead increases of 10 µg/dL or greater or any blood lead level greater than 25 µg/dL will trigger an investigation of protective equipment and work practices. All workers on this project are informed of their blood lead levels as soon as they are received.

14. Training:

The following workers have been trained using the EPA Worker Training Curriculum and SOEH's *Guide For Protective Work Practices and Effective Worker Training*. The training was conducted by _________________(name, address, and phone number of training provider) on _________________(insert date).

Trainees	**Social Security Number**
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________

Plan completed by:

_________________ (name and signature)

_________________ (date)

Example of a Completed Worker Protection OSHA Compliance Plan

OSHA Written Compliance Plan

Date: 5/19/99

This plan has been developed to comply with the OSHA Construction Lead Standard, 29 CFR 1926.62.

1. *Location of Project:*

This job will take place at a private residence located at 2952 Channing Way, Anywhere, New York. A previous lead inspection of this residence by Carefree Consultants, Inc., revealed that windows, window frames, and all interior walls in both units are coated with lead-based paint (the range was 1.5 mg/cm^2 to 24 mg/cm^2). In some areas the existing lead-based paint is deteriorated, with loose and peeling paint chips. The existing lead-based paint represents a hazard to workers who may disturb it during lead hazard control or renovation activities.

2. *Brief Description of Job:*

The abatement job will involve the removal and replacement of six windows in the residence and the encapsulation or enclosure of kitchen and bathroom walls.

The primary window replacement activities that are expected to generate leaded dust are manual removal of existing wood frame windows and cleaning.

3. *Schedule:*

Work will proceed according to the following schedule:

Window Replacement

Day 1: Initial setup, including placement of plastic sheeting on interior floor and exterior ground surfaces for containment purposes.

Begin manual removal of windows. All window components will be wetted with water mist prior to removal to minimize dust generation.

Daily cleanup: wet sweeping, HEPA vacuuming

Day 2: Complete removal of all windows.

Preparation of window openings for replacement windows—sawing or planing may be required.

Install replacement windows; employ daily cleanup as above.

Apply new caulking around replacement windows; final cleanup.

Encapsulation and Enclosure

Day 1: Initial setup, including placement of plastic sheeting on floors, and nonmovable furnishings, appliances, and furniture items.

Prepare surfaces for enclosure system by removing loose and peeling paint. All surfaces will be thoroughly wetted with water mist prior to scraping. Surfaces will be lightly scraped with 9-inch metal paint scrapers.

Daily cleanup: wet sweeping followed by HEPA vacuuming and mopping with detergent solution

Day 2: Install all mineral glass wallcovering material.

Manually apply the initial and final coats of the liquid encapsulant, polymer surfacing system over the mineral glass substrate. Rollers and brushes should be used to apply liquid encapsulant. Allow 8 hours to dry between coats, or until surface is hard and dry to the touch. Install enclosure system (drywall) over encapsulated surface.

Daily cleanup

Day 3: Final cleaning

4. *Equipment and Materials:*

Window Replacement

"Olofson" metal frame, thermal-pane, replacement windows (Model 000–111), HEPA vacuums, trisodium phosphate detergent, protective clothing, cotton work gloves, electric power saws, hammers, wrecking bars, pry bars, screwdrivers, plastic sheeting, and other hand tools as needed.

The abatement job will also include encapsulation or enclosure of all interior walls in the kitchen and bathroom areas. The primary activities that are expected to generate leaded dust are manual scraping and cleaning involved with surface preparation.

Encapsulation and Enclosure

"Cover It Up" Encapsulant System (Item 333–55), drywall, metal scrapers, compressed air- powered water pumps, rollers, brushes, butyl rubber gloves, respirators, cutting shears, brooms, HEPA vacuums, detergent solution, mops, and plastic sheeting.

The job is expected to start on July 11, 1999, and end on July 13, 1999. This compliance plan will take effect immediately on July 8, 1999. The competent person will conduct worksite visual inspections on a daily basis.

5. *Crew:*

The replacement of windows and encapsulation enclosure will each be completed by a crew of two workers. Crew assignments are as follows:

R. Smith, T. Jones	Crew 1, Window Replacement
Z. Topp, J. Gonzales	Crew 2, Encapsulation/Enclosure

6. *Competent Person:*

Mr. Homer Simpson, a licensed lead abatement supervisor, will be onsite at all times and will act as the competent person for occupational health and safety issues. Mr. Simpson's lead supervisor license number is: XMZ 678. Mr. Simpson will conduct daily inspections of the work areas to ensure that control measures, work practices, personal protective equipment, and hygiene facilities are used as prescribed in this document.

7. *Control Measures:*

The primary control method for this project is method substitution; that is, building component replacement and encapsulation and enclosure will be used for lead-based paint hazard abatement, instead of onsite paint removal.

During replacement, existing window frames, sashes, and troughs will be wetted with water mist prior to removal to reduce airborne dust generation during removal activities. During both replacement and encapsulation, all scraping or sawing activity will be done on wet surfaces; all debris will be wetted down before handling. Building components coated with lead-based paint will be wrapped in plastic sheeting after removal to reduce contamination of workers' hands and clothing during handling and disposal. After initial surface preparation for encapsulation and window removal, it is expected that there will be minimal disturbance of existing lead coatings during this job. Wet methods (mopping) and HEPA vacuums will be used during cleaning to minimize worker exposures to lead.

To reduce generation of leaded dust in the work areas, paint chips and dust will be vacuumed on at least a daily basis with HEPA-filtered vacuums. Final cleaning will be accomplished by three successive cleanings consisting of HEPA vacuuming alternated with wet mopping with trisodium phosphate solution. The use of HEPA vacuums and wet cleaning methods will minimize worker lead exposures.

8. *Technology Considered in Meeting the Permissible Exposure Limit:*

The *HUD Guidelines for Evaluation and Control of Lead Hazards in Housing* and other publications were reviewed to determine the appropriate engineering controls to be used in this project. The only specialized equipment that will be utilized for this project are HEPA-filtered vacuum cleaners and air-powered water pumps with high-pressure hoses attached to aerosol-generating nozzles (for water misting of surfaces). Natural ventilation will be utilized, as mechanical ventilation with HEPA-filtered exhaust fans has not been found to reduce worker lead exposures with the methods that will be used during this project.

9. *Respirators:*

All individuals in the work area will be provided with a half-mask, air-purifying respirator equipped with HEPA cartridges or a powered air-purifying respirator if so requested. Respirators will be provided in the context of a complete respiratory protection program; the written respirator program is attached.

Respirators will be required during window removal, surface preparation for encapsulation, any sawing or use of power tools, manual scraping, cleaning activities, and final cleanup. Respirator use during other activities, including initial setup (such as laying down plastic for containment), and enclosure and encapsulation after surface preparation is not necessary, *unless* other workers nearby (same interior room or outside wall) are performing activities for which respirators are required.

10. *Protective Clothing:*

Disposable protective clothing will be worn at all times inside the work area. Protective clothing will be made of breathable fabric to reduce the potential for worker heat stress. If visibly contaminated with paint dust or chips, protective clothing will be vacuumed before it is removed.

11. *Hygiene Facilities:*

Handwashing facilities will be used to decontaminate workers. The facilities will be located in a portable trailer that will be parked in the driveway or parking area of the residence. The trailer will contain two sinks, a fresh water tank, hot water heater, wastewater collection tank, and easily cleanable floors and benches. Labeled plastic bins with covers will be used to separate disposable protective clothing from street clothing. Hot water, soap, and towels will be provided. Hands and face will be washed before all breaks and at the end of the day. Wastewater will be collected, pretreated onsite with filtration, and disposed of in accordance with prior arrangements made with the Anywhere Municipal Wastewater Treatment Facility. The trailer will be cleaned with a HEPA vacuum and wet washed twice each week.

12. *Air Monitoring Data:*

Previous data for lead abatement projects conducted with similar controls, environmental conditions, personnel, and methods were reviewed. Air sampling will not be performed on this job, since typical exposures have already been established for these work crews (see attached report from previous jobs prepared by XYZ Industrial Hygiene, Inc.). Based on these results, the major exposures to lead will occur during window removal, although significant exposures may also occur during cleanup.

In previous work conducted by the same contractor and work crew on similar houses in the same city, using the same methods, *maximum* personal exposures measured for various activities were: window removal and replacement, 121 $\mu g/m^3$; encapsulation, 24 $\mu g/m^3$; cleaning, 110 $\mu g/m^3$; final cleaning, 50 $\mu g/m^3$; and initial setup, 6 $\mu g/m^3$. The environmental conditions in the homes previously abated closely resemble the current location. These maximum exposures are expected to represent "worst-case" exposures because they did not include breaks or setup time; it is expected that 8-hour, time-weighted average exposures on this job will be lower than these figures. However, worker respiratory protection requirements will be based on the maximum exposures to allow for unexpected variations.

13. Medical Surveillance Program:

A medical surveillance program is already in place for this work crew. It is supervised by Dr. William Jones, a board-certified occupational health physician with Occupational Health Clinic, Inc. (phone: 800–555–1111). Worker blood lead levels are measured initially before the onset of work, each month for the first 6 months of employment, and every 6 months thereafter. Blood lead levels for current employees who will be assigned to this job are 5–12 µg/dL, based on the May report (see attached). Worker blood lead increases of 10 µg/dL or more will trigger an investigation of protective equipment and work practices. All workers on this project are informed of their blood lead levels as soon as they are received.

14. Training:

All workers have been trained using the EPA Worker Training Curriculum. The training was conducted by Joe Smith, a certified industrial hygienist with XYZ Industrial Hygiene, Inc., and Bill Smith, the competent person, on March 3–5, 1993.

Workers trained on March 3–5 include:

R. Smith

T. Jones

Z. Topp

J. Gonzales

The job proceeded as planned. However, in the next month, one worker's blood lead level increased from 12 to 25 µg/dL. This employee was one of the most productive members of the crew. The employer investigated the possible causes of the significant increase (10 µg/dL or more). After observing and interviewing the worker on a subsequent job, it was clear that the worker was not wearing the half-mask, air-purifying respirator all the time and was not using enough water to moisten surfaces before scraping. A powered air-purifying respirator was provided to increase the worker's understanding of the need for respiratory protection. Additional training and counseling by the physician was also provided to this individual. The following month's blood lead level declined to 16 µg/dL, but the supervisor continued to conduct special oversight of this individual.

Plan completed by:

________________________________ (name)

________________________________ (signature)

________________________________ (date)

Chapter 10: Hazardous and Nonhazardous Waste

Managing Hazardous and Nonhazardous Waste: How To Do It

This checklist is based on existing Federal requirements. The U.S. Environmental Protection Agency (EPA) is considering changes in the hazardous waste regulations for waste generated by lead-based paint abatement activities. Until changes are formally adopted, however, those individuals producing hazardous and nonhazardous solid waste should comply with the existing regulations outlined in the Resource Conservation and Recovery Act (RCRA), Subtitles C and D. States should be consulted when determining how to manage abatement waste in a given locale. Although EPA has the authority to enforce the RCRA regulations, the States are the principal enforcement authorities.

1. Determine if the waste will result from an interim control or an abatement effort. Interim control waste from single and multifamily residences may be exempt from hazardous waste regulations, if the waste is generated as part of routine residential maintenance. Contact your State to determine whether interim control waste can be handled as household waste. Even if exempt from hazardous waste management requirements, interim control waste should be managed carefully in accordance with State regulations and other practices described in this chapter.

2. Waste from abatement activities must be evaluated for the RCRA Toxicity Characteristic. Contact State or local agencies to determine whether they have special regulations for abatement waste.

3. To minimize the total quantities of waste generated, conduct abatement efforts that generate reduced quantities of both hazardous and nonhazardous waste for disposal. For example, remove unpainted material (e.g., glass from windows) and unpainted wood, metal, concrete, and bricks from demolition waste, and separate painted waste that could be recycled. Do not use architectural components coated with lead-based paint as mulch or in any other construction unless lead-based paint has been properly removed.

4. As a preabatement screening step, make a RCRA hazardous waste toxicity characteristic determination (using existing knowledge or waste analysis data) for various components from each of the lead-based paint abatement waste categories. Depending on the hazardous waste determination, segregate hazardous abatement waste from nonhazardous waste, and accumulate accordingly in separate containers.

5. Separate abatement waste into the following four categories (described more fully in Table10.1).

Category I:	Low Lead Waste (typically nonhazardous)
Category II:	Architectural Components
Category III:	Concentrated Lead Waste (typically hazardous)
Category IV:	Other Waste

6. Determine how much hazardous waste will be produced. If less than 100 kg (approximately 220 pounds or 1/2 of a 55-gallon drum) of hazardous waste per month will be generated, it is considered “conditionally exempt” abatement waste and may be managed as solid nonhazardous waste and delivered to a State-licensed or -permitted solid waste management facility. (HUD recommends that such waste not be incinerated.) The RCRA hazardous waste manifest is not required when shipping this waste to an offsite disposal facility.

7. Do not accumulate more than 1,000 kg of the conditionally exempt abatement waste at any time. Handle the waste according to the HUD-recommended management practices described in this chapter.

8. If more than 100 kg of hazardous waste per month will be generated, comply with RCRA hazardous waste regulations. At a minimum, the following Federal requirements must be met:

   - Obtain a Generator Identification Number before shipping the hazardous waste offsite facility for management, recycling, or disposal.
   - Accumulate hazardous waste in storage tanks or containers. Label storage units as "hazardous waste," recording the accumulation start date on the label. Train workers on waste handling and emergency procedures.
   - Maintain storage containers or tanks in compliance with the 40 CFR Part 265, Subpart I or J, standard.
   - If more than 1,000 kg per month of hazardous waste is generated at the site, do not accumulate hazardous waste for longer than 90 days. A hazardous waste storage permit is generally necessary when the waste must be stored for longer than 90 days. (See accumulation requirements for generators producing more than 100 kg and less than 1,000 kg of hazardous waste per month explained in Section IV.)
   - Engage the services of a licensed hazardous waste transporter and/or a management facility with proper permits.
   - Prior to shipment, package hazardous waste and properly label, mark, and placard the packaged waste according to U.S. Department of Transportation regulations.
   - Complete and sign the Uniform Hazardous Waste Manifest, and get the signature of the transporter on the manifest when releasing a load of hazardous waste. You must receive a signed manifest back from the designated hazardous waste facility within 35 days.
   - Comply with the RCRA Land Disposal Restrictions including notification and certification requirements.
   - Submit biennial reports describing waste generation and management activity when generating more than 1,000 kg per month of hazardous waste at each site.
   - Maintain all waste determination and handling records for at least 3 years.

9. HUD recommends that nonhazardous Category II architectural components be wrapped and sealed in plastic, covered during transport, and disposed of in a State-approved solid waste landfill. Such waste should not be burned in a municipal solid waste incinerator, recycled to produce mulch, or reused unless all lead-based paint is removed.

10. Nonhazardous solid waste must be discarded in accordance with State and local requirements.

Chapter 10: Hazardous and Nonhazardous Waste

I. Introduction

This chapter describes the Federal requirements and recommended practices that apply to managing waste generated by lead-based paint abatement or interim controls. Owners, abatement contractors, transporters, and disposal facilities are responsible for managing their waste properly. Improperly managed lead-contaminated waste can pose serious risks. For example, it can contaminate soil and groundwater. Discarded building components that are coated with lead-based paint may be inadvertently reinstalled in other dwellings. In addition, workers may bring leaded dust into their homes if their work clothes are not cleaned or disposed of properly. Waste management regulations are strictly enforced; violators can be fined.

EPA is considering revising the existing hazardous waste regulations that govern waste generated from lead-based paint abatement activities. The primary Federal statute governing waste management from generation to disposal is the Resource Conservation and Recovery Act (RCRA). RCRA defines the criteria for hazardous and nonhazardous waste. While hazardous waste management must meet Federal standards, most States are authorized by the U.S. Environmental Protection Agency (EPA) to administer the basic RCRA hazardous waste program. Owners and lead hazard control contractors should observe the waste management practices described in this chapter and comply with State or local regulations. States and local governments may also institute hazardous waste requirements that are more stringent than Federal standards (EPA, 1990a).

II. Overview of Federal Requirements: Determining if a Waste Is Hazardous Under RCRA

RCRA regulates all "solid" waste, which is defined broadly to include liquid, solid, and some gaseous waste, except for certain waste that is regulated under other Federal law. Most abatement and interim control debris is likely to be solid waste, which can be either hazardous or nonhazardous. Waste water, such as mop and shower water, that is disposed of in a municipal wastewater treatment system, is regulated under the Clean Water Act and thus is exempt from RCRA. Local water departments are authorized to regulate water discharges from lead hazard control sites.

Solid nonhazardous waste is regulated at the Federal, State, and local levels. EPA has established mandatory minimum requirements for environmentally acceptable waste management facilities that receive nonhazardous solid waste (40 CFR Parts 257 and 258). States must establish comparable or more stringent standards.

RCRA Subtitle C regulations define a "generator" as any person at a particular facility or location whose act or process produces a hazardous waste. Both property owners *and* contractors involved in abatement/interim control actions can be considered generators. Generators must answer the following questions:

- Does the generator have knowledge that the waste is hazardous under RCRA regulations?
- Did a test define the material as a RCRA hazardous waste ("characteristic hazardous waste")?
- Is the waste exempt from regulation as "hazardous" under RCRA rules?

- Is the waste included on EPA's list of hazardous waste?
- If the waste is hazardous (or nonhazardous) what Federal, State, or local standards must be satisfied?

For most abatement and interim control projects, the owner is a generator. Although the owner may designate the contractor to handle paperwork and hazardous waste management, the owner is ultimately responsible for proper waste disposal. Contractors must have a RCRA permit to transport hazardous waste and may combine such waste from different owners for transport only if each owner agrees and only if permitted by State and local regulations.

Generators must determine whether their waste is either listed as or characteristic of hazardous waste. Generators must test or use their existing knowledge of the waste to determine if it exhibits hazardous characteristics, unless it is otherwise exempted (see Section IV).

Waste exhibiting one or more of the following four characteristics is considered hazardous:

- Toxicity.
- Corrosivity.
- Ignitability.
- Reactivity.

A. Toxicity

Waste that exhibits the Toxicity Characteristic (TC) poses a substantial threat to human health and the environment. Waste toxicity is measured by using the Toxicity Characteristic Leaching Procedure (TCLP) (40 CFR 261.24). The TCLP extract is analyzed for lead (or other constituents) to determine if it is above or below the allowable TC regulatory threshold, which for lead is 5 ppm (milligrams/ liter).

"Leachable" lead analysis differs from "total" lead analysis, which is typically performed on paint chips during a risk assessment or inspection, in that leachable lead is dependent on the type of lead *compound* present and the size of the particle (that is, its solubility). Because total lead analysis does not determine the specific lead compound present, it is difficult, if not impossible, to predict how much of the lead will be leachable. Therefore, XRF or paint-chip analysis (by the usual hot nitric acid digestion/ atomic absorption spectroscopy methods) are unlikely to help determine leachability. The total lead levels determined by a paint-chip analysis are usable in two circumstances: (1) total lead level that is very low (e.g., less than 100 ppm), indicates that waste should not exceed the TC regulatory threshold; and (2) total lead levels can be used in combination with total waste volume estimates to determine whether recycling for lead recovery is feasible.

Appendix 10 contains practical questions and answers about testing abatement waste using the TCLP and selecting a laboratory.

B. Corrosivity

Corrosive waste has a pH that is either less than or equal to 2 (highly acidic) or greater than or equal to 12.5 (highly basic), or which can corrode steel at a certain rate (40 CFR 261.22). Unneutralized caustic paint strippers and acidic paint strippers (including the resulting sludge) may be corrosive.

C. Ignitability

Ignitable waste generally includes liquids with flash points below 140°F (60°C), flammable solids and compressed gases, and oxidizers (40 CFR 261.21). Certain solvents from paint strippers (e.g., xylene) and the resulting sludge or slurry waste may be ignitable.

D. Reactivity

Lead-based paint hazard control projects are unlikely to produce reactive waste. Reactive waste includes substances that are capable of easily generating explosive or toxic gases, especially when mixed with water (40 CFR 261.23). These also include waste that is unstable and undergoes violent change without detonating.

E. Listed Wastes

Waste may *also* be hazardous under RCRA if included on EPA's list of hazardous waste.

Lead-based paint hazard control jobs are extremely unlikely to generate "listed" waste. EPA's current list, which can be found in 40 CFR 261.31 through 33, includes specific source waste (waste from specific industries), generic waste (waste from common manufacturing and industrial processes, such as solvents), and discarded or "out-of-spec" commercial chemical products (such as creosote and some pesticides).

III. Waste Management Procedures

Waste management procedures are summarized in Figure 10.1.

A. Interim Control Waste

The waste from interim controls may be exempt from RCRA hazardous waste regulations, under the exclusion for household waste (see 40 CFR 261.4(b)(1)). To be excluded, household waste should meet two criteria. First, the waste must be generated by individuals on the premises of a household, and second, the waste must be composed primarily of materials found in the waste generated by consumers in their homes. Solid waste generated *as part of routine residential maintenance* by a homeowner, resident, or contractor would generally be part of the "typical" household waste stream, and thus would be exempted from hazardous waste regulations under the RCRA household waste exclusion. Generators should contact State RCRA authorities for assistance in determining the limitations of the household waste exclusion for waste from interim controls at specific sites.

The State may determine that waste from interim controls is hazardous waste. In this case, if the waste is produced in small quantities (i.e., *less than 100 kg of hazardous waste per month*), it could be excluded as "conditionally exempt" under the small quantity generator exemption. (See Section III.D). Even if interim controls waste is exempted, waste with a high concentration of lead (e.g., high efficiency particle air (HEPA) vacuum debris and filters, sludges from filtering waste water, paint chips) should be handled carefully (i.e., contained in drums or wrapped in plastic with taped seams, and covered during transport).

Waste water from mopping or cleaning operations, upon filtration, could be poured down the toilet provided that local authorities approve of such a practice. Waste water can be filtered effectively by using a 20 µm pore size filter, although a pump may be necessary to force the water through the filter. A coarse screen or cheesecloth is often used as a prefilter.

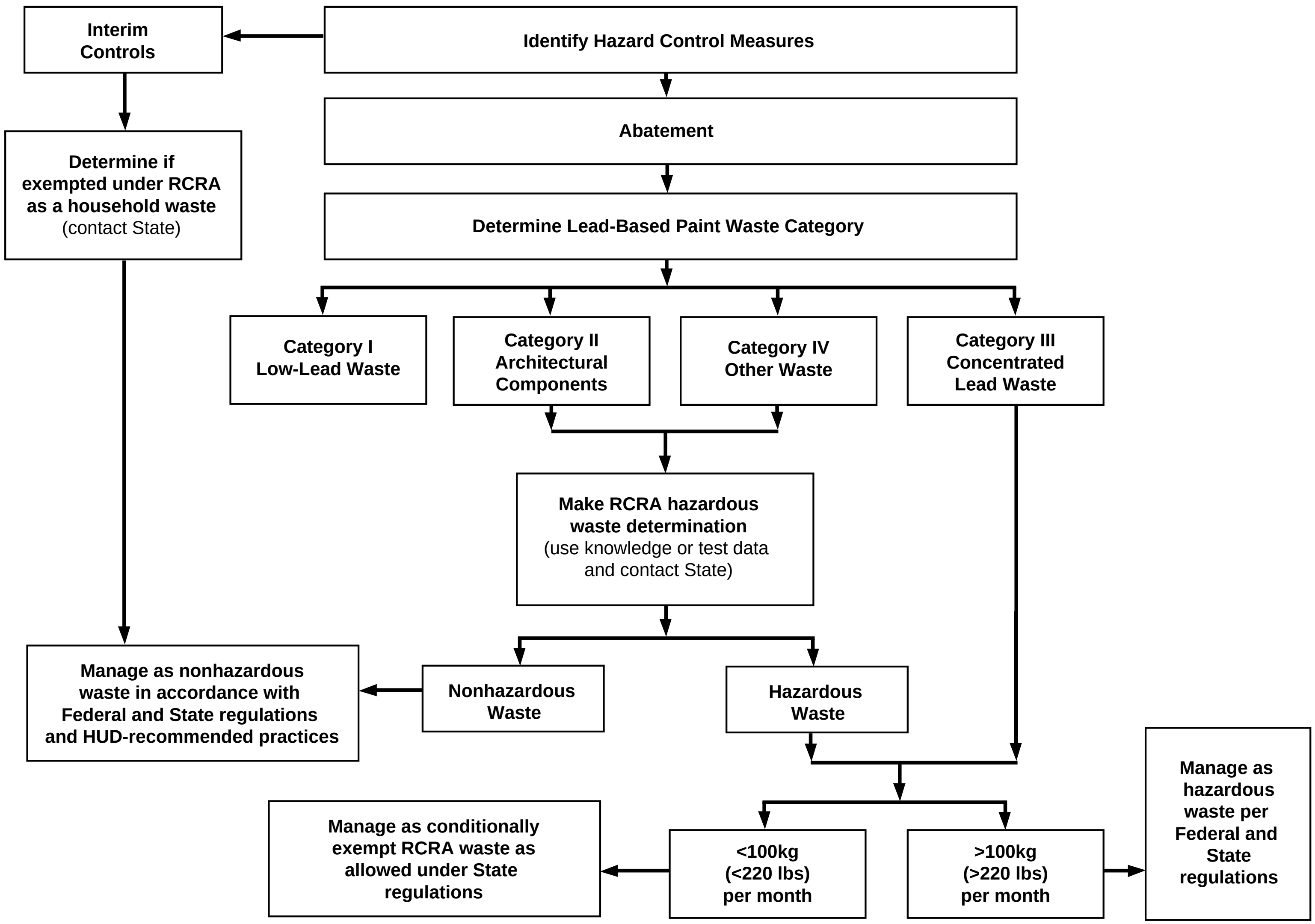
If significant quantities (10 gallons or more) of water are produced, owners should contact the local waste water treatment facility before discharging the liquid to determine if there are any specific pretreatment standards to be implemented, and inform the facility of the quantity of water to be discharged and its probability of containing phosphates or other cleaning agents.

B. Abatement Waste

Under RCRA, abatement waste is classified separately. The distinction primarily lies in the difference between routine maintenance and permanent control. Even though abatement waste may be similar to waste created from interim controls, it is typically generated from a one-time activity as opposed to temporary, routine maintenance. Abatement waste may also be stored until either work is complete or enough waste has been generated to make up a shipment load. Abatement waste, therefore, is not covered under the RCRA household waste exclusion.

Waste from abatement activities may be similar to waste from construction, demolition, and renovation. Waste generated from construction, demolition, and renovation do not meet the routine maintenance criteria (discussed in Section III.A). In 1984, EPA determined that the latter category of waste is not household waste (49 FR 44998, November 13, 1984). Some States may have special management standards for abatement wastes. Contact your State to determine the status of abatement waste under State regulations.

Figure 10.1 Waste Management Procedures.



The type of abatement waste management implemented depends upon the quantity and type of waste material. Some types of waste will always contain a high concentration of leachable lead, while others will differ by physical component, depending on the abatement methods used at each job site. Waste should be physically separated into categories of "like materials." This practice prevents the contamination of nonhazardous waste with hazardous waste. A

Table 10.1 Categories of Abatement Waste

Category	Description	Examples of Wastes
I	**Low Lead Waste**	Filtered personal and commercial wash water. Disposable personal protective clothing that has been HEPA vacuumed before disposal. Plastic sheeting cleaned prior to disposal (misted and wiped) and carpeting. Any waste that is determined to be nonhazardous by TCLP testing and is not an EPA-listed hazardous waste.
II	**Architectural Components**	Painted finish carpentry items, for example: ❖ Doors. ❖ Windows. ❖ Window trim and sills. ❖ Baseboards. ❖ Railing. ❖ Moldings. Other painted building components, for example: ❖ Metal railings. ❖ Radiators. ❖ Walls. ❖ Stone or brick.
III	**Concentrated Lead Waste**	Sludge from paint stripping. Lead-based paint chips and dust. HEPA vacuum debris and filter. Unfiltered wash water. Hazardous waste. Any waste included on EPA's list of hazardous waste.
IV	**Other Waste**	Material that cannot be determined, using knowledge of the waste, to be either hazardous or nonhazardous must be tested using the TCLP.

reduction in the amount of hazardous waste reduces disposal costs. Abatement waste should be segregated into several categories, as shown in Table 10.1 (EPA, March 1993).

If a dwelling is being partially or completely renovated or demolished as part of the lead hazard control work, these categories are not applicable. In this instance, the demolition debris could be segregated into painted and unpainted waste material so that the latter category of waste could be recycled, if appropriate. The remaining lead-based paint demolition debris should be managed as one waste stream and evaluated to determine if it is hazardous.

C. Categories of Abatement Waste

RCRA rules and HUD recommended management practices are summarized in Table 10.1. The categories are based on EPA's study to determine which waste materials from abatement activities are likely to exhibit the hazardous waste characteristic of toxicity for lead (EPA, 1993). However, the study results were limited and inconclusive for some types of waste, and EPA concluded that additional confirmatory analysis would be needed. In lieu of testing, the generator may use the limited data from this study, or other studies, in making their hazardous waste determinations. However, the generator is ultimately liable for any improper disposal. All generators should retain documentation to substantiate their waste determinations.

1. Category I—Low Lead Waste

Contents

This waste category typically passes the TCLP because it exhibits concentrations of leachable lead below 5 ppm. It includes filtered personal wash water and mop water, disposable personal protective clothing that has been HEPA vacuumed before disposal, plastic sheeting that has been misted and cleaned before disposal, carpeting, and nonhazardous waste (EPA, 1993). Wash water does *not* include unfiltered spent stripper solutions, stripper sludges, or any other liquid paint removal products, all of which are Category III waste. In lieu of testing, generators may use the EPA report test results to supplement their knowledge of the waste in making their hazardous waste determinations.

The EPA report acknowledges the existence of limited data on plastic if certain abatement methods were used. However, according to contractors, if plastic is thoroughly cleaned (misted and swept or wiped to remove lead-based paint and dust), it will typically pass the TCLP (Aulson, 1992).

The ultimate responsibility for making the proper waste determination still rests with the generator. Generators should test any Category I waste that they believe might fail the TCLP.

RCRA Waste Management Rules

Category I waste should be disposed of in accordance with the applicable Federal requirements (40 CFR Part 257 or 258), in accordance with RCRA Subtitle D regulations and State and local solid waste requirements.

HUD Recommended Practices

HUD recommends that generators follow the following practices for nonhazardous abatement wastes.

- The waste should be wrapped in suitable plastic (6-mil polyethylene or equivalent), and all seams should be sealed with tape during storage and transport to the disposal facility. (Some disposal facilities do not accept waste wrapped in plastic. In this case, the waste should be covered in plastic during storage and transport only.)
- The waste should be stored in a designated secure (locked) area.
- Liquid waste water should be disposed of in the toilet after applicable pretreatment steps (e.g., filtering, gravitational separation), if any, have been satisfied. Waste water should not be poured into storm drains or onto the ground.
- Dumpsters should have lids and be padlocked. Wrapping and sealing in plastic may not be necessary if a covered transport vehicle is used and if plastic is used to line walkways to the vehicle during loading.

Wrapping and sealing waste materials in plastic, however, will minimize final cleanup and dust generation from abrasion of loose components coated with lead-based paint.

2. Category II—Architectural Components

Contents

This category includes waste defined as intact, discarded architectural components exceeding 60 mm (2.5 inches) in either width or length, which are often referred to as finish carpentry or painted building components. (The 60 mm cut-off is consistent with EPA's existing definition of hazardous debris in 57 FR 37223, August 18, 1992.)

Such components include painted doors, door trim, windows, window trim or sills, baseboards, soffits, facia, columns, railings, moldings, radiators, walls, and stone or brick. Paint chips that are removed or fall off these components are likely to be hazardous waste and are not included in this category. Category II does not include lead sheeting.

RCRA Waste Management Rules

EPA may revise the regulations that apply to architectural components. Until that time contractors and property owners must follow existing RCRA, State, and local requirements. Under current RCRA regulations, such material (as well as other solid waste) must be evaluated using knowledge of the waste or results from the TCLP. (See Appendix 10 for suggestions on selecting a laboratory to conduct the TCLP and minimizing the volume of architectural components that fail.)

Generators should contact State agencies for any information or data on the characteristics of lead abatement wastes in their area. In all cases, States must be consulted when generators are determining how to manage lead abatement wastes, since they are the principal enforcement authorities for the applicable regulations.

EPA waste-study results for lead-based paint architectural components are inconclusive, and EPA is currently gathering additional data on

Figure 10.2 Seal Abatement Debris in Plastic Before Transporting Offsite.

this type of waste in support of anticipated regulatory changes. Until these changes become final, current regulations require that the generator evaluate architectural components for their potential to be characteristic hazardous waste under RCRA.

Under RCRA (40 CFR 262.11(c)), generators may use their knowledge of the waste, in lieu of testing, to identify characteristic hazardous waste. When using knowledge or relevant information, the generator is responsible for supporting the claim that the waste is nonhazardous. In the case of architectural components, a variety of site-specific factors may affect the TCLP results of architectural components. Factors include the age of the building, thickness of the paint, sampling protocol, etc. For example, if certain types of painted components from several single-family houses (or several units of multifamily housing from a given period of construction (e.g., 1950–1960) in a given neighborhood are found to pass the TCLP, it may be reasonable to assume that such components in other houses or units of the same period and neighborhood would also pass.

HUD Recommended Practices

Even if classified as nonhazardous wastes, HUD recommends the following procedure for handling architectural components:

- Once components are removed from the contained work area, the cutting or breaking of painted materials or any action that is likely to generate leaded dust should be prohibited.
- Separate glass from windows for recycling.
- While it is still inside the work area, waste should be wrapped in 6-mil polyethylene plastic (or equivalent) and all seams should be taped shut. It should be confirmed in advance whether the selected disposal facility will accept waste wrapped in plastic. If not, the waste should be covered with plastic during storage and transport only.
- Waste should be stored in a designated and secure area separate from the work area. If material is stored or handled outside, 6-mil plastic sheeting should be placed underneath and on top of the material to prevent soil contamination. Plywood or other durable material should be placed on top of the plastic to prevent puncture of the plastic by nails or other fasteners.
- Waste should be transported in covered vehicles to minimize lead dispersal into the environment.
- Waste should not be disposed of in a solid waste incinerator and it should *not* be reused or recycled for mulch.
- Nonhazardous solid waste should be disposed of *only* in State-licensed or -permitted solid-waste landfills.

3. Category III— Concentrated Lead Waste

Contents

This category consists of "listed" hazardous waste, and any other waste exhibiting hazardous characteristics and likely to leach lead above 5 ppm and thereby fail the TCLP. Category III waste frequently includes paint strippings, lead paint chips and dust, HEPA vacuum debris and filter, and any other hazardous waste. TCLP results for these materials typically surpass the allowable regulatory level for lead (5 ppm). Although the EPA report on waste disposal in this category included rags, sponges, mops, and scrapers, these materials may not contain significant levels of leachable lead if they are properly cleaned prior to disposal.

Although it is extremely difficult to anticipate TCLP results for lead-contaminated soil using lead concentration, anecdotal evidence indicates that if lead in soil exceeds 5,000 ppm, such soil is likely to fail the TCLP and thus be considered hazardous waste (Spitler, 1994). The converse, however, is not necessarily true because total lead is not easily correlated with leachable lead.

RCRA Waste Management Rules

Category III abatement waste usually exhibits lead toxicity characteristics. In the absence of site-specific testing data to the contrary, Category III waste should be considered hazardous (EPA, 1993).

In lieu of relying on EPA data, generators may test the waste to make a site-specific determination. If the site-specific testing indicates that the waste passes the toxicity test, then the waste is not considered hazardous. For liability purposes, test records should be maintained for at least 10 years.

Some hazardous waste transporters and management facilities will require their own TCLP testing before accepting waste.

Waste management standards vary depending upon the quantity of hazardous waste produced. Under RCRA, generators producing less than 100 kg/month (about 220 pounds/month) of hazardous waste qualify as "conditionally exempt," small-quantity generators and may handle such waste as nonhazardous, as described earlier in this section and also in Section IV.

HUD Recommended Practices

Even if the abatement waste is exempt from hazardous waste regulations under the small quantity exemption, HUD recommends the following procedures for handling Category III waste:

- Wrap in plastic with seams sealed shut (if disposal facility allows).
- Cover during transport.
- Prohibit from being treated at a solid waste incinerator.
- Dispose only in a State-permitted or -licensed solid waste landfill.

4. Category IV—Other Waste

Category IV includes all waste that does not fall into one of the other three categories, such as excavated lead-contaminated soil. Category IV waste should be tested to determine if it exhibits any of the RCRA hazardous characteristics unless the generator has knowledge indicating that the waste should not be hazardous. (See Appendix 10 for guidance in selecting a laboratory to conduct the TCLP.) If the waste is determined to be hazardous, it should be handled as Category III waste; if nonhazardous, as Category I solid waste. For liability purposes, all test results should be retained for at least 10 years. Contact your State to determine whether any of the wastes belonging to this category are automatically, or could be determined to be, hazardous.

D. Quantity of Hazardous Waste

When determining the hazardous waste generator status (e.g., less than 100 kg per month or greater than 100 kg per month), generators must account for all hazardous waste generated on site, including nonabatement waste that may be hazardous. (See Section IV regarding steps that can be taken to minimize the quantity of waste.)

1. Less Than 100 kg of Hazardous Waste

Under RCRA, if less than 100 kg/month (approximately 220 pounds/month or 25 gallons of liquid) of hazardous abatement waste is produced (e.g., from small abatement jobs at single-family dwellings), then the generators automatically qualify as "conditionally exempt, small-quantity generators." Such waste, at a minimum, must be disposed of in State-licensed or -permitted solid waste management facilities or hazardous waste disposal facilities.

In addition, no more than 1,000 kg (approximately 2,200 pounds) of hazardous waste may be stored onsite at any one time. Generators should contact State waste management authorities for guidance in determining the applicability of the small quantity generator exemption under State regulations.

2. More Than 100 kg of Hazardous Waste

If more than 100 kg per month of hazardous waste is likely to be produced by abatement actions for a single owner at a single site, a hazardous waste manifest must be completed before the waste is shipped offsite (see Section IV for a discussion of the RCRA hazardous waste management requirements). Hazardous waste from a single-family dwelling may or may not exceed the 100 kg per month limit. The hazardous waste generated from a multifamily housing abatement project will most likely exceed the 100 kg per month generator limit and the generator will therefore be subject to applicable RCRA hazardous waste management requirements (e.g., accumulation time limit, packaging and shipping requirements, land disposal restrictions, and recordkeeping requirements from 40 CFR Part 262.)

TCLP tests can be performed on debris from pilot projects or debris generated by identical abatement procedures in identical structures to indicate whether the waste will be considered hazardous (see Appendix 10).

Generators producing more than 100 kg/month of hazardous waste must apply for and obtain an EPA identification (ID) number (from the appropriate agency) prior to shipping the hazardous waste offsite. Since the application process is lengthy, it is advisable to apply for the ID number several weeks prior to the start of a job. In most cases, the State waste management authority will issue EPA ID numbers to generators, and, for short-term abatement jobs, some States may provide temporary ID numbers. Additional waste handling and disposal requirements are discussed in Section IV below.

Before work begins, it is important to contract with a hazardous waste management company that has an EPA identification number for the transportation and management of hazardous waste and to secure cost estimates for waste transportation, treatment to meet land disposal restrictions (discussed in Section IV below), storage, and disposal.

3. Waste Water

If significant quantities of waste water (greater than 100 gallons) will be produced, the local waste water treatment facility should be contacted to determine if special measures should be taken before the waste water is poured down the toilet. The treatment facility should be informed if phosphate detergent or other cleaners were used during cleaning. The water should not be discharged until the proper area authority has granted permission to do so. Waste water should never be poured onto the ground or pavement.

E. Lead-Based Paint Waste From Public Buildings

For nonresidential public buildings (e.g., schools, libraries), all waste from lead hazard control efforts should be managed according to the procedures described earlier for abatement waste. Such waste may be similar to residential abatement waste in many respects; however, since these buildings are not "households," the household waste exemption for interim control waste does not apply. EPA is considering this waste along with residential abatement waste for possible regulatory changes.

IV. RCRA Hazardous Waste Management Requirements

The requirements for generators producing more than 100 kg/month of hazardous waste are set forth in 40 CFR Part 262. Generators producing quantities between 100 and 1,000 kg/month are referred to as "small-quantity generators," but are considered conditionally exempt. Those producing amounts more than 1,000kg/month are "large-quantity generators." In some instances, the requirements differ for small- and large-quantity generators. The regulations for hazardous waste generators require:

- Obtaining an EPA identification number.
- Meeting specified pretransportation standards.
- Completing hazardous waste manifest forms.
- Complying with land disposal restriction notification and certification.
- Maintaining records.

A. EPA Identification Number (40 CFR 262.12)

Generators must apply for an EPA generator ID number for each abatement site. The 12-character number is used by EPA and the States to maintain a nationwide tracking system on hazardous waste activity. All hazardous waste generators; transporters; and treatment, storage, and disposal facilities must have EPA ID numbers. One number per worksite is required; multifamily housing units may not require separate numbers, if the housing project is a contiguous property (see the definition of "onsite" in 40 CFR 260.10).

To obtain an ID number, generators should call or write the State hazardous waste management agency or the nearest EPA regional office, and request EPA Form 8700–12, "Notification of Hazardous Waste Activity," or the appropriate State form. The form should be completed and submitted to the State hazardous waste contact listed in the accompanying information booklet before work begins.

B. Pretransport Requirements (40 CFR 262.30 Through 262.34)

1. Onsite Accumulation of Waste

Under certain conditions, small-quantity generators may accumulate up to 6,000 kg (approximately 13,200 pounds) of hazardous waste onsite for 180 days, or 270 days if the treatment, storage, or disposal site is more than 200 miles away. Large-quantity generators may store such waste onsite for only 90 days. Under temporary, unforeseen, and uncontrollable circumstances, the generator may seek an accumulation period extension of a maximum of 30 days from EPA (or an authorized State agency), if such extension is obtained prior to expiration of the 90-day storage period. Generators storing hazardous waste longer than these allowable time periods can be fined for violations, and will be considered storage facilities requiring RCRA regulation.

Generators storing hazardous waste onsite must meet certain requirements.

- Proper Storage: Both small- and large-quantity generators must label stored hazardous waste properly and indicate the accumulation start date (see Figure 10.3).
- Emergency Plan: Small-quantity generators must have in their possession basic safety information to be used during an emergency. Large-quantity generators must have a written emergency plan (see Figure 10.4).
- Personnel Training: Small-quantity generators must ensure that their employees are familiar with emergency spill and accident procedures. Large-quantity generators must have an established training program that includes the identification or availability of:
  - Waste handling procedures.
  - Emergency response actions/contingency plans.
  - Emergency contacts and equipment.
  - Medical treatment and supplies.
  - An emergency coordinator.

2. Waste Minimization Plans

Section 3002(b) of RCRA requires small- and large-quantity hazardous waste generators to develop written waste minimization plans. Since Federal regulatory requirements do not exist for these plans and existing EPA guidance is geared toward industry, HUD recommends that contractors develop a short written plan describing procedures to:

- Recycle, or otherwise dispose of, window glass and other unpainted solid waste as appropriate.
- Clean plastic sheeting used for containment by removing lead paint and dust.
- Avoid mixing hazardous and nonhazardous waste.
- Recycle lead-based hazardous waste at an RCRA Part B-permitted lead smelter when appropriate.
- Seek a waste management contractor with experience in waste minimization.
- Consolidate paint chips.
- Remove unpainted components from the hazardous waste stream.

3. Packaging

EPA has adopted the U.S. Department of Transportation's (DOT's) hazardous materials transport packing methods to prevent leakage of waste or release of dust during transport, and to mandate proper marking (or placarding) of the packaged waste to identify associated characteristics and dangers. Hazardous waste transporters or disposal facilities can provide advice on appropriate packaging methods.

4. Selecting a Transporter and Waste Management Facility

Since generators are liable for improper waste handling, it is critical to select a hazardous waste transporter and a management facility that have the proper EPA ID numbers and necessary permits.

Table 10.2 Management of Abatement Waste

Waste Management Practices	**Category I: Low Lead Waste**	**Category II: Architectural Components**[1]	**Category III: Concentrated Lead Waste**	**Category IV: Other Waste**
RCRA Requirements	Manage as nonhazardous solid waste.	Depending upon knowledge or TCLP testing results, manage as solid hazardous or nonhazardous waste.	If more than 100 kg/month manage as hazardous waste. If less than 100 kg/month manage as solid waste.	Use TCLP to determine if waste is considered hazardous.
HUD Recommended Practices	Applicable	Applicable if knowledge or TCLP testing indicates that it is *nonhazardous*.	Applicable if less than 100 kg/month otherwise subject to full RCRA regulations.	Only applicable if TCLP testing shows waste is *nonhazardous.*
✥ Wrapped in plastic; seal all seams with tape (if acceptable to the disposal facility).	X	X	X	X
✥ Stored in designated, secure area.	X	X	X	X
✥ Covered during transport.	X	X	X	X
✥ Prohibit cutting/breaking outside work area.	X	X	X	X
✥ Cover ground with 6-mil plastic if handling outside.	X	X	X	X
✥ Prohibit disposal in solid waste incinerators and reuse recycling for mulch.	X	X	X	X
✥ Recommend disposal in State-licensed/permitted solid waste landfill.	X	X	If appropriate	X

Generators should investigate the answers to the following questions about facilities under consideration:

- Do they have an EPA ID number?
- Have they successfully completed similar jobs?
- Can they supply references? How do the references describe their service?
- How long have they been in business?
- Has the firm been cited by EPA or State agencies for any environmental violations?
- How much waste are they capable of handling over a given period of time?
- Can they handle both solid and hazardous wastes?
- Are they willing and able to perform special management actions (such as covering vehicles during transport)?
- Do they have experience dealing with RCRA land disposal restrictions?
- Do they have insurance?

Generators should also check with other generators, trade associations, the Better Business Bureau, and the Chamber of Commerce regarding the firm's qualifications. Written contracts with transporters and management facilities, at a minimum, should provide for the following items:

- Scope of work and schedule, including waste-segregation procedures.
- Testing and analysis of waste.
- Emergency procedures.
- Cost estimates and the handling of overruns.
- Payment procedures.
- Liability and responsibility for claims.
- Quality assurance plan.

Figure 10.3 Hazardous Waste Container Label With Accumulation Start Date.

Property owners may want to consult with legal experts on RCRA before signing contracts.

C. Manifesting the Waste (40 CFR Part 262.20 Through 262.22)

A hazardous waste manifest must accompany all hazardous waste shipments (unless the waste is generated by a conditionally exempt, small-quantity generator). The manifest is a multicopy form that tracks the waste from generator to final disposal. The generator, transporter, and a representative of the designated management facility must each sign this document and retain a copy.

The generator's signature certifies that (1) the manifest is complete and accurately describes the shipment, (2) the shipment is ready for transport, and (3) reasonable efforts have been made to minimize the amount and toxicity of the waste generated.

The designated waste management facility must return a signed copy of the form to the generator to confirm that the waste reached its destination. If this copy is not received by the generator within 35 days of shipment, the generator must contact the transporter and/or the owner or operator of the disposal facility to determine the status of the shipment. If the signed manifest copy is not received within 45 days of shipment, the generator must send an exception report to the EPA Regional Administrator (or authorized State official). The exception report

Figure 10.4 Sample Emergency Plan.

The **emergency coordinator** is _________________. If not at the site, he/she can be reached at _______________ 24 hours/day. The backup coordinator is ________________.

Emergency Procedures

In the event of a **fire**, call the local fire department immediately. Evacuate occupants and workers from the building to a safe location.

If liquid hazardous waste **spills onto soil or surfaces**, contain the spill and attempt to clean it up, while taking precautions to protect yourself.

If large quantities of liquid hazardous waste **spill directly into a stream or other surface water**, contact the National Response Center to report the spill.

Emergency Phone Numbers (Post these numbers near a telephone. If no phone is available onsite, post the numbers in a visible location and identify the nearest phone.)

Fire Department:
Police Department:
Local Emergency Response Coordinator:
Backup Local Emergency Response Coordinator:
National Response Center: 1–800–424–8802

Emergency Equipment

Have the following equipment onsite:

- Fire extinguisher.
- First aid supplies.
- Extra protective clothing and respirators.
- Material to contain and clean up spills.

Be sure all workers know where to locate these emergency supplies.

must include an explanation of the generator's effort to ascertain the whereabouts of the waste and the results of those efforts, as well as a copy of the signed manifest. The EPA or authorized State will then initiate the process to locate the missing waste. This regulation is strictly enforced.

The manifest form is often provided to the generator by the transporter or waste management facility. Blank manifest forms may also be obtained from the State hazardous waste agency (see Figure 10.5)

D. Land Disposal Ban Notification and Certification (40 CFR 268.7 and 40 CFR 268.9)

RCRA requires that all hazardous waste meet certain restrictions before it can be land disposed. Generators of more than 100 kg of hazardous waste per month must meet land disposal restrictions (LDRs). In general, these restrictions require that the waste be treated using a particular method, or that it be treated to meet a specific numerical standard, *before* being land-disposed. The hazardous waste transporter or management facility will assist in satisfying land disposal restrictions, including completing applicable paperwork.

Abatement projects producing hazardous lead waste containing particles that will pass through a 60 mm (approximately 2.5 inches) sieve must meet land disposal restrictions for RCRA hazardous waste code D008. Such waste includes paint chips, dust, sludges, and filter cake. To meet the concentration-based extract standard for lead, which is 5 ppm (see 40 CFR 268.42), land disposal restrictions require that D008 waste be treated before it is sent to a hazardous waste landfill (57 FR 37194, August 18, 1992). No technology is specified for treatment to meet this standard. On September 14, 1993 (58 FR 48092), EPA proposed alternative treatment standards for hazardous soil. When finalized, these standards would apply to any excavated soil that is considered hazardous.

Abatement projects that produce hazardous lead waste containing particles that will not pass through a 60 mm sieve must meet the treatment standards for hazardous debris. Such debris includes painted bricks, concrete, wood and woodwork, metal, plaster board, uncleaned plastic covering, and vacuum and respirator filters. The land disposal restriction standards for hazardous debris provide two treatment alternatives:

- The waste may be "stabilized" to meet the predisposal treatment standard for lead (40 CFR 261.41 through 268.43) and then sent to a hazardous waste landfill (57 FR 37194, August18, 1992).
- The waste may be treated using several different treatment methods: physical extraction, chemical extraction, thermal extraction, destruction, and immobilization (see 40 CFR 268.45 Table 1, 57 FR 37278, August 18, 1992). If one of these methods is used, the treated wood or metal debris is no longer considered hazardous and can be disposed of in a solid waste landfill. However, the residue from the treatment process must be treated to meet the concentration-based standard for lead (40 CFR 268.45(d), 57 FR 37278, August 18, 1992).

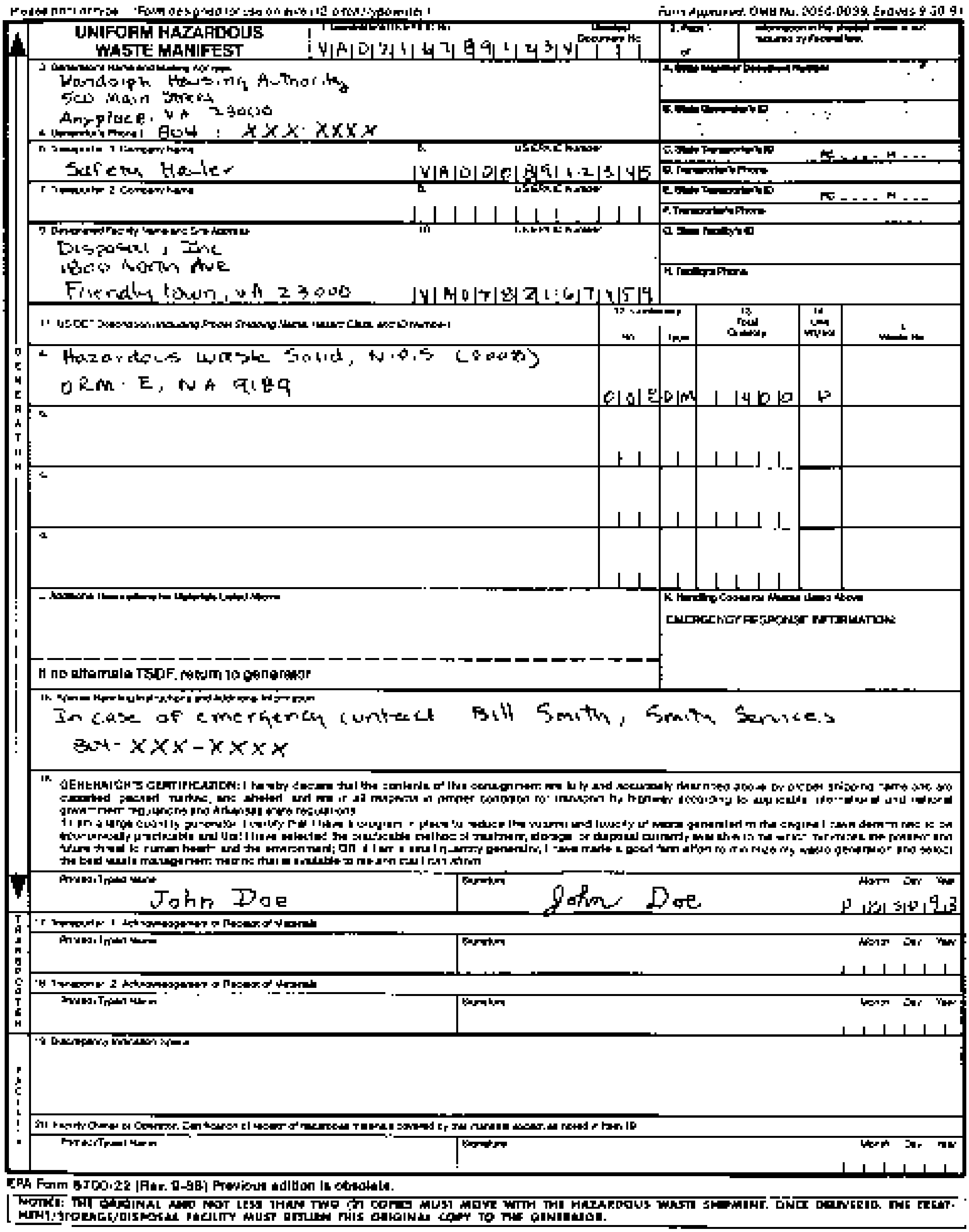
Prohibitions on storage of "restricted" hazardous waste (40 CFR 268.50) and requirements for treating "restricted" waste in onsite tanks or containers are applicable to hazardous lead waste (40 CFR 268.7).

The generator must either *notify* the hazardous waste treatment/disposal facility that the waste does not meet the land-disposal treatment standards or *certify* that the waste does meet the standards. All notifications and certifications must identify the restricted waste, applicable treatment standards, manifest number for the waste shipment, and any available waste analysis data. The treatment standards are listed in 40 CFR 268.41 through 268.43.

E. Recordkeeping (40 CFR 262.40 through 262.44)

Generators must maintain three categories of records, which are described below.

Figure 10.5 Sample Waste Manifest.



UNIFORM HAZARDOUS WASTE MANIFEST

VAD 214 47 89 1 43 4

Randolph Housing Authority
500 Main Street
Anyplace, VA 23000
804 : XXX : XXXX

Safety Hauler

VAD 020 891 2345

Disposal, Inc
1800 North Ave
Friendly town, VA 23000

VAD 748 21 6 7 4 5 9

a. Hazardous waste Solid, N.O.S. (D008) ORM-E, NA 9189

001 DM 1400 P

EMERGENCY RESPONSE INFORMATION

If no alternate TSDF, return to generator

In case of emergency contact Bill Smith, Smith Services
804-XXX-XXXX

GENERATOR'S CERTIFICATION:

John Doe

John Doe

EPA Form 8700-22 (Rev. 9-88) Previous edition is obsolete.

NOTICE: THE ORIGINAL AND NOT LESS THAN TWO (2) COPIES MUST MOVE WITH THE HAZARDOUS WASTE SHIPMENT. ONCE DELIVERED, THE TREATMENT/STORAGE/DISPOSAL FACILITY MUST RETURN THIS ORIGINAL COPY TO THE GENERATOR.

1. Biennial Reports

Large-quantity generators must submit a report every 2 years to the State hazardous waste agency or EPA regional office that details the generator's activities. Such reports are usually not required for abatement jobs of less than 2 years' duration.

2. Exception Reports

Generators must retain copies of all exception reports identifying instances when a signed manifest copy was not returned by the waste management facility designated to receive the waste shipment, and describing their efforts to locate lost shipments. The generator is responsible for notifying EPA or the appropriate State agency of lost shipments.

3. Three-Year Retention of Reports, Manifests, and Test Records

Generators are required to retain all manifests, results of hazardous waste testing, and land-disposal notifications/certifications for 3 years. However, for liability reasons, records should be kept for at least 10 years.

The following types of information should be retained.

- Type of waste.
- Weight of shipments.
- Number of drums or containers shipped.
- TCLP results.
- Laboratory name.
- Identity of person conducting TCLP sampling.
- Location of samples.
- Hazardous waste storage locations.
- Type of storage containers.
- Abatement method.
- Name of property owner and contractor.
- Name of project designer (if applicable).

V. Waste Management Case Study

The following is a case study of typical waste management practices in a lead hazard control job. A single-family dwelling has undergone a risk assessment. The home is a single-story building of approximately 1,500 square feet that contains three bedrooms and one bathroom. The risk assessor identified interim controls as an option for some surfaces and abatement as the only option for others. The owner decided to undertake a combination of interim control and abatement actions.

A. Lead Hazard Control Measures

Interim control measures consisted of cleaning and applying polyurethane to the wooden kitchen floor, replacing carpet in one bedroom, repainting certain areas, and treating friction surfaces on one door.

Abatement measures consisted of replacing selected woodwork (e.g., facia, exterior trim board); replacing 17 windows and 1 exterior door; and wet scraping deteriorated paint from bathroom and kitchen walls and enclosing these areas with gypsum board and melamine, as appropriate.

B. Waste Generated and Management Steps Taken

Before work began, the owner and contractor held a meeting and agreed in writing that the contractor would handle all RCRA and other State waste management requirements. The owner agreed to sign the manifests prepared by the contractor.

1. Interim Control Waste

Interim control debris that was determined by the State to be a household waste was managed as solid nonhazardous waste and sent to a solid waste landfill. This waste included one HEPA vacuum filter, two respirator filters, cleaned plastic sheeting that had been used to contain the work area, discarded and rinsed tools, paint chips from limited scraping, discarded carpeting, aluminum scraps left over from treating friction surfaces, and waste water filters.

Approximately 20 gallons of liquid waste from cleaning operations were produced. This waste water contained potentially high levels of lead and phosphate. The water was filtered and the solid material was disposed of as specified above. Filtered waste water was poured into the toilet after permission was granted by the local water authority.

2. Abatement Waste

In anticipation of the work, the contractor developed a waste minimization plan and conducted limited TCLP testing on the windows and exterior trim that were slated for removal. This information was used to estimate waste disposal costs, establish waste segregation procedures, and determine the necessity of obtaining an EPA ID Number. The contractor hired a laboratory to conduct TCLP testing (see Appendix 10 for guidance in selecting labs); the lab agreed to fax test results to the contractor within 36 hours of receiving samples. The contractor also identified a hazardous waste contractor to handle such waste, if necessary.

After having removed all loose paint, the contractor provided the laboratory with two core samples (core samples may be obtained using a hole saw) from the window and one exterior trim sample in a 9.5 mm square. The test results indicated that none of the samples leached lead in excess of 5 ppm and thus both the windows and exterior trim could be considered nonhazardous waste. The contractor estimated that Category III and IV waste was unlikely to exceed 220 pounds, and thus did not apply for an EPA ID Number. The contractor and property owner retained test results to document the waste characterization decisions and handling procedures.

The contractor also developed waste-minimization specifications for workers, directing them to sort the waste into three categories (after separating glass for recycling): solid waste/architectural components, hazardous waste, and waste requiring TCLP testing. Each category was managed separately.

RCRA solid nonhazardous waste (including architectural components) consisted of 15 sets of personal protective clothing that was HEPA vacuumed prior to its removal, windows (one pile stacked approximately 10 feet high, 6 feet long, and 5 feet wide), approximately 500 linear feet of window trim, one exterior door, cleaned plastic sheeting, and rinsed rags and mops.

Glass was removed from the windows and sent to a local permitted glass recycling facility. The remaining solid material was placed in 6-mil plastic or heavy-duty plastic bags and sealed shut with tape. The material was stored in a separate location and disposed of at a State-permitted solid waste landfill.

Filtered waste water was disposed of in the toilet.

RCRA hazardous waste was stored in a 55-gallon drum in a garage, separate from the other wastes. Hazardous waste included two HEPA filters, dust/debris from the HEPA vacuum, two respirator filters, and a small amount of paint chips. Total waste weighed less than 220 pounds (100 kg) and thus was managed as solid nonhazardous waste. The waste was disposed at a State-permitted landfill that met Federal design standards (40 CFR 258).

Wastes requiring TCLP testing included unrinsed rags and mops, samples of which were cut into small pieces and sent to the laboratory. TCLP testing results were as follows: sample leachable lead (ppm)—Rag 1=10.20, Mop 1=8.60.

These materials were added to the Category III RCRA hazardous waste. Because the total hazardous waste amount did not exceed 220 pounds, it was sent to a State-permitted solid waste landfill. The property owner and contractor retained the TCLP test results to document waste characterization and handling decisions.

Chapter 11: Interim Controls

Interim Control: How To Do It

1. Owners of properties in good condition may decide to proceed directly to interim control without a risk assessment. This involves stabilizing any deteriorated paint (see Section II), on the assumption that all deteriorated paint contains lead-based paint, thoroughly cleaning all surfaces (see Section IV), and covering all bare soil (see Section V). These measures should be followed by a risk assessment (not a risk assessment screen) to determine if the property meets clearance standards and if any hazards were left uncorrected. All interim control activities should be carried out in accordance with the procedures described in these *Guidelines*.

2. Alternatively, an owner may first have an independent risk assessment performed by a certified professional to determine if lead-based paint hazards exist and to minimize hazard control activities.

3. Together with a certified risk assessor, planner, or other designer, develop a site-specific lead hazard control plan based on the hazards identified, the feasibility of the control measures, occupant protection, and financing. For interim controls and some abatement techniques, the plan should include how and when ongoing monitoring by the owner and reevaluation by a certified risk assessor or certified inspector will be performed. (See Chapter 6 for standard reevaluation schedules.)

4. For building components, determine which hazards will be addressed with interim controls (dust removal, paint stabilization, and/or control of friction/abrasion points). For lead-contaminated soil, decide which interim control measure is appropriate for the climate and the planned use of the area.

5. Develop specifications (if appropriate). The amount of detail provided should be commensurate with the size of the job. The specifications should state how any abatement activities and other construction work (e.g., weatherization) will coincide with the interim control work. It may be preferable to combine interim controls with abatement in many cases.

6. Although interim controls are not expected to generate hazardous waste, the planner or risk assessor should make this assessment for each project and notify local authorities if the local jurisdiction requires it.

7. Select a qualified, trained contractor to complete the hazard control work. For some small jobs, onsite maintenance workers may be able to perform the work. In either case, Occupational Safety and Health Administration (OSHA) regulations require all interim control workers to be trained.

8. Select the appropriate interior and/or exterior Worksite Preparation Level (from Chapter8) to protect residents.

9. Notify residents of the dwelling and nearby dwellings of the work and when it will begin. Distribute educational materials furnished by the U.S. Environmental Protection Agency (EPA) and/or the State or local government to residents about lead poisoning and lead-safe practices.

10. Correct any existing conditions that could undermine the success of the interim controls (e.g., structural deficiencies, moisture problems, uncleanable surfaces).

11. For exterior work, preinterim control soil samples should be collected but not necessarily analyzed until clearance soil samples have been collected, analyzed, and compared to clearance standards. If soil levels are below applicable limits, the baseline samples need not be analyzed (see Chapter 15).

12. Execute interim control work. See the Step-by-Step Summaries in each section of this chapter for information about dust removal, paint film stabilization, friction and impact surface treatments, and interim soil controls.

13. Store all waste in a secure area and make sure that it is properly labeled (see Chapter 10). Dispose of all waste properly.

14. Conduct daily and final cleanups (see Chapter 14).

15. Have an independent, certified inspector technician or risk assessor conduct a clearance examination 1 hour after cleanup to let dust settle (see Chapter 15). If no preliminary risk assessment was performed, only a certified risk assessor can conduct the clearance examination/risk assessment. If clearance is not achieved, complete interim controls and/or reclean. Following a successful clearance examination, the property owner should receive documentation to that effect, including a schedule for required reevaluation (if applicable). Local authorities may also require a Statement of Lead-Based Paint Compliance.

16. Pay contractor and clearance examiner.

17. The owner should conduct ongoing maintenance and monitoring of interim controls to ensure that they remain in place. Periodic reevaluations by a certified risk assessor should be completed according to the reevaluation schedule in the hazard control plan of the property.

18. Maintain records of all lead hazard control, reevaluation, and monitoring activities and turn them over to any new owner upon sale of the property.

Chapter 11: Interim Controls

Section I

I. Principles of Interim Control

A. Introduction

While interim controls have been carried out in some public housing developments under the name of "in-place management," the concept is relatively new in the field of lead hazard control. Interim controls are intended to make dwellings lead-safe by temporarily controlling lead-based paint hazards, as opposed to abatement, which is intended to permanently control lead hazards. See Chapter 12 for a more detailed discussion of the difference between abatement and interim controls. In Title X of the Housing and Community Development Act of 1992, interim controls are defined as ". . . a set of measures designed to reduce temporarily human exposure or likely exposure to lead-based paint hazards, including specialized cleaning, repairs, maintenance, painting, temporary containment, ongoing monitoring of lead-based paint hazards or potential hazards and the establishment and operation of management and resident education programs." Interim control measures are fully effective only as long as they are carefully monitored, maintained, and periodically professionally reevaluated. If interim controls are properly maintained, they can be effective indefinitely. As long as surfaces are covered with lead-based paint, however, they constitute potential hazards.

Basic elements include planning, implementation of interim controls, cleanup and clearance, education of residents and maintenance staff, ongoing maintenance and monitoring by the owner, and periodic reevaluation by a certified professional. The term "certified professional" means a certified risk assessor or certified inspector.

Interim lead hazard control measures include:

- Repairing all rotted or defective substrates that could lead to rapid paint deterioration (repairing defective building systems that cause substrate damage may be a prerequisite for effective interim control but is outside the scope of interim control per se).
- Paint film stabilization (see Section II)—stabilizing all deteriorated lead-based paint surfaces by removing deteriorating paint and repainting.
- Friction and impact surface treatments (see Section III)—treating floors and interior window sills and window troughs so that they are smooth and cleanable.
- Treating friction and impact surfaces, such as windows, doors, stair treads, and floors, when they are generating lead-based paint chips or excessive levels of leaded dust that cannot be controlled with ordinary cleaning.
- Treating protruding, accessible surfaces, such as interior window sills, where lead-based paint may be present and there is either visual or reported evidence that children are mouthing or chewing them.
- Treating all bare soil containing excessive levels of lead.
- Dust removal and control (see Section IV)—cleaning surfaces to reduce levels of leaded dust to acceptable levels, including cleaning carpets, if they are contaminated.
- Educating residents and maintenance workers on how to avoid lead poisoning.
- Conducting reevaluations by certified individuals, ongoing monitoring by owners, and observation by residents.

After completion of lead hazard control measures, an independent, certified inspector technician or risk assessor should carry out a clearance examination, which includes a visual inspection to determine whether all necessary lead hazard control measures were completed and collecting dust samples to determine whether floors, interior window sills, and window troughs meet clearance levels.

The property owner should implement an active maintenance regime to ensure that the property continues to be free of hazards. Such a maintenance regime should consider the likelihood that leaded dust may be tracked into the housing unit from the outside. Periodic visual monitoring and reevaluation according to a site-specific schedule prescribed in the risk assessment report should be carried out to determine whether the dwelling unit continues to be free of hazards.

B. When Interim Controls Are Appropriate and When They Are Not

Unless precluded by regulation, interim controls are most easily implemented when most surfaces with lead-based paint are intact and structurally sound and lead exposure comes primarily from deteriorating paint and excessive levels of lead in household dust and/or soil. Interim controls are also appropriate if the housing unit is slated for demolition or renovation within a few years. In many cases resources will not be available to finance permanent abatement, making interim controls the only feasible approach.

If the housing unit has substantial structural defects or if interior or exterior walls or major components, such as windows and porches, are seriously deteriorated or subject to excessive moisture, interim controls are unlikely to be very effective. Paint cannot be effectively stabilized unless substrates are dry, structurally sound, and waterproof. Other interim control measures, such as window repair, would also not be very effective if structural problems are likely to result in rapid treatment failure. Any structural problems should be repaired before interim controls can be implemented. If these problems cannot be repaired, then more frequent reevaluation will be necessary in case of premature failure.

Federal, State, and local legislation or regulations may require that certain lead hazards be permanently abated rather than controlled on an interim basis. For example, HUD requires that public housing authorities abate all lead-based paint in dwelling units undergoing comprehensive modernization. Title X requires that lead hazards be abated in the course of substantial rehabilitation projects that use more than $25,000 of Federal funds per dwelling unit. Some State and local governments have enacted laws and regulations requiring that cer-tain lead hazards be abated.

Whenever building components are replaced, energy-efficient products should be used. This will help reduce energy consumption and also reduce the length of time it takes for new components (energy-efficient doors and windows) to pay for themselves.

C. Determining the Scope of Interim Controls

The property owner may decide to rely on a risk assessor to determine whether interim controls are appropriate, identify treatment options, and estimate the long-term costs of the various available options. (See Chapter 5 for a discussion of risk assessments.) In some cases in which HUD funding will be used, a risk assessment or a paint inspection will be required. Some State or local laws may also strongly recommend or even require a risk assessment before lead hazard controls can be carried out.

Unless prohibited by local law, the property owner may elect to proceed with lead hazard control measures without a risk assessment or a paint inspection. When no evaluation is conducted, the property owner must assume that all surfaces have lead-based paint, all floors and dust traps are contaminated, and all bare soil is also contaminated. In this case, the property owner could waste money if surfaces are treated that do not contain lead-based paint. When there is a substantial likelihood that some treatable surfaces do not contain lead-based paint, the cost of risk assessment may well be recovered by a more focused effort on confirmed hazards.

Some State and local laws prescribe certain treatments in order for the housing unit to qualify as lead-safe. Insurance companies or lenders may also prescribe certain treatments if a property is to qualify for insurance coverage or a loan. In all cases, the property owner should ensure, at a minimum, that required lead hazard control measures are carried out.

Whenever a housing unit is to be weatherized or rehabilitated, it is usually cost effective to control lead hazards at the same time. Usually, normal weatherization or rehabilitation activities can also eliminate some lead hazards if the work is modified so that it can be performed safely. However, if not carried out properly, these efforts will increase the risk of lead poisoning. In those situations, abatement is usually the most appropriate intervention since windows and other components are often replaced. It will usually be more expensive and disruptive to carry out weatherization or rehabilitation and lead hazard control separately.

D. Preparing a Lead Hazard Control Plan for Multifamily Housing

Conducting interim controls of lead-based paint hazards in multifamily housing presents issues not generally found in single-family housing. In most occupied multifamily developments, it is not feasible, financially or logistically, to carry out hazard control activity in all dwelling units at once. In properties with a relatively small number of dwelling units, it may be possible to proceed unit by unit and complete the hazard control work quickly. In larger properties, however, decisions must be made as to the order of the work in dwelling units and common areas, and perhaps, in rooms or components within dwelling units and common areas. Even when an entire building is vacant and undergoing renovation, hazard control elements of the work must be identified and scheduled. Therefore, it is usually advisable that there be a lead hazard control plan for properties with more than approximately 10 units.

Owners should have an independent certified risk assessor prepare a lead hazard control plan to address lead-based paint hazards identified by the risk assessment or, if no risk assessment has been conducted, the specific hazards that are assumed to be present. The plan should prioritize and schedule control measures and any additional hazard evaluations so that available resources are targeted for maximum benefit. Lead hazard control planners or designers may also be helpful in preparing such a plan. In developing the plan, the risk assessor should consult with the property owner to gain insights about the property to determine which strategies will be most appropriate. The goal of this consultation is to combine in the plan the risk assessor's knowledge of lead-based paint hazards with the property owner/manager's knowledge of the particular property—its maintenance history, persistent problems, occupancy profile, capital improvement program, etc.

In developing a lead hazard control plan, it is reasonable to consider treating units occupied by children under age 6 or pregnant women first. Common play areas, day-care centers, or dwelling units serving as day-care centers may also be candidates for early treatment. It is reasonable to consider the fact that it is less expensive to conduct hazard controls effectively and safely in vacant units than in occupied units; thus, it may be appropriate to postpone some hazard control treatments until unit turnover. It is reasonable to consider the possibility of relocating families with young children from uncontrolled units to hazard-controlled vacant units in order to more quickly and cost effectively reduce childhood exposure to lead in the environment.

At a minimum, a lead hazard control plan should include the following elements:

- A schedule for hazard control, usually in units with young children or pregnant women first, followed by other units. The schedule should show how lead-based paint hazards will eventually be controlled in *all* units.

- A commitment on the part of the owner and manager to control lead-based paint hazards that are generated during routine maintenance work or normal building aging, what those controls consist of, and how those controls will be implemented.
- Specific measures that will be taken during unit turnover (often paint stabilization, specialized dust removal, and perhaps the provision of cleanable surfaces on floors, sills, and troughs and some minor building component replacement).
- A schedule for performing risk assessments, lead hazard control screens, and inspections and/or clearance examinations in all units or a representative sample of units.
- A schedule for hazard control actions to be completed in common areas.
- A schedule for reevaluations and visual monitoring by certified risk assessors and owners or their representatives, respectively.
- A description of how maintenance workers and other staff will be trained to handle lead-based paint hazards safely.
- Designation of an individual, preferably on the staff of the owner or the property manager, who is responsible for matters associated with lead-based paint hazards.

E. Combinations of Interim Controls and Abatement of Certain Hazards

In many dwellings owners will choose a combination of interim controls *and* abatement. This decision is best made by consulting a certified risk assessor. For example, it is possible to stabilize deteriorated lead-based paint and remove excess levels of leaded dust (interim controls), but at the same time enclose some lead-based painted surfaces, replace some lead-based painted components, or remove lead-based paint from some surfaces (abatement). Such combinations of interim control and abatement treatments might well be the most cost-effective response to a property owner's lead hazard problem, particularly if carried out when the dwelling unit is vacant.

F. Qualifications of Interim Control Contractors

Title X does not require certification of contractors who carry out interim controls. However, OSHA requires that all interim control workers be trained under 29 CFR 1926.21(b)(2), even if lead exposures are below the action level (see Chapter 9). Interim control activities frequently disturb lead-based paint and typically take place in areas with excessive levels of leaded dust. Therefore, while not required by EPA, it is recommended that interim control workers and supervisors, whether employed by the property owner or an independent contractor, be trained, preferably through an accredited abatement course.

G. Cleanup and Clearance

Section IV of this chapter describes how leaded dust can be removed as an interim control measure. In some dwellings dust removal from a few surfaces may be sufficient. Chapter 14 describes cleanup after abatement or a more comprehensive set of interim control measures. Whether leaded dust is removed as the primary element of interim control or as final cleanup after more comprehensive control activity, the objective is the same—providing residents with a clean and easily cleanable unit.

Like abatement, interim controls are intended to make a dwelling unit safe for children; therefore, interim controls are subject to the same clearance testing requirements and documentation as abatement. Clearance examinations *must* always be conducted following interim control work (Chapter 15 describes clearance examinations).

H. Education

While education of the residents, particularly the children's caregivers, is not in itself sufficient to prevent childhood lead poisoning, it can assist residents in reducing the risk that their children will be seriously poisoned.

Therefore, education is an important adjunct to any lead hazard control system.

The property owner is responsible for the condition of the dwelling unit and for advising occupants to report any deteriorating paint. The owner should also distribute to the occupants any educational materials furnished by the State or local government or by a local lead-poisoning prevention organization.

The educational materials should advise occupants of all the potential sources of lead poisoning. This includes lead-based paint, lead-contaminated dust and soil, and also lead in water, pottery glazes, glass, some imported cosmetics, and home remedies. Materials should suggest simple preventive measures, such as washing children's hands before eating and after play, and washing toys. Children's nutrition is also important. Foods high in iron and calcium reduce absorption of lead into children's bodies while fatty foods increase the rate of absorption. The EPA Lead Hazard Information Pamphlet is a useful resource that can be obtained by calling 1–800–LEAD–FYI. Property owners, managing partners, and remodelers should also obtain these educational materials.

I. Maintenance, Monitoring, and Reevaluation

See Chapter 6 for a complete discussion of reevaluation and Chapter 17 for information on maintenance. The success of interim control measures depends not only on the adequacy of their initial application, but also on whether they remain effective over time. To remain effective they must be maintained and monitored. Property owners or their agents should routinely (e.g., annually) visit the property and visually ensure that interim controls remain in place. They should also respond promptly whenever an occupant reports any deteriorating paint. Any failure of interim controls that is identified should be corrected promptly.

An important component of maintenance is ensuring that leaded dust levels remain below acceptable levels. This can best be achieved through regular cleaning of areas where leaded dust is likely to accumulate. Property owners should, therefore, undertake thorough cleaning of the unit upon vacancy if, during ongoing monitoring, they find that excessive levels of leaded dust have accumulated.

To ensure a reasonably lead-safe environment for young children, dwelling units that continue to contain lead-based paint and potential lead hazards should be reevaluated by a certified inspector or risk assessor. The schedule should be developed on a site-specific basis.

J. Resident Protection During Control Activities

Any activity that disturbs lead-based paint can generate leaded dust. While interim control activities are less likely to generate leaded dust than abatement activities, any scraping or sanding without high-efficiency particulate air (HEPA) attachments can generate dangerous levels of dust. Whenever dust-generating activities are carried out, residents and particularly young children should stay out of the rooms (preferably the entire house) and should not return until all dust and debris are removed and the dwelling unit has been thoroughly cleaned (see Chapter 8).

K. Waste

Most interim control activities are not expected to generate hazardous waste since interim controls will generate less than 100 kilograms of lead per month, exempting them from hazardous waste regulations. See Chapter 10 (Hazardous and Nonhazardous Waste) for further guidance.

L. Statements of Lead-Based Paint Compliance

State or local governments may require inspectors or risk assessors who carry out clearance examinations to provide a Statement of Lead-Based Paint Compliance. The Statement would provide evidence that described interim controls have been completed and that leaded dust levels are at or below applicable standards. Insurance companies and lenders could rely on the Statement in framing their underwriting criteria. Such a system would provide an inducement for property owners to control lead hazards and give them hard proof of compliance.

The Statement of Lead-Based Paint Compliance would be valid for a limited period of time based on the standard reevaluation schedule for the property. The Statement could be extended when a reevaluation demonstrates that the conditions of lead safety continue to be met. Some States may limit the number of recertifications. Others may permit recertification until some event such as substantial rehabilitation takes place. Insurance companies or lenders may impose their own requirements.

M. Documentation

Lead hazard evaluation, lead hazard control, and maintenance and monitoring activities associated with interim controls should be documented. Several specific documents are of particular importance. These include:

1. Risk Assessment and/or Inspection Report. This document records the findings of any risk assessment or inspection, including any inspection of painted surfaces and the collection and analysis of samples for determination of the lead content in dust, soil, and/or water. A risk assessment that finds no lead-based paint hazards would also justify issuance of a certificate.

2. Lead Hazard Control Plan. This document explains the schedule of hazard control actions in multifamily housing (see section I.D. of this chapter).

3. Clearance Examination Report. This document records the basis for clearance of the property so that it is ready for occupancy (see Chapter 15).

4. Reevaluation Reports. These reports indicate that the hazard control measures are still in satisfactory condition and that the dwelling is still in a lead-safe condition. Reevaluations are performed on a schedule discussed in Chapter 6.

5. Maintenance and Monitoring Log. This log records the results of the property owner's or property manager's monitoring visits. Any repairs made as a result of these visits or notices of defects from occupants should also be recorded.

6. Statement of Lead-Based Paint Compliance. This document states that on a particular date the inspector or risk assessor confirmed through an onsite investigation that the dwelling met applicable requirements. The Statement of Lead-Based Paint Compliance is issued to the property owner, with copies provided to the residents and to the State or local code enforcement authority, if required under State or local law or regulation. The Statement of Lead-Based Paint Compliance is valid for a limited period of time based on the site-specific reevaluation schedule contained in the risk assessment report.

Paint Film Stabilization: How To Do It

1. Eliminate any exterior leaks in the building envelope (e.g., roofing leaks, gutter or downspout problems, missing or damaged doors, roof flashing, missing opening trim, missing glass in windows, defective or missing caulk and glazing, loose fasteners).

2. Eliminate any interior water leaks (e.g., plumbing leaks; clogged condensate drip lines for air conditioners; missing water pans for hot water heaters; inadequately ventilated attic spaces; clogged bathtub drains; missing tile, grout, or caulking in bathtubs; windows that won't close completely).

3. Select and implement an appropriate Worksite Preparation Level (see Chapter 8).

4. For exterior work, collect soil samples before the work begins (unless soil sampling has already been completed for a risk assessment). These samples need not be analyzed unless clearance samples show soil lead levels are above applicable clearance standards.

5. Repair all rotted structural, siding, or railing components; defective plaster; missing door hardware; loose siding or trim; and loose wallpaper.

6. Prepare surface by wet scraping or wet sanding. Do not remove paint by burning or torching, power sanding without HEPA attachments, or abrasive blasting. Dry scraping and chemical strippers with methylene chloride are not recommended.

7. Clean, degloss, neutralize, and rinse surfaces. Surfaces should be dry before priming or repainting.

8. Select primer and topcoat by considering longevity, moisture resistance, and organic compound content with low volatility. Paint film stabilization involves the application of at least two coats (the primer and the topcoat). Use a primer/topcoat system from the same manufacturer to ensure compatibility.

9. Apply all paints at appropriate thickness (see Table 11.1) or according to manufacturer's directions. Apply paint only during proper temperature, wind, and humidity conditions. Allow sufficient time for each coat to dry fully.

10. Conduct final cleanup (see Chapter 14).

11. At the end of the lead hazard control project, have a certified inspector technician or risk assessor conduct a clearance examination and provide appropriate documentation or statements of lead-based paint compliance.

12. Conduct reevaluations annually as indicated in the site-specific schedule (Table 6.1). Perform ongoing maintenance of paint and restabilize paint whenever deterioration is discovered.

Section II

II. Paint Film Stabilization

A. Typical Lead Coatings and Their Failures

The lead in lead-based paint may be found as white pigments (lead carbonate, sulfate, or silicate), or colored pigments (chrome yellow, red lead, gray, and other orange, green, and red pigments). These pigments were mixed with other components in an oil vehicle, and traditionally thinned with volatile organic solvents and a drying agent. Driers containing lead were used to accelerate the conversion of the liquid coating to a dry film. Paint films can fail rather quickly under real-life conditions, making ongoing monitoring important. Paint films should be quickly but carefully stabilized whenever a resident or owner reports that paint is deteriorating.

1. Moisture

Oil paints (virtually all lead-based paints are oil paints) form a hard, usually glossy, low-permeable and inflexible coating. Water, either in the form of water vapor or liquid, is the single greatest cause of premature paint coating failures. Once a substrate gets wet, the impermeable paint coating is pushed away from the substrate due to vapor formed by heat from the sun or other sources. Repeated soaking/warming cycles result in microscopic failure of the paint and then an accelerated failure as more and more openings become available, allowing the substrate to become increasingly wet. Expansion and contraction caused by small ice crystals during the wet winter months also cause paint deterioration.

A significant number of homes are poorly constructed, ventilated, or maintained, and allow moisture to be trapped. The 26 main causes of premature paint failure from moisture are described in Figure11.1.

2. Aging

All binders age and some cure over time. This continued curing causes the paint to become too brittle to accommodate the normal expansion and contraction of the substrate, resulting in cracking and peeling. Exterior paints are also attacked by sunlight, which can cause chalking. These slow aging processes mean that even a well-managed and protected surface will deteriorate eventually.

3. Mechanical Damage

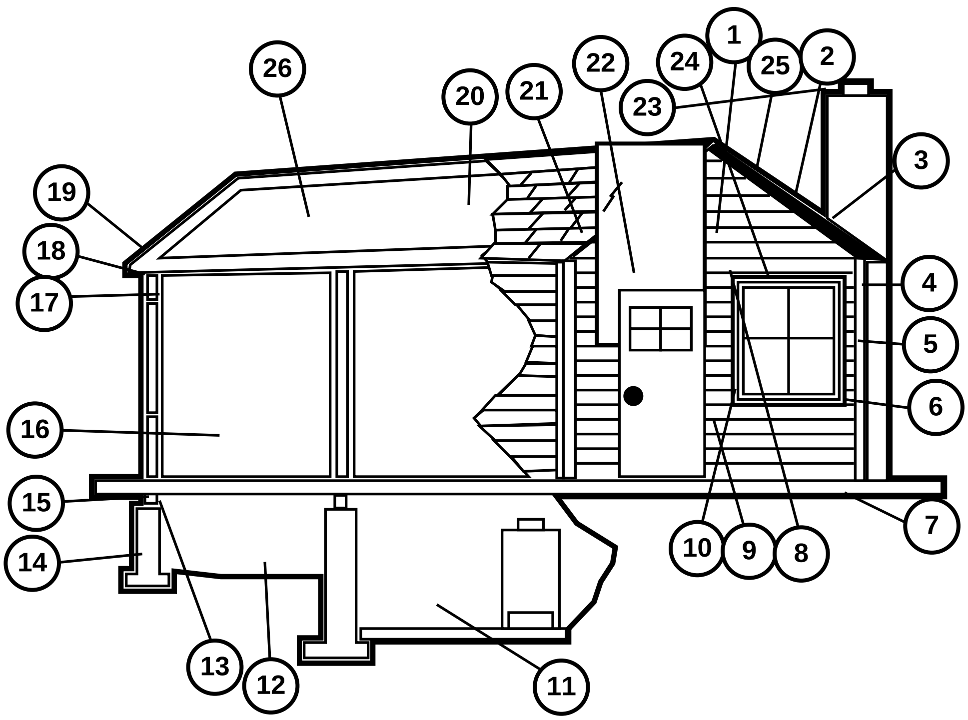
The two basic kinds of mechanical damage (abrasion and impact) can be minimized only by careful management. Paints exhibit tremendous variability in hardness, impact resistance, and abrasion resistance. High-performance coatings (e.g., polyamide epoxy, urethane-reinforced alkyds, and epoxy-modified enamels) can withstand over 10,000 more scrubbing cycles than inexpensive flat vinyl paints (Banov, 1978), although some of these paints may not be appropriate for residential use. Failure from impact or friction is often accelerated by the selection of a low-performance coating.

4. Chemical Incompatibility

Since oil and water do not mix, oil paints applied over wet substrates will not adhere. The failure may occur within a week, and may cause the paint film to be pulled directly from the substrate. Although oil paints stick relatively well on surfaces slightly contaminated with organic material, dirt, and oil, they do not adhere well to fatty or heavily greased surfaces.

Most latex paints do not adhere to chalky or smooth and glossy paint films. Epoxies will fail prematurely when applied over latex coatings and some oil coatings. Some chemical-based strippers contain such large amounts of wax and other stabilizers that almost no subsequent coating will maintain good adhesion. If the substrate has been stripped with a caustic paste and not neutralized properly, the highly alkaline pH will

Figure 11.1 Moisture-Related Causes of Paint Failure.



(1) siding exceeds 14-percent water content; (2) no cricket where chimney meets roof; (3) no step flashing at side of chimney; (4) corner rim not caulked; (5) exposed nailheads rusting; (6) no window wash at window sill; (7) wood contacts earth; (8) no drip or gutter at eaves; (9) poorly fitted window and door trims; (10) waterproof paper not installed behind trim; (11) damp, wet cellar unventilated at opposite sides; (12) no ventilation of unexcavated space; (13) no blocking between unexcavated space and stud wall space; (14) no waterproofing or drainage tile around cellar walls; (15) no foundation water and termite sill; (16) plaster not dry enough to paint; (17) sheathing paper that is not waterproof; (18) vapor barrier omitted—needed for present or future insulation; (19) roof built during wet, rainy season without taking due precaution or ventilating on dry days; (20) roof leaks; (21) inadequate flashing at breaks, corners, roof; (22) poorly matched joints; (23) no chimney cap; (24) no flashing over openings; (25) full of openings, loosely built; (26) no or inadequate ventilation of attic space.

cause deterioration of the subsequent paint. On the exterior, salts may build up on the surface of paint films in eaves and soffits and prevent paint adhesion. These salts must be removed with water to allow good adhesion.

Portland cement and older plaster substrates are extremely alkaline and should be aged or etched with mild acid solutions prior to spot sealing with a primer.

5. Poor Surface Preparation

A 100-year-old house, repainted every 8 years, may have at least 12 coats of paint. If surface preparation for only one of those coats was insufficient, localized failures will occur. Because of the slow erosion of the binder in exterior paints, chalking can cause poor adhesion of new coatings. Chalk must be removed and appropriate primers applied to prevent subsequent failures. Surfaces must be free from oil, grease, and dirt. Paint stripper residue must be removed, either with solvents or alkali cleaners such as trisodium phosphate. Hard, glossy oil films require deglossing to allow waterborne coatings to adhere properly.

B. Substrate Condition and Repairs

1. Building Envelope Leaks

The quality and endurance of a paint coating is dependent on the quality of the substrate over which it is applied. The substrate must be dry, structurally sound, and waterproof. Roofing leaks, including porches, gutters, and downspouts, must be fully repaired prior to stabilizing the lead-based paint film. Temporary roofing repairs like asphalt patching material, piecing in downspouts and gutters, and short-term paint-on coatings are not recommended. Within 4 months, these quick fixes may fail and result in subsequent failure of the lead-based paint.

The purpose of painting is to protect the substrate and improve its appearance. In lead-based paint stabilization, the main goal is to make intact a dangerous, poisonous coating to prevent excessive lead exposures. Paint stabilization is most effectively and economically completed after the following defects have been fully corrected:

- Damaged or missing roof flashing.
- Damaged or missing door and window flashings.
- Siding in contact with soil.
- Water running down siding.
- Missing or deteriorated opening trim.
- Missing glass in windows.
- Missing, damaged, or deteriorated caulking.
- Loose and rusty fasteners.

2. Interior Repairs and Water

The major type of repair that must be completed prior to paint film stabilization involves eliminating moisture sources. Plumbing leaks, especially in bathrooms and kitchens, are often the cause of paint film failure on the ceilings and walls below. A few major soak/dry cycles can bring the lead-based paint or leach lead salts to the surface. The following interior defects should be corrected permanently in conjunction with interior lead-based paint stabilization projects:

- Visual leaks in waste lines, traps, supply lines, or fixtures above or in rooms undergoing stabilization or where suspected lead-based paint is present.
- Clogged condensate drip lines for air conditioners.
- Water heaters and washers without pans and overflows above or in rooms undergoing stabilization or where suspected lead-based paint is present.
- Inadequately ventilated attic spaces.
- Inadequately ventilated bathrooms, kitchens, and laundry areas.
- Clogged bathtub drains.
- Interior windows that are loose or do not close completely.
- Broken or missing glass in windows.
- Improper or deteriorated caulking in bathrooms or kitchens.
- Plugged or blocked weep holes in storm windows.

Needless friction and abrasion points on lead-contaminated surfaces should also be repaired. As structures age, sag, and adjust, components can bind or abrade each other. The following friction points should be eliminated when discovered on lead-contaminated surfaces (see SectionIII):

- Doors and doorjambs, heads, and thresholds.
- Cabinet doors and drawers.
- Window sashes, jambs, heads, and parting beads.

3. Water Vapor Management

Paint exposed to excess water vapor can fail within hours of initial application. Almost all exterior trim flashing and caulking serves a functional purpose by covering seams and joints and keeping out air and water. All missing or deteriorated trim, flashing, and caulking should be replaced prior to stabilization. Open cracks in bathrooms and kitchens should be taped with fiberglass mesh wall tape, spackled, and then sealed to eliminate water penetration. Minor repairs to the plaster substrate should be completed, allowed to dry, and sealed with white shellac or an acrylic latex. Exterior cladding and attic spaces should be ventilated to allow the escape of water vapor. Small wedges can be driven between clapboards, circle vents can be installed, or the walls may be sealed from the inside using caulking and a very low-permeable primer. Soffit and ridge ventilation of at least 1 square inch of vent per 300 square inches of ceiling area is recommended. The following vapor maintenance defects should be permanently corrected prior to stabilizing lead-based paint:

- Deteriorated or missing caulking or grout at tub and shower surrounds.
- Painted-over vents on siding or roof.
- Deteriorated or missing caulking that allows air infiltration (e.g., at trim, outlets, light fixtures, pipe penetrations).
- Crawl space not covered with low-permeable barrier (vapor barrier).

4. Substrate Repairs

Prior to stabilizing lead-based paint, the following defects must be permanently corrected:

- Dry rotted or rusty structural, siding, or railing components.
- Wall and ceiling plaster that is loose from the underlying lath (sagging plaster).
- Missing door hardware (e.g., hinges or knobs).
- Loose siding or trim.
- Loose wallpaper.

C. General Paint Application Guidelines

1. Appropriate Conditions

Because the guidelines in this chapter have been developed primarily to stabilize and seal lead-based paint, the general requirements for repainting should be rigorously followed. The painters should be professional, skilled, and willing to guarantee their work. Strict adherence to the paint manufacturers' recommendations for air and substrate temperatures, required primers, relative humidity, and recoating time should be conscientiously enforced. The completed primer and topcoat must be applied at the manufacturers' coverage rate and should never be thinner than 2.5 mil. Table 11.1 contains other recommended procedures for paint film stabilization.

2. When Paint Film Stabilization Will Not Last Very Long

Under certain conditions, paint stabilization will not last very long. These are:

- Prerequisite repairs not possible.
- High probability of future physical damage.
- Stairwell walls with visual and likely physical damage (enclosure with wood wainscot is an acceptable alternative to paint stabilization).
- Children's play equipment (removal of paint or disposal of equipment are better options).
- Wall surfaces that are structurally unsound.
- Walls with a layer of wallpaper over or under lead-based paint.

Table 11.1 Recommended Minimum Thickness of Dried Paint Film for Lead-Based Paint Stabilization (in mil)

Topcoat	Primer Thickness	Topcoat Thickness	Total Coating Thickness
Acrylic enamels	1.0	1.5	2.5
Alkyd enamel	1.0	1.5	2.5
Water-reducible epoxy	1.0	2.0	3.0
Urethane-modified alkyd/porch and deck enamel	1.0	2.0	3.0
Epoxy-modifier enamel	1.0	2.0	3.0

- Weep holes in storm windows not cleared to allow ventilation and drainage of water.

Paint film stabilization will yield the best results when the surface and building system have been properly prepared. If prerequisite repairs cannot be completed before paint film stabilization, the reevaluation period should be shortened substantially. The owner's monitoring frequency should also be increased.

D. Worksite Preparation

Choice of Worksite Preparation Level depends upon the size of the area to be stabilized and other factors (see Chapter 8). Occupants should never be present in the work area. Plastic sheeting should be used to capture falling paint chips and make the cleanup process more efficient.

For exterior work, soil samples should be collected before the work begins. These samples need not be analyzed until postabatement soil samples have been collected, analyzed, and compared to clearance standards. If soil samples collected after the work has been completed are below applicable limits, the preinterim control samples need not be analyzed (see Chapter 15).

E. Paint Removal Methods

The recommended approaches to surface preparation are as follows:

- All loose surface material should be removed by hand treatments (i.e., wet scraping, wet sanding).
- Surface contaminants that prevent adhesion should be eliminated by cleaning (e.g., chemical degreasing, trisodium phosphate washing, or other equivalent detergent followed by thorough rinsing).
- Surface gloss should be eliminated by chemical etching or HEPA vacuum-assisted sanding.
- Adhesion to the substrate should be enhanced by chemical etching, applying rust inhibitors, spot sealing, and/or wet sanding.

Certain paint removal practices are prohibited, including open-flame burning or torching, machine sanding or grinding without using a HEPA vacuum local exhaust system, uncontained hydroblasting or high-pressure wash, open abrasive blasting or sandblasting without using a HEPA vacuum, and use of heat guns above 1,100 °F.

Other paint removal practices are not recommended, including dry scraping (except for limited areas) and use of chemical strippers containing methylene chloride.

Further information on these prohibited methods is provided in Chapter 12, SectionIV.

1. Wet Scraping

The goal of safe scraping is to minimize the creation of dust while removing loose paint. The best tool for this work is a scraper attached to a HEPA vacuum, which very efficiently removes small dust particles generated during scraping.

The large chips that fall to the floor will be captured by the 6-mil plastic floor containment. Continuously misting the surface with water from a small atomizer or garden-type sprayer will minimize dust generation. A small amount of detergent can be used as a wetting agent. This procedure is best completed by two people—one scraping, the other wetting the surface. Simple dust-gathering devices, like a damp rag wrapped around the head of a draw scraper, capture the smallest dust particles while directing the larger paint chips onto the floor containment area (see Figure 11.2).

2. Wet Sanding

When preparing a surface by sanding (especially with fine-finishing grits), it is quite possible to contaminate an entire household with fine particles of lead-contaminated dust. Traditional orbital sanding devices may be used *only* in conjunction with a HEPA vacuum filter attachment (see Figure 11.3). Dry sanding should be replaced by wet sanding except near electrical circuits.

Any liquid that does not interfere with subsequent paint adherence may be used (e.g., water, Varsol, phosphoric acid etch for iron, and trisodium phosphate).

Patching material for drywall, plaster, and wood can be wet sanded using sponges (see Figure 11.4).

Wood, metal, and painted surfaces that require a fine cosmetic finish may be sanded using wet-dry sandpaper and water or an oil paint solvent. Relatively rough surfaces may be finished using wet foam sanding blocks created by dipping a sponge in an aluminum oxide grit. These sponge sanders are ideally suited for wet sanding and can be easily cleaned by immersing in a bucket of trisodium phosphate or other cleaner.

Rather than sanding to get a grip on an old gloss coat of paint, the painter should chemically treat the surface with specialized products such as Liquid Sandpaper™, taking care to provide adequate ventilation if volatile substances are released.

F. Surface Cleaning

1. Dust and Chips

Good surface preparation will remove damaged, oxidizing, and deteriorated paint surfaces, but will also create leaded dust and chips. Therefore, after the surface has been allowed to dry, it should be HEPA vacuumed to collect surface dust. Prior to applying primer, the surface should be tested for its pH by placing litmus paper against the wet surface (see Figure 11.5). The surface must be rinsed with clear water or a weak acid solution until it reaches a pH between 6 and 8 for most new paints.

2. Oils, Waxes, and Mold

While oil and alkyd paints have some tolerance for oil in the substrate, acrylic latex paints will fail prematurely if applied over greasy or oily surfaces. For waxes like crayons and some polishes, a combination of household ammonia and water should be used for cleaning, followed by a thorough rinse. Surfaces in baths and kitchens that may be prone to contamination by airborne grease and oils, fatty soap films, or mold can be cleaned with a 5- to 6-percent solution of trisodium phosphate or other suitable cleaner and rinsed thoroughly. On some varnished kitchen cabinets, the finished surface may become coated with organic films after extended use. The surface should be cleaned with a nonflammable solvent before painting.

G. Priming

To maximize the life of a paint job, a system of compatible coatings is necessary. Primers are designed to adhere tightly to the old paint while leaving a rough, bondable surface on the outside. Prior to priming wood and plaster, substrates should have a moisture content of no more than 15-percent relative humidity on the exterior and 10-percent relative humidity on the interior. Top-quality primers work better, last longer, and treat more substrate types. Consider the following factors when selecting a primer:

- Type of substrate (e.g., wood, metal, gypsum, masonry).
- Type of existing substrate coating (e.g., acrylic latex paint, varnish, oil enamel).
- Interior or exterior application.
- Topcoat (only use manufacturers' recommended primers; use a single manufacturer for both primer and topcoat).

1. Oil- and Alkyd-Based Primers

Oil primers are compatible with a system of multiple coats of oil paint over a wood or plaster substrate. The similar solvents used in the old and new paints have a tendency to soften the surface of paint, creating a better bond. Oil primers are also effective vapor barriers. On the other hand, oil primers contain volatile organic chemicals that can cause adverse health effects and may cost more than waterborne paints. Many States regulate the amount of volatile organic chemicals in paint.

2. Waterborne Primers

The most durable waterborne paints are made with an acrylic or acrylic-containing binder. While acrylic latex primers and topcoats are an excellent combination for new wood, they may not be compatible with the lead-based oil paints that cover the substrate. Waterborne paints usually emit less volatile organic compounds and may be less expensive than oil paints.

H. Topcoats

To maximize cost-effectiveness and prolong the efficiency of a coating used as a lead hazard control method, it is important to purchase paint with a long lifespan. Inexpensive, low-grade paint or special mixes should not be used in lead-based paint stabilization programs. Paints and clear finishes used for paint stabilization jobs require outstanding adhesion, durability, chemical resistance, and flexibility. Therefore, the owner should request the most durable and the highest grade of paint.

Marine paints free of lead and mercury and varnishes (used on boats, docks, etc.) are especially durable and abrasive-resistant, because

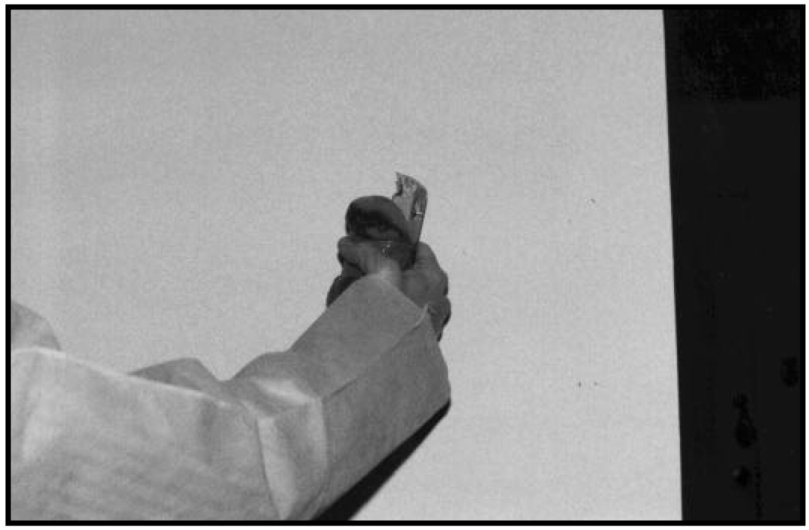
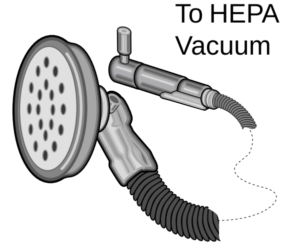


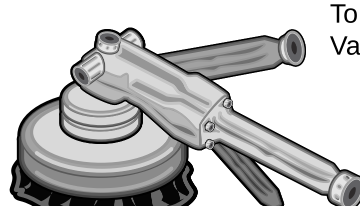
Figure 11.2 Wet Scraping Tool.

Figure 11.3 HEPA Vacuum Sanders.

HEPA Sanders

Sanding generates huge amounts of dust. HEPA sanders are sanders fitted with a HEPA vacuum to catch and filter lead dust as it is created. Use a HEPA sander when sanding lead paint. Limit the use of HEPA sanding to flat surfaces for feathering or finishing only.





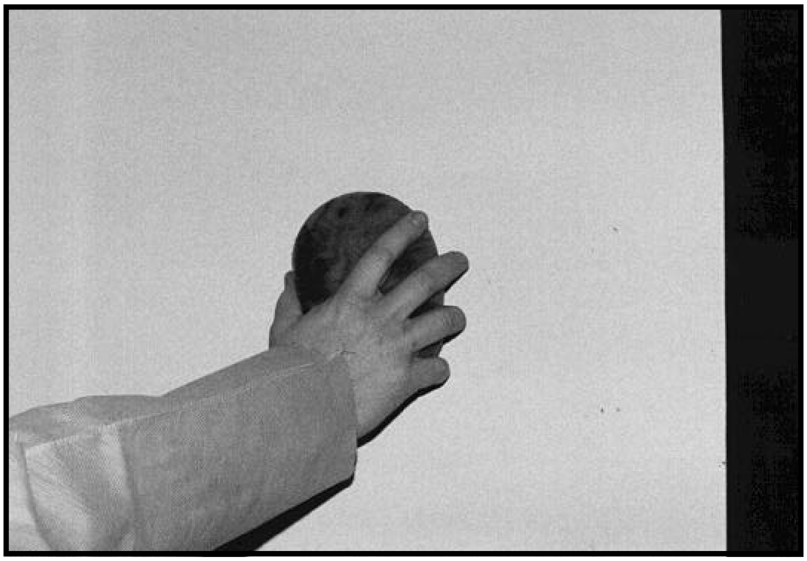


Figure 11.4 Use a Sponge To Wet Sand and Smooth New Patching Material.

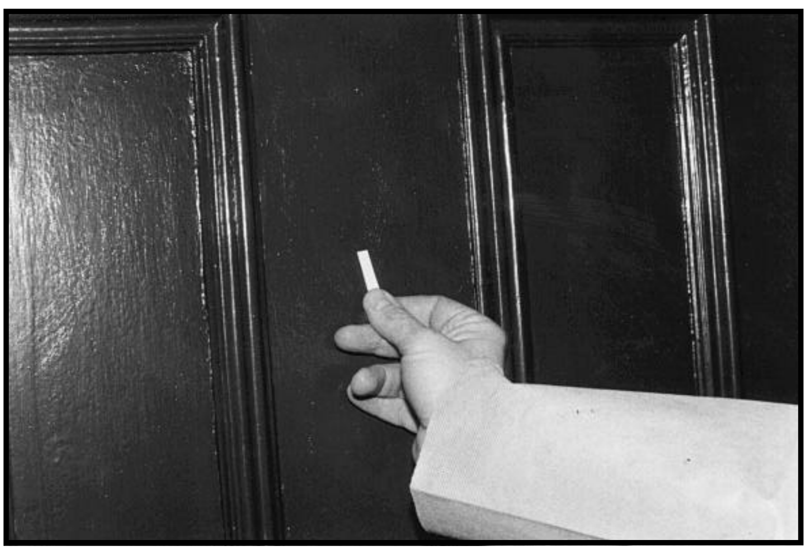


Figure 11.5 Use Litmus Paper To Determine the Surface pH Before Applying New Paint.

they are formulated with more resin than house paints and the resin is of the highest quality. However, some marine paints are not appropriate for residential use (e.g., bottom paints or mildew-resistant paints contain poisons and must be avoided, so that lead is not replaced by another toxic substance). High-gloss floor and deck enamels offer the next best level of protection. In general, the higher the gloss, the more durable, impact-resistant, and moisture-resistant the coating. Among types of paint finishes, gloss, semigloss, and eggshell coatings are much more resistant to abrasive cleaners and the detergents used in followup maintenance procedures than flat finishes.

A satisfactory service life of 4 to 10 years may be achieved with latex and alkyd-based paints, although much more rapid deterioration can occur under adverse conditions. High-performance coatings applied properly to ideal substrates may offer a service life of 10 to 25 years. High-performance coatings include epoxy-modified alkyds, epoxies, urethanes, epoxy-polyesters, and polyesters. However, these types of coatings should only be selected after consulting the manufacturer as to the specific intended use(s) and after considering the following factors:

- Possible presence in the new coating of lead, chromate, mercury, and other heavy metals (and other toxic substances).
- Compatibility with existing paint film.
- Ability to be repainted in future maintenance operations (epoxies and urethanes are difficult to repaint).

Some lead-based paint encapsulants are made out of similar materials and may last longer than paints on some surfaces (see Chapter13).

A 100-percent acrylic latex product could last 10 years on the average exterior under optimal conditions (Cassens and Feist, 1991). A low-cost nonacrylic latex may last less than 4 years. The additional material costs (126 percent to 200 percent) of high-priced paints and any special primers are minimal when compared to the cost of performing more frequent paint film stabilization. (See Table 11.3 for finishes typically used for lead-based paint stabilization.)

I. Cleaning and Clearance

Containment removal, extensive cleaning, and clearance testing is required following stabilization and recoating. (See Chapters 14 and 15 for discussion of cleaning and clearance.)

J. Reevaluation and Monitoring of Lead-Based Paint Stabilization

Immediately after completion of any paint stabilization job, the paint begins the slow process of deterioration from mechanical damage, ultraviolet rays, rain, snow, and wind. A well-prepared substrate, which is sealed, primed, and topcoated with premium house paints, can withstand between 4 and 10 years of weathering in temperate climates. At the other extreme, a small scratch in a metal railing located in a coastal town may lead to extensive corrosion and major paint failure within a much shorter time. Assuming a proper paint job, paint life is directly related to the environment to which it is exposed. Cyclical changes in the environment are responsible for the greatest rate of paint destabilization. Rapid changes in temperature, moisture content, and relative humidity cause small stress cracks at joints and between dissimilar materials. Exterior paint life can be extended considerably by annual inspections and maintenance (spot scraping, spot priming, and topcoating deteriorated areas). While a new paint job on interior plaster and wood can last 5 to 10 years with only minor fading, repainting will be required much more frequently in dwellings with more wear and tear. Spot priming and spot topcoating as soon as a deterioration is noticed can extend the life of the interior surfaces.

Table 11.2 General Recommendations for Applying Paint

- Paint only when surface and ambient temperatures are between 50 °F and 90 °F when using a water-thinned coating, and between 45°F and 95°F for other types of coatings.
- Maintain coatings in container at a temperature range of 65 °F to 85 °F at all times on the job.
- Paint only when the temperature is expected to stay above freezing.
- Paint only when wind velocity is below 15 mph.
- Paint only when relative humidity is below 80 percent.
- Observe the recommended spread rate for each kind of coating.
- Tint each coat differently if the same paint is to be used for successive coats to ensure complete coverage.
- Allow sufficient time for each coat to dry before applying another. Use the same brand for each coat.
- Allow adequate time for the topcoat to dry before permitting service to be resumed.
- Do not put doors back into use until they have dried completely.
- Do not paint over weep holes in the bottom of storm window systems; if the weep holes are blocked or plugged, drill a hole to permit proper ventilation and drainage of rainwater. Failure to clear weep holes will cause premature paint failure in window troughs.

Table 11.3 Finish Coats for Lead-Based Paint Stabilization

Options	Base	Cost per Gallon	Difficulty Level	Comments and Recommendations
Varnish	Oil alkyd resin, clear finish	$18–$36		Can be touched up very easily.
Acrylic latex	Water	$12–$18	Safest and easiest to use.	May not adhere to alkyd enamels.
Polyurethane resins:				
Alkyd	Oil-volatile organic solvent	$20–$36	Easy to apply. Very durable.	Cannot be touched up without sanding off gloss.
Moisture-cured	Volatile organic solvent	$32–$38	Harder to apply.	Needs adequate relative humidity to cure.
Waterborne clear finish	Polyurethane water	$35–$60	Can be hard to apply.	Safer to apply than organic solvent-containing coatings.

Source: Adapted from *A Consumer's Guide to Renovation, Repair and Home Improvement*, J. Wiley & Sons, 1991.

Friction and Impact Surface Treatment: How To Do It

1. Select and implement the appropriate Worksite Preparation Level (see Chapter 8).
2. For windows, remove stop bead and parting strip and dispose of properly. Wet scrape deteriorated paint. If the window trough is badly weathered, cap with back-caulked, aluminum coil stock. If necessary repair window weight and pulley system. Install new window channel or slide system and replace stop bead (and parting strip if required).
3. For doors, remove doorstop and dispose of properly. Remove door by pulling out hinge pins. Mist and plane door to eliminate friction points. Reinstall door and install new doorstop.
4. For stairs, install a hard, cleanable covering on treads (i.e., rubber tread guards). Carpeting may be used instead, but it must be securely fastened so that it does not cause abrasion. Stabilize paint on banisters, balusters, and newel posts.
5. For baseboards, remove and dispose of shoe molding and replace.
6. For abraded outside wall corners, install new plastic or wood corner bead.
7. For drawers and cabinets, remove and replace cabinet doors or remove paint by offsite stripping. Strip paint from drawers and drawer guides or plane impact points and repaint. As an alternative, install rubber or felt bumpers at points of friction or impact.
8. Repaint porches, decks, and interior floors.
9. Have a certified risk assessor or certified inspector conduct a clearance examination.
10. Perform ongoing maintenance and monitoring of treatments. Reevaluations should be conducted by certified risk assessors based on the reevaluation schedule for the specific property (see Chapter 6).
11. Provide educational materials to residents. Information should include proper cleaning routines and the sticky tape method of removing loose paint.

Section III

III. Friction and Impact Surface Treatment

A. Definition of Terms

1. Friction Surfaces

Friction surfaces are those surfaces covered with lead-based paint that are subject to abrasion, which may generate leaded dust. The most critical friction surfaces are generally those portions of a window that are rubbed when the window is opened and closed (see Figure 11.6). The actual area(s) of adjacent surfaces that rub together should not be painted. This includes the jamb, stop bead, and parting strip, and sometimes the sash. Other common friction surfaces include tight-fitting or rubbing doors, cabinet doors and drawers, stairway treads and railings, and floors painted with lead-based paint, including exterior decks and porches.

Friction surfaces on doors and windows will generate less leaded dust when they are kept in good operating condition and in a state of good repair. Friction surfaces can also often be covered with a temporary or permanent covering to eliminate the friction. The covering itself, however, must be abrasion-resistant.

However, if the component is deteriorated, it may be more cost effective to simply replace it than to attempt to treat friction surfaces (see Chapter 12).

2. Impact Surfaces

Impact surfaces are generally protruding surfaces that tend to be bumped or banged. These impacts can cause small chips of paint to become dislodged and fall to the floor, thus covering the floor with small amounts of loose lead-contaminated dust and chips (see Figure 11.7). The most common impact surfaces are doors and doorjambs, door trim, doorstops, outside corners of a wall, baseboards, and shoe moldings along the baseboard, stair risers, and chair rails (see Figure 11.8).

Impact surface problems can be lessened by placing barriers in front of the impact surface, such as new shoe molding in front of baseboards, or a new chair rail to protect lead-based painted walls from jolts by the backs of chairs. Impact surfaces can also be covered with an impact-resistant material (e.g., placing corner beads over outside corners of walls).

B. Lead Hazard Control Measures

The control measures described in this section involve a combination of both interim control and abatement treatments of windows, doors, stairs, baseboards, drawers, cabinets, porches, decks, and interior floors. These treatments are likely to control lead hazards more effectively and for longer periods than stabilizing painted surfaces.

The treatments described below require special construction and cleanup skills that should be implemented by trained personnel only.

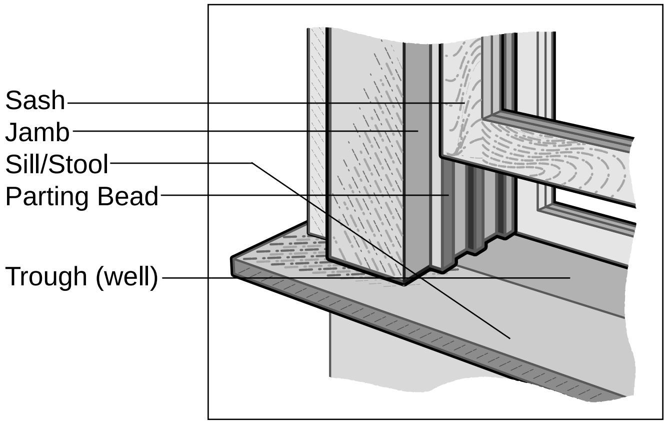
1. Window Systems

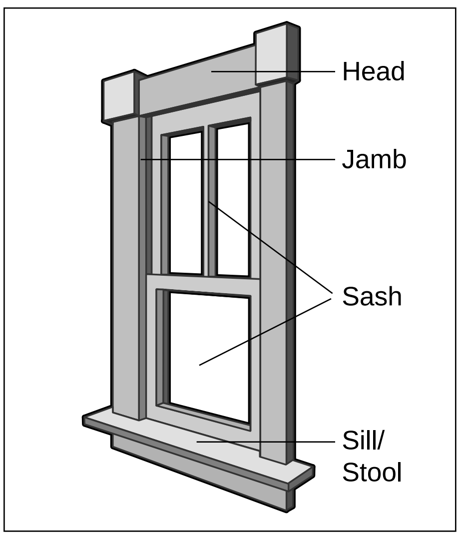
Window systems may be the largest source of leaded dust and chips in the home and are also the most complex to treat. Window paint tends to deteriorate more rapidly than other painted surfaces due to moisture, variations in temperature, and exposure to the elements. In addition, painted friction surfaces, including the jamb, stop bead, and parting bead are abraded or "sanded" each time windows are opened and closed. If the wood becomes weathered, dust is trapped and is difficult to remove.

Before beginning any window treatment, the Worksite Preparation Level for windows should be implemented (see Chapter 8).

The stop bead holding in the lower sash should be misted with water and scored with a razor knife along the edges to facilitate its removal. The stop bead should be pried off, wrapped in plastic, and sealed with tape for disposal. Next, the lower sash should be removed. The jamb, parting bead, sash, window trough, and peeling trim should be misted with water, and loose and flaking paint should be carefully scraped away.

Figure 11.6 Window Friction and Impact Points.





All surfaces should be HEPA vacuumed, paying particular attention to the window trough. If badly weathered, the window trough should be capped with aluminum coil stock (or equivalent), which is back caulked and nailed into place (see Figure 11.9).

All surfaces should be thoroughly scrubbed with a cleaning agent suitable for leaded dust removal and rinsed with clean water. Any necessary repairs to the weight and pulley system should be made at this time. The sash should be reinstalled with a new stop bead and any additional paint loosened by the hammering should be wet scraped. All surfaces should be HEPA vacuumed one more time and the new stop bead should be primed and painted. The plastic used to protect the surrounding area must be misted, folded with the dirty surface inside, and placed in a double 4-mil or single 6-mil plastic bag. The bag should be sealed and labeled to identify the contents for later disposal. Floor surfaces should be HEPA vacuumed beneath the plastic and several feet around the plastic on each side. The floor should be mopped with the cleaning solution, rinsed with clean water, and HEPA vacuumed a final time.

For further protection it is possible to install replacement window channels or slides. Aluminum, vinyl, and polyvinyl chloride (PVC) plastic channels are available (see Figure 11.10).

In this case, both the stop and parting beads should be removed, both sashes taken out, the chain and pulley system disconnected, and the pulleys removed. All other surfaces should receive the same treatment as described above. The jambs should be repainted and the window channels installed with the old sashes and a new interior stop bead.

Covering painted surfaces with coil stock or channel systems is technically an enclosure abatement measure combined with interim controls since the whole window system is not enclosed. This combination of abatement and interim controls provides a great deal of flexibility to the property owner. In many cases it will permit the most cost-effective strategy to be used.

If windows are badly deteriorated, it may be more cost effective to replace them, particularly in young children's bedrooms or in rooms in which young children frequently play.

2. Door Systems

Doors present a problem when the doorframe becomes misaligned due to settlement or when multiple coats of paint reduce frame clearance to the point where the door sticks, rubs, or even chips paint on the door or doorstop when opened and closed. The simplest approach is to rehang the door so that it no longer rubs against the doorjamb.

To accomplish this, the area should be protected with plastic taped to the floor, as described in Chapter 8. Heavily painted doorstops can be misted, scored with a razor, and pried loose. The stop should be wrapped in plastic and sealed with tape for disposal. Friction points on the door should be noted. Hinge pins should be removed and the door carefully planed (preferably outside the unit) to eliminate the friction points. (Note: Planing of doors will generate considerable leaded dust and paint-chip contamination and may be more easily completed offsite in a controlled environment.) The minimum Worksite Preparation Level that should be used is Interior Level 2. A new doorstop, if necessary, should be installed and any paint loosened by the hammering should be wet scraped. The new stop and planed areas should be primed and all surfaces repainted, as described in Section II of this chapter. The floor beneath the plastic and several feet around the plastic should be thoroughly HEPA vacuumed and mopped with a suitable cleaning solution.

3. Stair Systems

There are a number of treatments that will control lead hazards on stairs. Installation of rubber tread guards will lessen or eliminate friction on the tread (see Figure 11.11). The tread guards should cover the entire width of the stairs.

Covering the treads *and* risers with carpeting can be useful in lessening friction and impact. It is important that carpeting be securely installed and cover the entire width of the stairs, since loose-fitting carpeting can cause abrasion and subsequent dust releases. However, since carpeting is difficult to clean effectively, installation of hard, cleanable surfaces (for example, tile) is generally preferable to carpet.

4. Baseboards and Outside Wall Corners

Damage to baseboards subject to frequent impact can be lessened by the replacement of the shoe molding at the bottom of the baseboard

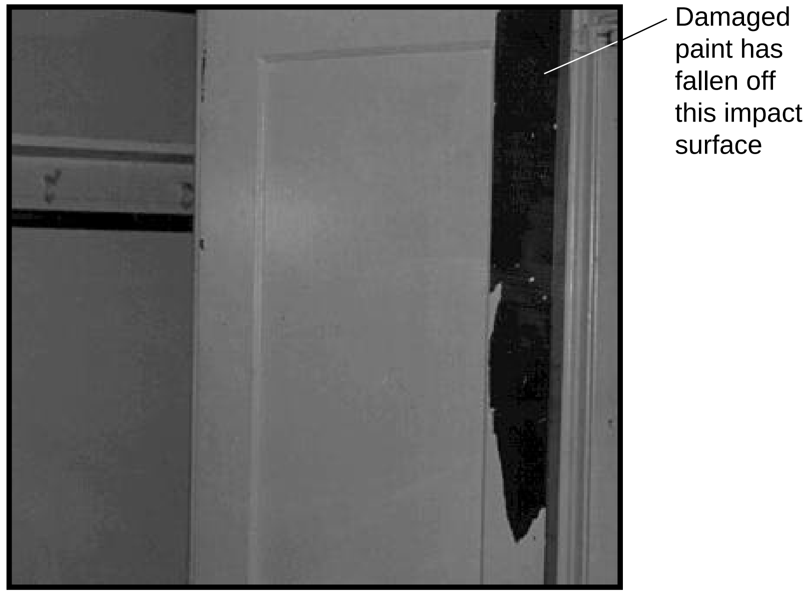


Figure 11.7 Damaged Paint on an Impact Surface.

Figure 11.8 Impact Surfaces.

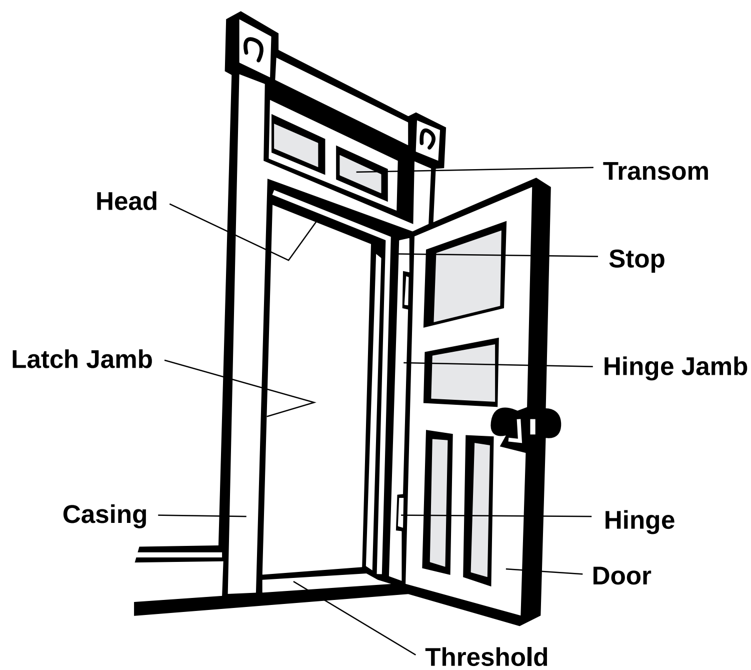
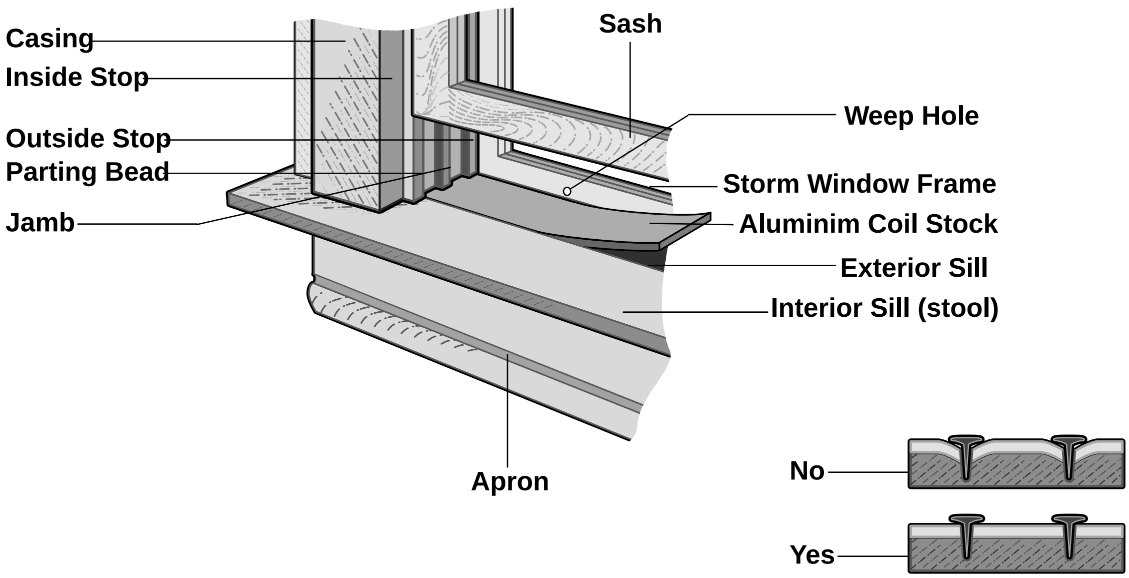


Figure 11.9 Enclose the Window Sill and Window Trough.



(see Figure 11.12). This relatively inexpensive treatment provides a barrier that prevents chair and table legs from actually striking the lead-based painted surface. Shoe molding should be removed by misting the surface, scoring with a razor, and prying the molding loose. The molding should be wrapped in plastic and sealed with tape for disposal. Since the baseboard is not necessarily removed, installation of new molding is a combined abatement/interim control measure. New shoe molding should then be back caulked.

Impact or abrasion of outside corners of walls can be reduced by the installation of a wooden or plastic corner bead (see Figure 11.13).

5. Drawers and Cabinets

Drawers and cabinets coated with lead-based paint present a potential risk when doors or drawer facings do not fit properly. This is especially important when the cabinet or drawer is used for storing food, eating utensils, or bathroom articles, such as toothbrushes.

Cabinet doors can be carefully removed and discarded, or can be stripped offsite and planed where necessary to fit properly, and repainted. These activities should only be performed after all articles are removed from the cabinet and the immediate area is contained. The exterior and interior of the cabinets should be thoroughly cleaned before articles are returned.

Drawers can also be removed and stripped offsite. Drawer covers can be planed at impact points and repainted. Installation of rubber or felt bumpers will also reduce impact with the painted surface of the cabinet.

6. Porches, Decks, and Interior Floors

Porches, decks, and interior floors with lead-based paint can be significant generators of paint chips and leaded dust particles through abrasion or impact. At a minimum, the paint should be carefully stabilized and covered with polyurethane or high-quality paint. Decks and floors must be smooth enough so that dust can be removed by normal cleaning without special

Figure 11.10 Window Channel Guides That Reduce Friction.

- Remove the bottom sash. If the counter-weight ropes or chains are in place, do not let them drop into the weight compartment.

- Remove the paint from edges that rub against stop, stool, and parting bead. Wet planing is a good method.

- Rehang the sash(es) in a compression track. If there is no counter weight or spring system, install one to keep the sash in place.

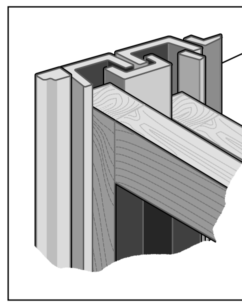


Figure 11.11 Covering Stairs With Tread Guards.

A rubber tread with metal nosing works well. Rubber nosing that fits snugly on the nose may work if the stairs are not used very often.

- Enclose risers with thin plywood (like luan plywood) or some other hard material. Whatever you use must fit snugly.

- Back caulk the edges of treads. Place them and nail or screw them down. Screw or nail the metal nosing on.

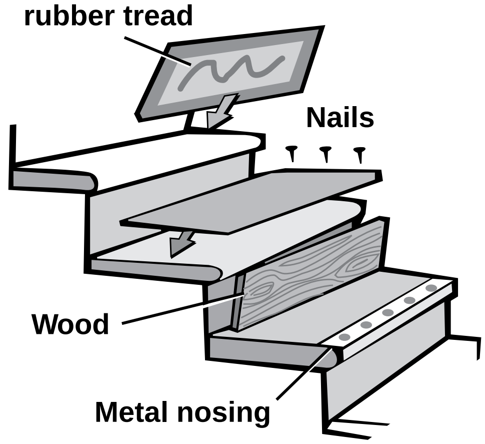
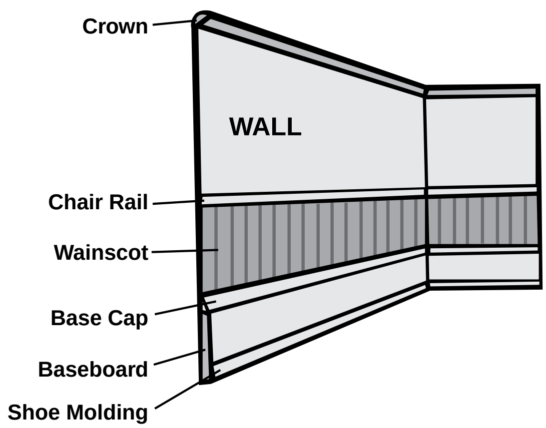


Figure 11.12 Shoe Molding Is an Acceptable Impact Surface Treatment for Baseboards.



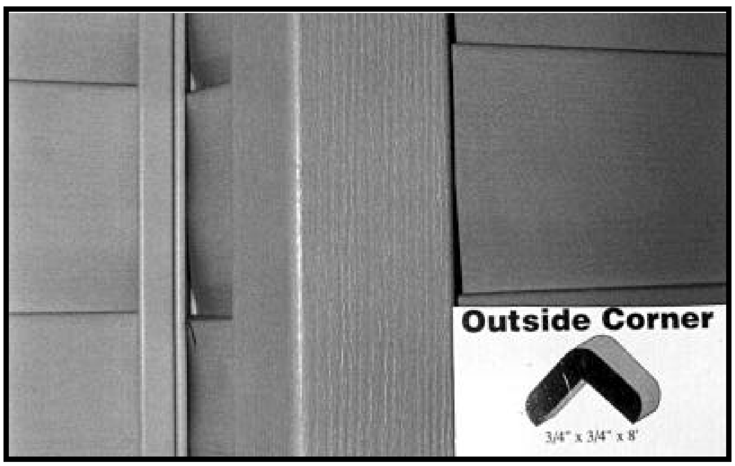


Figure 11.13 Corner Bead Coverings Can Be Used on Outside Corners of Walls.

equipment. If funds are available, abatement of floors is strongly recommended, usually through enclosure with new flooring or covering.

C. Lead Hazard Control Measures Performed by Residents

There are also a number of lead hazard control measures that owner-occupants or residents of rental dwellings can carry out. Owners of rental properties should provide residents with educational materials furnished by State or local agencies or lead-poisoning prevention organizations that include the following basic information:

- Children's toys should not be placed beneath windows or near surfaces subject to frequent friction or impact.
- If there is a sudden loosening of paint material through friction, impact, or any other reason, occupants should use the sticky tape method to remove loose paint described in Table 11.4.
- Porch decks, interior floors, and other horizontal surfaces should be wet mopped at least twice a month.

Table 11.4 Sticky Tape Technique for Removing Loose Paint on Impact Surfaces for Owner/ Occupants or Residents

1. Place a piece of plastic or paper beneath the area in question.
2. Press a piece of wide sticky tape firmly over the area of loose/chipping paint.
3. Wait a few seconds and then carefully remove the tape, taking the small chips of paint with it.
4. Place the tape in a plastic bag.
5. Carefully fold the piece of plastic or paper that was beneath the area and place it in the bag.
6. Seal the bag and clean the area.
7. Dispose of all waste materials in a secure manner; do not use the resident's trash cans for this purpose.

Dust Removal and Control: How To Do It

1. If the level of lead-contaminated dust exceeds the following levels, the dust should be removed. The present standards for wipe sampling are:

   - Window troughs, 800 µg/ft^2.
   - Interior window sills, 500 µg/ft^2.
   - Floors, 100 µg/ft^2.

   Bare floors and window components should also be made smooth and cleanable.

2. Correct any known or suspected lead-based paint hazards before dust removal.

3. Visually inspect other dust traps, such as radiators and floor grates. If visible dust is found, the component should be cleaned.

4. Distribute educational materials prepared by EPA or State or local government agencies to residents. These materials should warn residents that carpets, drapes, and upholstered furniture may be contaminated and should be cleaned or replaced.

5. Prepare the work area with Interior Worksite Preparation Level 1 or other proven containment method (see Chapter 8). If contaminated carpet is to be removed, the work area should be contained with Interior Worksite Preparation Level 3 or 4 (do not put down plastic sheeting on floors for carpet removal).

6. Clean all horizontal surfaces, beginning with HEPA vacuuming, followed by wet washing with a cleaning agent suitable for lead removal, such as a lead-specific cleaner or trisodium phosphate detergent. Test the cleaning solution before using to determine if it will discolor or damage surfaces to be cleaned.

7. Begin dust removal at the top rear room in the dwelling, working forward and down. Within rooms, start with the highest horizontal surface and work down. Clean windows, other dust traps, and finally the floors. When practical, clean dirty areas last within rooms to avoid spreading dust.

8. Place the HEPA vacuum on a smooth, hard surface or on a sheet of plastic during operation. Remove HEPA filters and bags offsite (not inside the dwelling) in a controlled environment.

9. During wet cleaning, replace rags, sponges, and mops frequently (at least once per dwelling). Use a two-bucket system for floors: one for the cleaning solution and the other for rinsing. Change the wash water at least once in each room.

10. Clean until no surface dust is visible. After cleaning rinse with clean water and a new sponge or cloth.

11. The owners of carpets and upholstered furnishings are responsible for their care. Recommend to the owners that highly contaminated or badly worn items should be discarded. To discard a carpet, mist the surface with water; seal in plastic sheeting, bags, or containers; and discard properly.

12. To clean area rugs, HEPA vacuum the top side with a beater bar or agitator attachment at a rate of 1 minute for each 10-square-foot area. Fold the rug in half and HEPA vacuum the backing of half the carpet without using the beater bar at a rate of 1 minute per 10 square feet. HEPA vacuum the exposed floor beneath the carpet, the bottom of the carpet, and the pad (if there is one), and fold the rug back into its original position. Repeat the process for the other half of the rug. Finally, HEPA vacuum the top side again with the beater bar at a rate of at least 2 minutes per 10 square feet. To summarize:

    - Vacuum the top side for 1 minute per 10 square feet.
    - Vacuum the bottom for 1 minute per 10 square feet.
    - Vacuum the top again for a final 2 minutes per 10 square feet.

    This is a total of 4 minutes for every 10 square feet of carpeting. Also vacuum the bare floor under the carpet.

13. For wall-to-wall carpeting that cannot be folded over, HEPA vacuum at a rate no faster than 2 minutes per 10 square feet in a side-to-side direction, followed by another pass at the same rate in a direction perpendicular to the direction of the first vacuuming, for a total of 4 minutes per 10 square feet. For wall-to-wall carpeting, it is not feasible to clean the floor underneath the carpeting.

14. To attain an even higher level of cleanliness, steam clean the carpet using a regular commercial cleaning system after performing the HEPA vacuuming in step 12 or 13.

15. Conduct clearance dust wipe sampling on rugs or furnishings that were cleaned to determine if the cleaning was effective.

16. To clean other upholstered furnishings, HEPA vacuum each surface three to five times. Steam cleaning is not recommended because it may damage the fabric.

17. Clean drop ceilings or the ductwork for forced air systems only when they are expected to be disturbed. HEPA vacuum and wet clean air vents or registers. Replace air filters in the forced air systems at the time of cleaning.

18. Have a certified inspector technician or risk assessor conduct a clearance examination (see Chapter 15). Repeat cleaning, if necessary. Conduct periodic reevaluations as explained in Chapter 6.

Section IV

IV. Dust Removal and Control

A. Introduction

Dust removal is a type of interim control that involves an initial treatment followed by recleaning as needed. This section provides information on when the removal of leaded dust (alone) is an appropriate interim control and how to accomplish it. Some dust removal will *always* be an element of interim control measures, either as a stand-alone treatment or as part of cleanup following other work.

1. Sources and Locations of Leaded Dust

Lead in settled house dust is a major source of lead exposure in young children. Leaded dust can come from deteriorating lead-based paint on interior and exterior surfaces, abrasion of lead-based paint on friction and impact surfaces, and the disturbance of lead-based paint during maintenance, renovation, or remodeling activities. Leaded dust can also originate from exterior soil or dust. Sources of lead-contaminated soil include weathering or scraping of exterior lead-based paint, past use of lead additives in gasoline, industrial point sources, and demolition and paint removal from buildings and steel structures. Lead-contaminated soil and exterior dust can be tracked inside by humans and pets or carried indoors by wind. Leaded dust can be produced by activities related to hobbies and can be carried home on the clothing of workers exposed to lead. Table 11.5 provides a summary of potential sources of lead in settled house dust.

Leaded dust can be found on surfaces and in crevices throughout a dwelling. Certain surfaces can act as major reservoirs of lead-contaminated dust, including windows, worn floors, carpets, and upholstered furnishings (see Table 11.6). Cleaning carpets, upholstered items, and worn floor surfaces can be difficult due to embedded dust and dirt. Furthermore, lead-contaminated dust can rapidly reaccumulate on household surfaces following dust removal (Charney, 1983).

Lead-contaminated dust in carpets and rugs, window coverings (drapes and curtains), mats, and upholstered furnishings is a hazard whether those items are supplied by the owner of the dwelling or by residents. Owners of rental units are responsible for cleaning such items or removing and replacing them only if they belong to the owners. However, the owner should provide residents with educational material furnished by a government agency or a qualified lead-poisoning prevention organization. Such material should include a warning that carpets and rugs, window coverings, mats, and upholstered furnishings may contain dangerous levels of leaded dust and that those items should be thoroughly cleaned or (preferably) removed and replaced if they are hazardous.

2. Removing Leaded Dust From a Dwelling

Both large, visible particles and small particles not visible to the naked eye need to be removed (see Figure 11.14 a and b). Leaded dust can be difficult to remove with ordinary housecleaning measures such as non-HEPA vacuuming, particularly in poorly maintained housing with rough and deteriorated surfaces (Charney, 1983; Farfel and Chisolm, 1987a). A HEPA vacuum is equipped with a special filter that removes nearly all small lead particles from the vacuum's exhaust airstream that would otherwise be redistributed throughout the dwelling.

A combination of HEPA vacuuming and wet cleaning is recommended for leaded dust removal. Wet cleaning is conducted with a solution such as a lead-specific cleaner or trisodium phosphate detergent. Even with special equipment and procedures, leaded dust can be difficult to remove from dust traps, carpets, nonsmooth surfaces, and surfaces abated by paint removal methods such as caustic chemicals (Ewers, 1993; Farfel and Chisolm, 1991; Farfel and Chisolm, 1987b).

Table 11.5 Potential Sources of Lead-Contaminated House Dust

Source	Process That Contributes to Lead in House Dust	Key Sites
Interior lead-based paint	Deteriorating paint.	All surfaces.
	Friction/abrasion.	Windows, doors, stairs, and floors.
	Impact.	Door systems, openings, baseboards, corner edges, chair rails, and stair risers.
	Water damage.	Walls, trim, and ceilings.
	Planned disturbances: (maintenance activities, repainting, remodeling, abatement).	All surfaces coated with lead-based paint.
Exterior lead-based paint	Tracking (by humans and pets) and blowing of leaded dust from weathered, chalked, or deteriorated exterior lead-based paint; also direct contact with such paint.	All exterior lead-based painted components, including porches and window sills.
	Demolition and other disturbances of lead-based paint on buildings and nearby steel structures.	Exposed soil, sandboxes, side walks, and window troughs.
Soil and exterior dust	Tracking (by humans and pets) and blowing of exterior soil/dirt contaminated with lead from deteriorating exterior lead-based paint; past deposition of lead in gasoline.	Exposed soil, sandboxes, side walks, streets, and window troughs.
Point sources	Releases from lead-related industries (i.e., smelters, battery recycling, incinerators).	Location of point sources.
Hobby activities	Cutting, molding, and melting of lead for bullets, fishing sinkers, toys, and joining stained glass. Use of lead-containing glazes and paints. Restoration of lead-based painted items.	Rooms in which hobbies are pursued.
Occupational sources	Transport of lead-contaminated dust from the job to home on clothing, tools, hair, and vehicles.	Vehicles and laundry rooms, changing areas, furniture, and entryway rugs.

Workers and residents removing leaded dust should not spread lead from one household surface to another (cross-contamination). Avoiding cross-contamination requires special knowledge, equipment, procedures, and precautions to protect residents, workers, and the environment. Enhanced routine cleaning procedures and practices as described in this chapter are recommended for use by property owners over ordinary cleaning practices and procedures. This is not to imply that routine housecleaning is totally ineffective. However, in certain cases,

Table 11.6 Major Dust Reservoirs and Potential Dust Traps

Interior	Exterior
Window sills Floors/steps Cracks and crevices Carpets and rugs Mats Upholstered furnishings Window coverings Radiators Grates and registers Heating, ventilation, air conditioning filters	Porch systems Window troughs Steps Exposed soil Sandboxes

routine housecleaning may need to be augmented by the special procedures detailed in this chapter.

The cleaning protocol contained in this chapter is different from that used following lead-based paint abatement and other interim control work. Postabatement cleaning is described in Chapter 14. The main differences are as follows:

- Only horizontal surfaces (and these vertical surfaces undergoing paint film stabilization, as explained in Section II of this chapter) are cleaned for dust removal; for cleanup following abatement, *all* surfaces are cleaned.

- A single pass with a HEPA vacuum and wet wash is used for dust removal; for cleanup following abatement, the cycle is HEPA vacuum, wet wash, HEPA vacuum again.

3. Creating Cleanable Surfaces and Determining Whether Dust Removal Alone Is Adequate

A risk assessment is recommended to determine whether the removal of leaded dust alone is an appropriate interim control, or whether other interim controls are needed in addition to dust removal. If no environmental testing or risk assessment has been performed, the property owner should assume that lead-based paint is present on all painted surfaces and that all horizontal surfaces have excessive dust lead levels.

The rest of this section will describe how risk assessors and owners should check floors and floor coverings to plan for dust removal activities.

- **Check condition of floors.** Smooth and intact floor surfaces, such as vinyl or linoleum sheet goods that still have a smooth finish and wooden floors that have a good finish of sealant (e.g., polyurethane or deck paint) can be effectively cleaned. If a floor surface is not smooth or intact, it will require the application of an appropriate sealer or covering and/or repair in order to make it smooth and cleanable. Examples of nonsmooth floor surfaces include floors with worn areas or tears; wood floors with gaps, cracks, splinters, and areas with no sealant coating; unsealed concrete floors; and replacement flooring with no finish treatment (e.g., plywood).

- **Check carpets, rugs, entryways, and mats.** Items such as area rugs or mats should be machine washed. Wall-to-wall carpets and large area rugs in fair to good condition can be cleaned, removed, and discarded or replaced (see section on carpets/rugs below). Consideration should be given to discarding rugs, carpets, and mats that are at the end of their useful lives, since cleaning may not be effective (see below for precautions on removal of carpets) (Ewers, 1993; IDHW, 1991).

Figure 11.14a Turning a Window Sill and Trough Into a Smooth and Cleanable Surface (before treatment).

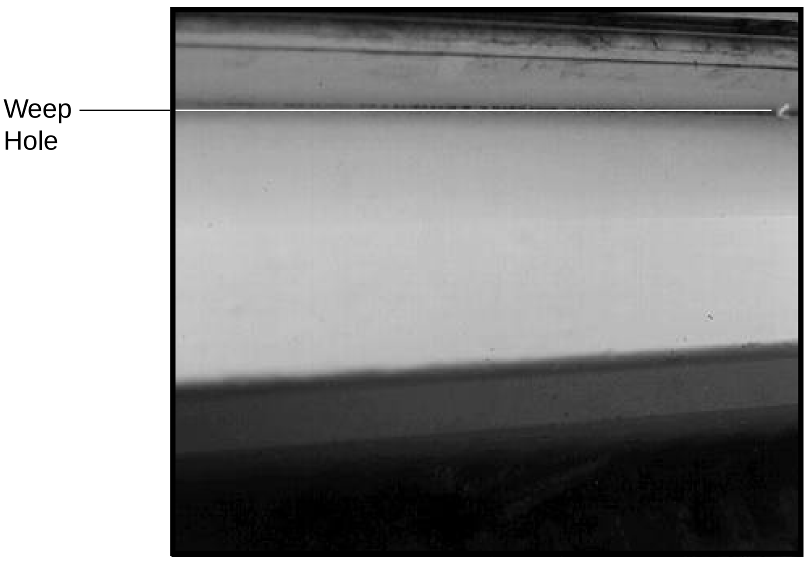


Figure 11.14b Turning an Exterior Window Sill Into a Smooth and Cleanable Surface (after treatment).

Notice Weep Holes Are Left Open to Allow Proper Drainage and Ventilation.

- Check for other potential dust traps. In addition to carpets, rugs, and mats, potential dust traps include radiators, floor grates and registers, drapes, blinds, and upholstered furnishings. These items should be included in the plan for dust removal. In rental properties some of these items may not belong to the building owner. Owners are responsible for the items they own, while residents are responsible for their own property. However, it may be in everyone's best interests to include all of these items in the dust removal plan.

4. Planning and Preparations

Once it has been determined that dust removal is an appropriate approach, the owner should determine if the dwelling unit will be occupied or vacant while the dust removal is occurring. Dust removal work may be performed by contractors, maintenance staff, or homeowners. Individuals performing the work should be properly equipped and trained in dust removal.

If dwelling units are occupied, the owner should coordinate with residents to ensure that the roles of all involved in the process are clear. The job should be organized so that dust removal work is performed in 1 day to minimize inconvenience to residents. An Interior Worksite Preparation Level 1 is almost always appropriate (see Chapter 8). Additional personnel and equipment may be required to perform simultaneous work in multiple rooms.

Role of residents. Owners should provide residents with educational materials prepared by public agencies that indicate how residents can help in removing leaded dust. The materials should indicate that residents perform the following tasks before the professional dust removal occurs:

- Wet wash all cleanable toys.
- Store all loose personal belongings in boxes, closets, or drawers to provide easy access to floors and other surfaces during dust removal.

- Remove drapes and curtains and collect any washable area rugs for cleaning. Clean or arrange for cleaning of these items and store them in sealed plastic bags. Wash blankets known to have been unprotected during renovation or remodeling activity that disturbed lead-based paint.
- Wash or dust unupholstered furniture using disposable cloths and spray polish.
- Change filters in heating and air conditioning units, except where routinely performed by the property manager.

5. Responsibilities of Owners

Owners should perform the following tasks prior to dust removal:

- Attempt to schedule dust removal when the dwelling is vacant (such as during unit turnover).
- If the unit will be occupied, notify residents of the date dust removal will occur.
- Provide a written notice/flyer from the local health agency with information on resident responsibilities for preparation and cleaning.
- Provide for the safety of occupants.
- Arrange for dust removal of wood or metal components of windows, built-in shelving, radiators, floors, porches, owner-supplied carpets and rugs, window coverings, mats, upholstered furnishings, and other dust traps.
- Provide and install cleanable "walk-off" mats at interior entryways. This will help residents control exterior leaded dust that may be tracked into the home (Roberts, 1991).
- Ensure that dust removal contractors comply with contract specifications. Large multiunit contracts may require an onsite monitor.
- Obtain written authorization from residents for dust removal where legal authority does not exist for such activity.
- Arrange for clearance examination.

6. Responsibilities of Contractors

Contractors or maintenance staff should perform the following tasks prior to and during dust removal (City of Toronto, 1990):

- Coordinate with residents and owners or managers of property.
- Cooperate with any independent, onsite inspector or risk assessor or project monitor who may be present on large, multiunit dust removal projects.
- Perform work according to contract/work specifications.

In the case where the owner's maintenance staff are performing the work, the owner is responsible for the following (otherwise the contractor is responsible):

- Ensuring that workers are properly trained and protected (see Chapter 9).
- Providing all safety and special cleaning equipment and supplies.
- Taking precautions to minimize damage to residents' belongings.
- Moving major furnishings within rooms to facilitate thorough cleaning.
- Responding to residents' questions, complaints, and concerns.

B. Methods of Dust Removal

The objective of any dust removal strategy is to provide a dwelling unit or common area in which the leaded dust levels on all horizontal surfaces are less than the clearance levels. Any cleaning method carried out by a property owner is satisfactory if it meets this performance standard and if workers and occupants are fully protected. The procedures in the following pages describe how best to meet that performance standard.

The dust removal strategy presented in this section focuses effort on horizontal surfaces and dust traps that can have accumulations of surface dust and embedded dust. Embedded dust is dust that is trapped within a fiber matrix (such as carpeting), in cracks and crevices (of wooden floors), under carpets, on greasy surfaces, or ground into surfaces. A combination of vacuuming with a HEPA vacuum and wet cleaning is recommended to remove both surface and embedded leaded dust from household surfaces. For upholstered furnishings HEPA vacuuming alone is recommended.

1. Cleaning Hard Surfaces

The standard dust removal procedure for hard surfaces and components (e.g., hardwood floors and window components) is HEPA vacuuming followed by wet cleaning with trisodium phosphate (Milar and Mushak, 1982), or a cleaner designed specifically for lead removal or an equally effective cleaner. One study found that HEPA vacuuming hard surfaces at a rate slower than 1 minute per square meter (approximately 10 square feet) did not remove substantially more leaded dust from hard surfaces than faster methods (Ewers, 1993).Therefore, no speed or time restrictions are necessary for hard surfaces (although such restrictions *are* appropriate for carpeted surfaces, as detailed below).

On hard surfaces HEPA vacuums should be passed over the entire surface with overlapping strokes using normal speed. Trisodium phosphate has been shown to aid in the removal of lead in dust. There is also strong anecdotal evidence that a lead-specific, strippable coating (Grawe, 1993) and a lead-specific detergent (Wilson, 1993) are at least as effective as trisodium phosphate in removing lead. These new products may in fact be more effective than trisodium phosphate, which is now banned in some areas. Any cleaning product may be used, as long as the cleaner's performance is evaluated by determining compliance with clearance criteria and lead-specific cleaning agents. Trisodium phosphate is most likely to permit easy compliance with clearance criteria, avoiding the need for repeated cleaning. Whenever a wet cleaner is used, a small area of the surface should be tested to make sure that it does not damage the surface or its coloring. If so, another wet cleaner should be used.

General work practices

- Clean from top to bottom and vacuum before wet cleaning. On multistory dwellings, start at the top level in the rear room and work in one direction toward the front (see Figure 11.15). Then repeat the process on the remaining floors in sequence. Within a room start with the highest horizontal surfaces and work down. This would typically result in the following cleaning sequence: tops of window heads, tops of sashes, mullions, and interior and exterior window sills and troughs. Clean dust traps such as radiators, followed by baseboards, and finally floors, vents/registers, and horizontal components of the ventilation ducts that can be easily reached. When practical, work from clean areas to dirty areas to minimize the spread of leaded dust to clean areas. It is usually not necessary to clean walls and ceilings for dust removal unless those surfaces have undergone paint removal or stabilization.

- When vacuuming, use crevice and brush tools where appropriate.

- If possible, place the vacuum unit on a smooth, hard surface that has been cleaned or on a clean sheet of 6-mil plastic rather than on a carpet. Vacuum exhaust, even on HEPA vacuums, can disperse dust when the exhaust airstream disturbs settled dust on a surface. A HEPA vacuum that exhausts air from the top or side rather than the bottom helps to minimize dust dispersal, making it unnecessary to use a sheet of plastic.

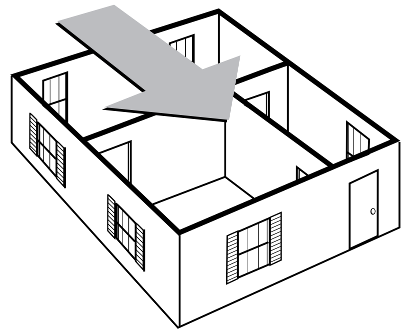
- Use disposable cleaning cloths or sponges. Be prepared to dispose of them during the cleaning process and replace with new ones.

Figure 11.15 Sequence for Dust Removal.

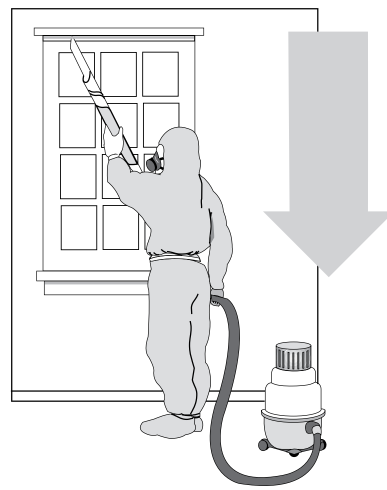
How to use a HEPA vacuum

1. Lightly mist area with water to keep dust levels down.
2. HEPA vacuum all horizontal surfaces.

Start at the end farthest from the main entrance/exit. As you vacuum, move towards the main exit and finish there.



Begin at the top of each room and work down. For example, start with the top shelves, the top of the woodwork, and so on, and work down to the floor. Do every inch of the windows, especially the window troughs.



- When cleaning household surfaces other than floors, the cleaning solution may be mixed in a plastic jug and poured directly onto sponges or cloths (EPA, 1992a). This procedure is designed to minimize the contamination of the cleaning solution with leaded dust. Frequently rinse the sponge/cloth in a bucket of clean water.

- For floors a two-bucket system is strongly recommended to minimize the potential for spreading leaded dust from one location to another. The cleaning solution should be mixed in one bucket; a second bucket should contain rinse water for the mophead. Frequently, at least once per room, change the rinse water in the bucket. A disposable sponge mophead with a built-in wringer (rather than a string mop) is recommended. A final cosmetic rinse is recommended using clean water or a commercial cleaning solution.

- Clean until surface dust is no longer visible. After cleaning a window or a floor, rinse with clean water using a new sponge or cloth.

- To make a cleaning solution with trisodium phosphate or other suitable detergent, mix with water according to the manufacturer's instructions for recommended concentrations. When using the cleaner (especially trisodium phosphate), wear gloves and eye protection gear and follow all manufacturer's instructions and precautions. OSHA regulations require an onsite eyewash station when using trisodium phosphate (29 CFR 1910.151). Also, concentrated trisodium phosphate solutions can damage and discolor some surfaces.

- Where possible, clean floors underneath rugs and carpets.
- For dust removal projects in multifamily housing, a truck-mounted vacuum unit with a HEPA filter exhaust may be preferable since the exhaust stream is located outside the dwelling and therefore is not likely to disturb dust inside the dwelling.
- Remove and dispose of HEPA vacuum cleaner bags and filters offsite, according to the manufacturer's instructions, in a controlled environment capable of capturing any dust released by the procedure. If the filters need to be changed in the middle of the job, take the vacuum unit outside the house, place it on a sheet of plastic, and remove the old filter carefully. Do not change filters inside the dwelling if possible (see Figure 11.16 a–f).

2. Removal or Cleaning of Carpets or Rugs

Carpeting and large area rugs can be major traps and reservoirs of leaded dust. Dirt embedded in fibers of carpets and rugs is not easily removed by cleaning. The procedures described in this section have been shown to reduce lead levels to a limited degree. Highly effective lead removal methods have yet to be identified (Ewers, 1993; IDHW, 1991). It is not likely that any cleaning process will remove all leaded dust embedded in carpets.

The first step in carpet dust removal is to decide if the carpet is going to be cleaned onsite, removed for disposal, or removed for professional offsite cleaning. It may be preferable to dispose of carpets that are in poor condition or those known to be highly contaminated with lead. In fact it may be more costly to clean a lead-contaminated carpet or rug than to replace it. When carpets are removed, the precautions described below should be followed to minimize the exposure of workers and residents to leaded dust.

Removal of carpets or rugs. When a carpet or rug is going to be removed from a dwelling for either disposal or offsite cleaning, the following procedure is recommended:

Mist the entire surface of the carpet to keep dust from spreading. Carefully roll up the carpet along with any padding. (If the padding is not going to be removed, clean it like an area rug.) Wrap the carpet in a sheet of plastic, seal it with tape, and remove it from the dwelling.

Because the removal of a carpet may generate significant amounts of airborne lead-contaminated dust, Interior Worksite Preparation Level 3 or 4 is recommended. If the area in which the carpet is located is not fully contained, HEPA vacuum the floor after removing the carpet so leaded dust is not tracked to other parts of the dwelling.

Cleaning area rugs. If cleaning of large area rugs is done onsite, the following steps are recommended:

- First, vacuum the pile side (the top side) with a HEPA vacuum equipped with a beater bar or agitator attachment on the vacuum head at a rate no faster than 1 minute for every 10 square feet. The purpose of the beater bar is to dislodge embedded dust (CMHC, 1992; Ewers, 1993; IDHW, 1991).
- Fold the rug in half, exposing the backing of half of the carpet. The backing of the carpet should be HEPA vacuumed without using the beater bar attachment (City of Toronto, 1990) at a rate of 1 minute per 10 square feet.
- Vacuum the exposed floor beneath the rug at normal speed and unfold the rug.

- Fold the rug in half again, exposing the backing of the other half of the carpet, and repeat the HEPA vacuuming of the bottom of the rug and the floor underneath.
- Unfold the rug.
- HEPA vacuum the pile side of the rug again using the beater bar attachment. Vacuum at a rate no faster than 2 minutes per 10 square feet.

Consideration should be given to a final cleaning step consisting of a steam cleaning of the pile side of the rug. Steam cleaning can remove additional, but limited, amounts of lead from rugs (IDHW, 1991). This cleaning can be done by the contractor, owner, or resident using commercially available equipment. For multiunit buildings consideration should be given to the use of truck-mounted cleaning equipment since it may be significantly more powerful than typical rental equipment for residential use.

Phosphate-containing detergents may be more effective than nonphosphate-containing, regular detergents when cleaning rugs (Milar and Mushak, 1982), although the new lead-specific cleaners have not yet been evaluated for carpets. If using a commercial cleaning detergent that does not contain phosphate or a lead-specific removal agent, consideration should be given to substituting a mild trisodium phosphate or lead-specific solution (less than half the recommended strength). It may be necessary to clean a small, inconspicuous area first to determine if the material is colorfast. In all cases a second cleaning with the regular commercial cleaner is recommended. New cleaners advertised as lead-specific can also be used since preliminary evidence indicates that they are successful (Grawe, 1993; Wilson, 1993).

Cleaning wall-to-wall carpeting. For cleaning wall-to-wall carpeting, the following procedure is recommended:

Vacuum carpeting with a HEPA vacuum equipped with a beater bar or agitator attachment on the vacuum head. The beater bar helps

Figure 11.16a Remove the HEPA Vacuum Filters and Disassemble the Vacuum With a Plastic Sheet Underneath.

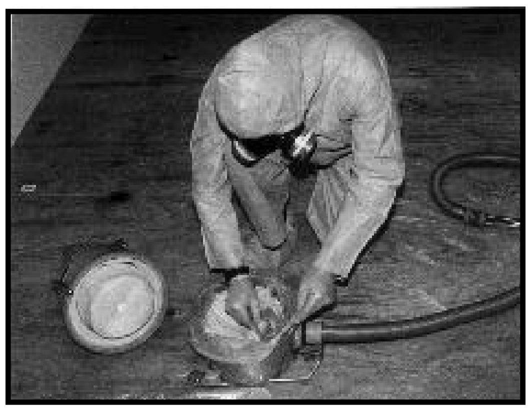


Figure 11.16b Disconnect Vacuum Bag From Hose Inlet.

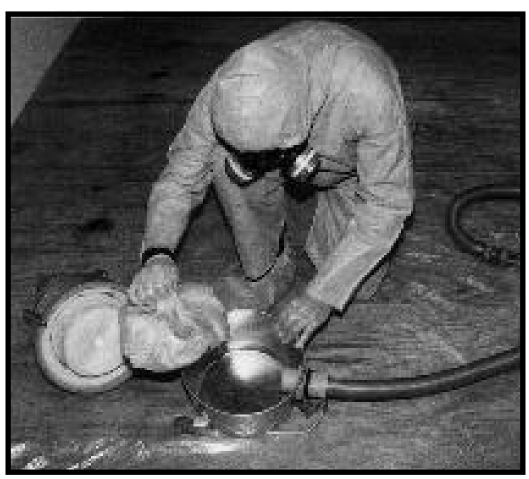


Figure 11.16c Remove Bag.

Figure 11.16d Tape Vacuum Bag Closed and Put Inside Plastic Trash Bag.

Figure 11.16e Wash or Replace Coarse Prefilters if Necessary.

Figure 11.16f Remove and Replace HEPA Filter Assembly.

to dislodge embedded dust. The total vacuuming time recommended is at least 4 minutes per 10 square feet of carpeting (Ewers *et al.*, 1993), divided into two segments of at least 2 minutes for each 10 square feet. The two vacuuming segments are performed in perpendicular directions. For example, the first segment may be done in an east-west direction, while the second is done in a north-south direction.

The provisions regarding steam cleaning and suitable detergents for area rugs also apply to wall-to-wall carpeting.

3. Cleaning Upholstered Furniture

The first step in dealing with upholstered furnishings is to determine if the item is going to be discarded or cleaned. It may be preferable to dispose of items that are in poor condition or known to be highly contaminated with lead.

The recommended dust removal procedure for upholstered furniture is HEPA vacuuming without steam cleaning or other wet cleaning procedures that could damage fabrics. Cloth throw covers, slipcovers, or fitted vinyl covers should be provided for all cleaned, upholstered items. This is particularly important for items at the end of their useful lives that would not hold up well under an aggressive vacuuming. A cloth cover material that can be easily removed and washed should be selected.

Upholstery surfaces should be HEPA vacuumed with three to five passes over each surface at a total rate of 2 minutes per 10 square feet.

4. Forced Air Systems and Drop Ceilings

This section provides a practical approach to dealing with these potential dust reservoirs. At the present time, it is not known whether leaded dust in forced air ducts and drop ceilings is a hazard to residents. Although one study has measured leaded dust in air ducts (city of Toronto, 1990), the results do not provide evidence that the lead is leaking out of the ducts and posing a hazard to children. If the ceilings or forced air systems contain leaded dust, they may present a hazard to maintenance or renovation workers who access them.

Where possible, return and supply air vent registers that can be easily removed should be taken out, vacuumed, and wet cleaned (see Figure 11.17). If the vent registers are sealed to the wall or floor with paint, the edges should be misted and scored to help free the vent register with a minimum of leaded-dust generation.

Air vent registers that cannot be easily removed should be vacuumed and wet cleaned in place. The horizontal surfaces in the ductwork that can be easily reached with the vacuum attachment can be cleaned. Water should not be poured down the air duct to clean the vent register; wiping with a damp sponge or mop is adequate.

Replace the air filters on heating units and air conditioners with new filters at the time of dust removal. Used filters should be placed in plastic bags and sealed prior to disposal to minimize the potential spread of leaded dust.

Leaded dust in nonforced air systems and drop ceilings is not considered a hazard to residents unless major disturbances of the ducts or ceilings are planned, such as repairs or relocations of ducts. When major disturbances of any type of duct or ceiling work are anticipated, cleaning will probably be warranted. This includes instances when forced air systems have the direction of airflow reversed during maintenance.

5. Resident Protection

To facilitate dust removal work and provide protection for occupants, only workers should be in the work area during the dust removal process. This will also help ensure that work can be completed in 1 day. The work area is defined as the room in which dust removal is occurring or where preparations are being made for dust removal. Interior Worksite Preparation Level 1 is usually adequate for dust removal unless lead-contaminated carpets or area rugs are being removed.

C. Followup to Dust Removal

Inspectors or risk assessors performing clearance examinations should check to see that all visible dust and dirt have been removed from the

Figure 11.17 Clean Air Vents Registers.

a. Vacuum and Remove Register Covers.

b. Vacuum Accessible Parts of Duct Opening.

c. Wet Wash Register Covers and Replace.

Table 11.7 Carpet Cleaning Steps

Step	Description	Time/10 ft^2
1	HEPA vacuum with beater bar at a rate no faster than 1 minute for every 10 square feet.	1 minute
2	Fold rug in half and HEPA vacuum bottom of rug without beater bar at a rate no faster than 1 minute per 10 square feet.	1 minute
3	HEPA vacuum bare floor and any padding (no rate restriction or beater bar).	Approximately 10–30 seconds
4	Fold other half of rug over and repeat steps 2 and 3 (no rate restriction and no beater bar).	Approximately 10–30 seconds
5	Fold rug back over so it is in its original position.	Approximately 10–30 seconds
6	HEPA vacuum top side of rug a final time with the beater bar. The rate is no faster than 2 minutes per 10 square feet.	2 minutes
	Total Time	**4.5–5.5 minutes**

Figure 11.18 Walk-Off Mats.

dwelling, followed by dust sampling. (See Chapter 15 for information on clearance.) The clearance test results will provide a means of checking that lead levels have been reduced by the dust removal work and will serve as a baseline for comparison to future test results.

Since it has been shown that lead-contaminated dust can reaccumulate on household surfaces following lead-based paint abatement and dust removal alone (Charney *et al*., 1983; Farfel and Chisolm, 1987b; Jacobs, 1992; Clark, 1993), ongoing monitoring and professional reevaluation of the dwelling, resident education, and continued cleaning are important elements of a dust removal plan.

Educational materials prepared by State or local government agencies or lead-poisoning prevention organizations should explain the need for periodic wet cleaning of household surfaces, with particular attention to dust traps and reservoirs, and the importance of promptly informing property owners or managers of needed repairs. Those materials should include instructions for proper replacement and disposal of air conditioning and heating unit filters. Some owners and municipalities provide cleaning kits to residents to encourage and support their ongoing dust removal efforts. (See Chapter 2 and Section I of this chapter for information on resident education.)

In addition, easily cleaned walk-off mats should be placed at entryways to control the tracking of leaded dust into the dwelling (see Figure 11.18).

Soil Interim Control: How To Do It

1. Determine if lead contamination exists by taking samples of bare soil. The soil should be considered contaminated if lead levels exceed 2,000 µg/g (pending an Environmental Protection Agency standard) in the yard or the building perimeter, or 400 µg/g in high-contact play areas. If bare soil levels are high (greater than 5,000 µg/g), interim controls are not appropriate. At least a total of 9 square feet of contaminated bare soil must exist in each yard or building perimeter for a hazard to be identified.
2. Use water to contain dust and clean equipment to prevent dispersion of lead.
3. Select an appropriate soil interim control, which may include impermanent surface coverings or land use controls.
4. Impermanent surface coverings, including grass (as seed or sod), other ground covers (e.g., ivy), artificial turf, bark, mulch, and gravel, may not be permanent. If the area to be controlled is heavily traveled, surface coverings such as grass are not appropriate.
5. If grass is selected, consult with the local agriculture extension service or a reputable local nursery to determine what grasses are appropriate for the locale, soil type, and sun/shade characteristics. Properly prepare the soil prior to seeding or sodding.
6. If bark or gravel is selected, apply the covering at least 6 to 12 inches deep. New bark, gravel, or other materials should not contain more than 200 µg/g of lead. These materials should be tested before use unless previous testing data are available.
7. If the soil is in a public recreation area, comply with Consumer Product Safety Commission standards on acceptable surface coverings in play areas.
8. Land use controls include fencing, warning signs, creation of alternative play areas (such as decking), and thorny bushes.
9. Install surface coverings and/or land use controls. For live ground covers (including grass), it is imperative that they are properly watered during the first 3 months and adequately maintained thereafter. Automatic sprinkler systems are appropriate for large properties.
10. Control water erosion by proper grading and installation of drainage channels (drainage channels may need to be fenced if they are accessible).
11. Control wind erosion by periodic watering, windbreaks, or foot-traffic controls.
12. Provide walk-off doormats at all entryways to reduce the tracking of contaminated dust and soil into the dwelling.
13. Have a certified risk assessor or inspector technician conduct a clearance examination and provide the necessary documentation.

14. Perform ongoing maintenance and monitoring of soil coverings and land use controls. Reevaluations of the surfaces should be conducted by a certified risk assessor or inspector technician based on the specific reevaluation schedule for that property.

15. If ongoing monitoring or reevaluations show that bare soil remains or reappears, interim controls are not effective. Soil abatement should be conducted (see Chapter 12), unless other interim controls can be shown to be feasible for the specific site.

Section V

V. Soil Interim Controls

A. Temporary and Permanent Soil Treatments

Interim control measures for lead-contaminated soil include surface coverings with grass, gravel, or similar materials, or land use controls, such as fences, thorny bushes, or decks, for preventing contact with the contaminated soil. These interim controls are designed to temporarily reduce exposure. How long they remain effective depends on many factors, including the durability and maintenance of the cover, degree of foot traffic, and climate.

Permanent soil abatement measures are covered in Chapter 12, Section V. If the control measure includes a permanent cover, such as asphalt or concrete, the method is classified as an abatement, whereas a temporary cover would constitute an interim control measure. If the soil contains very high amounts of lead (greater than 5,000 µg/g), permanent abatement strategies should be used.

B. Types of Interim Control Measures for Soil

Four categories of measures may be used as part of an interim control plan for soil. These are:

- Measures that alter the contaminated soil.
- Measures that alter the surface cover.
- Land use controls.
- Measures to reduce offsite transport of the contaminated soil.

Each of these activities should be carried out in a manner that prevents further dispersion of the contamination and prevents the area undergoing the interim control treatment from being contaminated in the process. Work practices for soil interim controls are similar to those for soil abatement and are described more fully in Chapter 12, SectionV.

1. Altering Contaminated Soil

Interim controls usually involve only minimal alterations to the soil. The installation of grass or other plantings, for example, will often involve surface cultivation or addition of a thin layer of new soil (no more than 3 inches) in order for the ground cover to become established.

2. Soil Surface Cover

A second interim control method involves adding a surface covering that will act as a barrier between the bare, lead-contaminated soil and people and pets. Various types of surface coverings may be considered, including:

- Grass (either through seeding or planting of sod).
- Other live ground covers (e.g., juniper shrubs, ivies).
- Artificial turf.
- Bark.
- Gravel.

The choice of a covering for a particular area depends on the climate, expected use, planned maintenance, and aesthetic preferences. For aesthetic as well as practical reasons, a property owner may choose to improve the surface cover over an entire soil area even though only a portion is bare.

The success of grass and other live ground covers is dependent on proper planting, regular maintenance, and most importantly, the ability to control the use of the area. In high-traffic areas use of grass as an interim control is unlikely to succeed. Other surface coverings such as artificial turf may be more appropriate. Where access to an area can be controlled, or where use is expected to be limited, grass and other live ground covers can be successful interim controls. Some ground covers, such as juniper bushes, can also effectively limit traffic through an area.

Table 11.8 Grasses and Their Appropriate Applications

Grasses That Grow From Seeds	Texture	Climate	Durability
Bahia grass	Coarse	Warm	Excellent
Colonial Bent grass	Fine	Cool	—
Creeping Bent grass	Fine	Cool	—
Common Bermuda grass	Medium to Fine	Warm	Excellent
Kentucky Bluegrass	Fine	Cool	—
Rough-Stalk Bluegrass	Fine1	Cool	Poor
Centipede grass	Medium to Fine	Warm	—
Dichondra	Coarse	Warm	—
Chewings Fescue	Fine	Cool	Poor
Creeping Red Fescue	Fine	Cool	Poor
Hard Fescue	Fine	Cool	—
Tall Fescue	Coarse	Cool	Moderate to Excellent
Annual Ryegrass	Coarse	Cool	—
Perennial Ryegrass	Fine	Cool	Excellent
Grasses That Grow From Sod			
Bahia grass	Coarse	Warm	Excellent
Hybrid Bermuda grass	Fine	Warm	Excellent
Kentucky Bluegrass	Fine	Cool	—
Centipede grass	Medium to Fine	Warm	Poor
Dichondra	Coarse	Warm	—
Tall Fescue	Coarse	Cool	—
Seashore Paspalum	Medium	Warm	—
Perennial Ryegrass	Fine	Cool	Excellent
St. Augustine grass	Coarse	Warm	—
Zoysia grass	Fine	Warm	Excellent

Before using grass or live ground covers as an interim control measure, a property owner should consult with a lawn care professional about soil preparation, appropriate grasses and plants to use, and future maintenance requirements. The county cooperative extension service or a reputable local nursery may be contacted for advice on types of grass to be used in specific geographic areas and for specific soil types, slope, and sunlight conditions. Table 11.8 offers a brief summary of grass types and their suggested uses. The local office of the U.S. Department of Agriculture Soil Conservation Service may also be able to provide advice about soil conditions in a specific geographic area. An owner of a large property may consider installing a sprinkler system to improve the maintenance effort. In any event some type of hose and sprinkler system should be made available.

When planting grass an owner should consider whether sod or seeding is more appropriate. Both grass seed and sod require restrictions on foot traffic until root systems and stems become established. Newly laid sod requires at least 2 weeks, while grass seed requires 1 to 2 months (Lane Publishing, 1989; Maryland Extension Service, 1993). Sod can be laid during most of the year (as long as the ground is not frozen) and requires less initial care. However, sod is more expensive than seeding and is less likely to develop the deep root systems that will allow the grass to withstand regular wear and tear. It is best to lay sod during the growing season.

At least 6 inches of bark or gravel are necessary to serve as a temporary ground covering (see Figure 11.19). There are anecdotal reports of high lead levels in replacement bark. Bark should be tested by laboratory analysis before use, unless it has been tested previously. Bark should not be used if it contains more than 200 µg/g of lead.

Figure 11.19 Bark Used as an Interim Control.

Bark or other suitable soft material should be used as surface cover for contaminated soil near play equipment. This will offer a degree of protection from injuries that may result from falling. Consumer Product and Safety Commission regulations dealing with acceptable surface coverings in play areas may apply to public areas (CPSC, 1991). Decking can also be used to reduce a child's contact with soil, although pets should be kept off the decking. Artificial turf can also be used, but may cause drainage problems if it is not permeable.

Rubber cushioning specifically designed for playgrounds can also be used to cover contaminated, bare soil in play areas.

Figure 11.20 Thorny Bushes as a Land Use Control.

3. Land Use Controls

To temporarily reduce human exposure to bare, contaminated soil, the following land use control measures may be considered:

- Fencing.
- Decks.
- Warning signs.
- Creation of alternative play areas for children.
- Removal of play equipment from bare areas.
- Educational efforts.
- Planting thorny or dense bushes (see Figure 11.20).

Preventing access to the bare, contaminated soil by fencing is most effective if other entrances and exits to the housing units can be maintained for use by residents, guests, commercial vehicles, and emergency vehicles (see Figure 11.21 a and b). Fencing may also be used to reduce exposure during a delay in the implementation of other interim control measures or soil abatement.

Educational efforts directed towards decreasing use of bare, lead-contaminated areas; avoiding eating or drinking in these areas; and frequent washing of hands may serve to reduce ingestion of the contaminated soil. The decision on whether to plant grass or erect barriers should

Figure 11.21a Fencing as a Soil Interim Control.

Figure 11.21b Fencing as an Interim Control for Bare Soil Hazards.

be site-specific and should consider the availability of alternative play areas, the location of contaminated soil with respect to entrances or exits, the likelihood that leaded dust may be tracked onto sidewalks or directly into the housing unit, the degree of supervision available, and local preferences.

4. Drainage and Dust Controls

Drainage controls may involve directing water flow away from the contaminated areas by alterations in adjacent grades and/or installation of drainage channels. Drainage channels that receive runoff from bare, contaminated soil areas may need to be fenced to reduce access. Dust generation can be reduced by periodic watering, the creation of windbreaks, or foot-traffic controls.

C. Controls to Minimize Migration of Soil Lead into Dwellings

Doormats can be used to minimize the entry of soil lead into the house. Doormats should be placed on the exterior and immediate interior of the entry doors. Mats should be cleaned by machine washing or other wet methods, not by beating or sweeping. (See Section V of this chapter for further information.)

Removing shoes at the doorway also greatly minimizes the amount of leaded soil and dust tracked into the house.

D. Monitoring and Reevaluating Soil Interim Controls

If grass or sod is planted, or if bark, gravel, or other similar covering is used, it should be monitored visually. The monitoring should occur frequently immediately after installation and can be reduced thereafter.

Chapter 12: Abatement

Abatement: How To Do It

1. Have a risk assessment or paint inspection performed by a certified risk assessor or a certified inspector technician who is independent of the abatement contractor.

2. Develop a site-specific lead hazard control plan based on the hazards identified and financing available. Select the appropriate interior and/or exterior Worksite Preparation Level (from Chapter 8).

3. Have the contractor obtain any necessary building or waste permits; notify local authorities if the local jurisdiction requires it.

4. Together with the contractor (or designer or risk assessor), select specific building component replacement items, enclosure materials, paint removal equipment and/or chemicals, tools, and cleaning supplies. Consider waste management and historic preservation implications of the selected treatment.

5. Develop specifications (usually for large projects only).

6. Schedule other construction work so that leaded surfaces are not inadvertently disturbed and unprotected workers are not placed at risk. Include time for clearance examinations and laboratory dust sample analysis in the scheduling process (see Chapters 3 and15).

7. Select a certified abatement contractor using the lowest *qualified* bidder.

8. Conduct a preconstruction conference to ensure the contractor fully understands the work involved (for large projects only).

9. Notify residents of the dwelling and adjacent dwellings of the work and the date when it will begin. Implement relocation (if appropriate).

10. Correct any existing conditions that could impede the abatement work (e.g., trash removal, structural deficiencies).

11. Post warning signs and restrict entry to authorized personnel. Implement the worksite preparation procedures.

12. For large projects only, consider conducting a pilot project to determine if the selected abatement method will actually work (pilot projects are sometimes completed before step4).

13. Collect preabatement soil samples, which may not have to be analyzed until postabatement soil samples have been collected, analyzed, and compared to clearance standards. If postabatement soil levels are below applicable limits, the preabatement samples need not be analyzed (see Chapter 15).

14. Execute abatement work. See the other sections of this chapter for Step-by-Step Summaries for building component replacement, enclosure, paint removal, and soil abatement methods. Observe local or State regulations if applicable.

15. Store all waste in a secure area and make sure it is properly labeled with an accumulation start date (see Chapter 10).

16. Conduct daily and final cleanup (see Chapter 14). Execute waste disposal procedures.

17. Have an independent, certified inspector technician or risk assessor conduct a clearance examination after waiting at least 1 hour after cleanup has been completed to let dust settle (see Chapter 15).
18. If clearance is not achieved, repeat cleaning and/or complete abatement work. Repeat clearance examination and, if clearance is achieved, obtain any required formal release or certificate of completion required by the U.S. Department of Housing and Urban Development (HUD) or local authorities.
19. Pay contractor and clearance examiner.
20. Conduct periodic monitoring and reevaluation of enclosure systems (if applicable) or lead-based paint that was not abated as indicated in Chapter6. Maintain records of all abatement, monitoring, reevaluation, and maintenance activities, and turn them over to any new owner upon sale of the property.

Chapter 12: Abatement

Section I

I. Principles of Lead-Based Paint Hazard Abatement

A. Longevity of Abatement

Abatement is the removal of either the building component or the paint itself or the near-permanent enclosure of lead-based paint hazards. From a public health perspective, properly conducted abatement is the desired response to lead hazards. Abatement has two principal advantages: it provides a long-term solution, and little (if any) monitoring or reevaluation of the treated surface is necessary since failure is less likely to occur. Abatement treatments provide a higher margin of safety than interim controls since the effectiveness of the work is less dependent on resident action, maintenance of housing stock, the conscientiousness of property managers, and the attention of maintenance workers during repair.

As used in this chapter, abatement can mean either correction of lead-based paint *hazards* (as defined in Title X) or treatment of all lead-based paint (as currently practiced in the U.S. Department of Housing and Urban Development (HUD) public and Indian housing program, where all lead-based paint is abated during rehabilitation work or when a child with an elevated blood lead level is identified). The methods explained in this chapter apply to abatement of both lead-based paint hazards *and* lead-based paint.

Interim controls, abatement, or a combination of the two are acceptable methods of addressing lead-based paint hazards. In contrast to interim controls, lead-based paint abatement refers to a group of measures that can be expected to eliminate or reduce exposures to lead hazards for at least 20 years under normal conditions. Since 20 years is the expected lifespan of many commonly used building components, abatement is the closest one can get to a "permanent" solution in housing. The abatement methods described in this chapter should be capable of lasting 20 years under typical conditions. Any methods developed in the future that also last 20 years will be acceptable as abatement methods. This orientation toward performance standards should provide owners and the abatement industry with opportunities for innovation and flexibility, ensuring that the abatement method selected is the one that is most cost-effective for a particular component.

The term "abatement" also includes a number of other activities that are not directly related to the work itself, but that must be included in the overall effort for the abatement to be successful. These activities include lead hazard evaluation, planning, cleaning, clearance, and waste disposal and are covered elsewhere in these *Guidelines*. The reader must study and understand the material in these other chapters prior to undertaking an abatement project. This chapter alone does not provide all the information necessary to complete a successful abatement job.

The definition of abatement (as used in this document) is different than the "traditional" abatement practices used in some local jurisdictions. Traditional abatement methods often involve dry scraping deteriorated paint, repainting, and dry sweeping without clearance. These methods are known to make leaded dust more accessible to young children and are therefore often counterproductive. Performed inadequately, or without sufficient protection, abatement is known to increase lead exposures to children (Amitai, 1987; Chisholm, 1985; Farfel, 1990; Rabinowitz, 1985a). When performed properly, abatement is known to be effective (Amitai, 1991; Staes, 1994; HUD, 1991; Jacobs, 1993a; Farfel, 1994; Staes and Rinehart, 1995).

Proper abatement refers to any measure designed to permanently eliminate lead-based paint hazards in accordance with standards established by the U.S. Environmental Protection Agency (EPA) Administrator pursuant to Title IV of the Toxic Substances Control Act (TSCA). Abatement strategies include removal of lead-based paint; enclosure of lead-based paint; encapsulation of lead-based paint (according to the standards and procedures set forth in Chapter 13); replacement of building components coated by lead-based paint; removal of lead-contaminated dust; removal of lead-based paint from painted building components (as a last resort); removal or covering of lead-contaminated soil with a durable covering (not grass or sod, which are considered interim control measures); and preparation, cleanup, disposal, postabatement clearance testing, recordkeeping, and monitoring (if applicable).

More than any other abatement method, removal of lead-based paint involves the greatest degree of disturbance and dust generation. Therefore, onsite removal of lead-based paint from a substrate should be carried out only if abatement rather than interim control is required and no other abatement method is feasible. For example, removal of paint from metal doorframes may be the only feasible abatement option, especially if the frames cannot be removed or enclosed and the paint cannot be stabilized. Paint removal may increase the level of lead in household dust and make effective cleaning more difficult. Even if dust clearance standards are met, any increase in leaded dust levels over baseline levels means some increase in exposure. Furthermore, all removal methods leave behind some residues embedded in the substrate, which could continue to pose a hazard if the surface from which the paint is removed is later disturbed.

Therefore, paint removal is the most invasive of abatement methods and should be avoided if possible. Enclosure and building component replacement are the least invasive and most preferred of the abatement methods.

Abatement also offers the greatest challenge to planning, since it is often performed in the context of other building construction work, while interim controls are more likely to be performed alone or as part of other maintenance work. In fact, many forms of abatement require special construction skills in addition to protective measures and dust control techniques. For example, one of the most common forms of lead-based paint abatement is window replacement. Abatement contractors need to possess adequate carpentry skills to install (for example) new windows, as well as the demolition, dust containment, and cleanup skills held by abatement contractors. While providing some guidance, this chapter is not intended to impart carpentry, painting, resurfacing, and other construction knowledge required for most types of abatement. Abatement contractors should either subcontract this type of construction work or acquire the necessary construction skills before the job begins. Of course, all construction work must be performed in accordance with local code requirements and all abatement work must be done by certified firms and individuals.

Many forms of abatement can be integrated into construction work, which provides an opportunity to install systems that will have long-term impact. For example, whenever building components, such as doors and windows, are replaced, the *Guidelines* recommend that they be replaced with products that are more energy-efficient. This will help reduce energy consumption and increase cost-efficiency.

EPA is establishing standard training curriculums and regulations for the training and certification of all individuals engaged in lead-based paint risk assessment, inspection, and abatement, and minimum performance standards for the purpose of certifying those individuals who supervise lead abatement projects and conduct clearance examinations. EPA's regulations will generally be implemented through State programs. All abatement contractors and firms must be certified to perform this type of work, and all abatement workers must be trained and certified. Certification of abatement contractors and completion of clearance examinations by independent, certified risk assessors or inspector technicians ensures that abatement work is conducted properly and safely.

For exterior work, preabatement soil samples should be collected but not necessarily analyzed until postabatement soil samples have been collected, analyzed, and compared to clearance standards. If postabatement soil levels are below applicable limits, the preabatement samples need not be analyzed (see Chapter 15).

B. Prohibited Abatement Methods

Some techniques are prohibited because they are known to produce extremely high levels of lead exposure and result in dwellings that are difficult if not impossible to clean up.

The techniques shown in Table 12.1 are prohibited in the residential setting under HUD regulations (HUD, reserved) and several State regulations (Massachusetts, Maryland, Minnesota, and Rhode Island).

C. Periodic Monitoring and Reevaluation

Compared to interim controls, one of the chief advantages of abatement is that owner monitoring and professional independent reevaluation are either unnecessary (in the case of complete lead-based paint removal) or required only infrequently (in the case of enclosure), since abatement measures are much less likely to fail (see Chapter 6). This minimizes the expense, cost, and time associated with reevaluation.

Abatements can be undertaken after inspections or risk assessments determine the presence of lead-based paint or other lead hazards (see Chapters 3 and 5 for a description of the differences between risk assessments and inspections). If this initial identification phase is not completed before abatement, then all painted surfaces must be assumed to contain lead-based paint above the regulatory limit. This may be cost-effective if it is likely that all surfaces that might be treated contain lead-based paint or if the housing unit is to be rehabilitated and all surfaces and components either covered or replaced.

The cost of carefully conducted inspections or risk assessments, however, is usually recovered by a more focused abatement effort, especially when component replacement or enclosure is considered. The cost savings of a more targeted abatement effort based on complete testing are noteworthy in the case of abatement as opposed to interim controls, since the costs of abatement are initially much higher than interim controls.

1. Recordkeeping

Recordkeeping is essential for all abatement methods, including removal. The location of enclosed or encapsulated lead-based paint should be made known to future residents, who may undertake remodeling or repair efforts that could reexpose the hazard. Depending on the jurisdiction, the location of enclosed or encapsulated lead-based paint may need to be filed with the appropriate municipal agency for future reference when issuing construction permits for renovation. The absence of lead-based

Table 12.1 Prohibited Lead-Based Paint Abatement Methods

1. Open flame burning or torching (includes propane-fueled heat grids).
2. Machine sanding or grinding without HEPA local vacuum exhaust tool.
3. Uncontained hydroblasting or high-pressure wash.
4. Abrasive blasting or sandblasting without HEPA local vacuum exhaust tool.
5. Heat guns operating above 1,100 °F.

Methods that may be prohibited in some jurisdictions and that are not recommended by HUD:

1. Methylene chloride paint removal products.
2. Dry scraping (except for limited surface areas).

paint should also be made known to future occupants, in order to avoid unnecessary testing expenses.

D. Types of Abatement

This chapter covers four types of abatement:

- Building component replacement.
- Enclosure systems (this section does not include encapsulation, which is addressed in Chapter13).
- Onsite and offsite paint removal.
- Soil removal or covering.

The available information on paint abatement methods is summarized in Table 12.2.

Experimental and innovative abatement techniques are currently being developed. The reader should not conclude that a particular method is not permitted simply because it is not discussed here. With the exception of the prohibited techniques listed above, new techniques should be developed, studied, and reported to HUD, the Centers for Disease Control and Prevention (CDC), EPA, and other Government agencies for distribution to the public.

E. Encapsulation

Encapsulants are coatings or rigid materials that rely on adhesion to a lead-based painted surface and are not mechanically fastened to the substrate. Because the performance standards mandated by TitleX have not yet been developed, encapsulants are considered separately in Chapter13. "*Enclosures*" (not to be confused with encapsulants) are defined as durable, rigid construction materials that are mechanically fastened to the substrate with screws, nails, or other mechanical fastening system that can be expected to last at least 20 years under normal conditions. These *Guidelines* do not consider encapsulation to be the same as enclosure. Depending on the particular circumstances and product, encapsulation can be either a form of paint stabilization (an interim control) or abatement (see Chapter 13).

F. Relationship to Renovation, Repainting, Remodeling, Rehabilitation, Weatherization, and Other Construction Work

Many forms of abatement involve the same physical work as other types of construction often performed in housing. In many cases, only the intent of the work differs. Lead-based paint abatement is intended to produce conditions that prevent lead poisoning. Other construction work is intended to, among other things, improve aesthetic living conditions, bring the dwelling up to code, preserve historical evidence, and promote energy efficiency. For example, window replacement could be considered to be a lead abatement method, renovation work, or weatherization work all at the same time.

While the intentions of each of these activities may differ, experience shows that many of them can be combined in order to yield savings. In the public housing program, for example, most of the abatement now underway occurs in the context of housing modernization or rehabilitation work. This approach has proven to be feasible and cost-effective.

Congress recognized the wisdom of combining lead abatement with rehabilitation work. In Section 1012 of Title X, any residential construction job receiving more than $25,000 per dwelling unit in Federal funds is *required* to have lead-based paint hazards abated. If $5,000 to $25,000 per dwelling unit in Federal funding is received, either abatement or interim controls must be implemented.

Finally, lead abatement procedures cannot guarantee that children will not be exposed to lead in the future. Enclosure systems could fail, exposing the hazard again. Soil coverings could also fail, resulting in excessive exposures. Surfaces that were made cleanable may deteriorate or may not be kept clean, allowing leaded dust levels to reaccumulate to hazardous levels. Nevertheless, abatement constitutes the most extensive and protective intervention presently available. If practiced properly, abatement will greatly reduce the risk of lead poisoning.

Table 12.2 Comparison of Lead-Based Paint Abatement Methods

Attributes	Method: Removal — HEPA Needle Gun	Removal — Heat Gun	Removal — HEPA Vacuum Blast	Removal — HEPA Sand	Removal — Remove/Replace	Removal — Caustic Paste	Removal — Offsite Stripping	Enclosure — Plywood Paneling	Enclosure — Gypsum	Enclosure — Prefab Metal	Enclosure — Wood, Metal, Vinyl, Siding
Skill Level	High	Moderate	High	Moderate	High	Moderate	Moderate	Moderate	Moderate	High	Moderate
Esthetics	Erodes surface	Gouges	Erodes surfaces	Gouges/ roughens	Good	Gouges	Good	Good	Good	Good	Good
Applicability	Very low, limited to metal and masonry	Wide, can damage some components	Very low, limited to metal and masonry	Low, limited by surface contour	Wide, dependent on skill level	Wide, can damage some components	Low, limited to components	Wide, walls	Wide, walls and ceilings	Varied, limited by components	Wide, walls
Lead Presence	Removed	Largely removed	Largely removed	Largely removed	Removed	Largely removed	Largely removed	Remains	Remains	Remains	Remains
Hazardous Waste Generation	Moderate	Moderate	Moderate	Moderate	Potentially high, pending TCLP test	High	High, but maintained offsite	Low	Low	Low	Low
Weather Limitations	Moderate	High	Moderate	Moderate	Minimal	High	None	Minimal	Minimal	Minimal	Minimal
Applicable to Friction Surface	Some	Yes	Some	Some	Yes	Yes	Yes	No	No	Yes	No
Speed of Methodology	Moderate	Slow	Slow	Slow	Moderate	Very slow	Can be slow, requires coordination	Moderate	Moderate	Moderate	Moderate
Training Required	High	Moderate	High	Moderate	High	Moderate	Moderate	High	High	High	High

This table is continued on next page.

Table 12.2 Comparison of Lead-Based Paint Abatement Methods (continued)

Attributes	Method										
	Removal							Enclosure			
	HEPA Needle Gun	Heat Gun	HEPA Vacuum Blast	HEPA Sand	Remove/ Replace	Caustic Paste	Offsite Stripping	Plywood Paneling	Gypsum	Prefab Metal	Wood, Metal, Vinyl, Siding
Capital Required	High	Low	High	Moderate	Moderate	Low	Low	Low	Low	High	Moderate
Worker Protection Required	High	High	High	High	Moderate	High	Moderate	Low	Moderate	Low	Low
Finish Work Required	Tentatively high	Moderate	Tentatively high	Moderate	Low	Moderate	Moderate	Wide	Wide	Limited	Wide
Product Availability	Limited	Moderate	Limited	Limited	Wide	Moderate	Limited, strip shops decreasing	Moderate	Moderate	Long	Long
Durability	Long	Long	Long	Long	Long	Long	Long	Moderate	Moderate	Moderate	Moderate
Labor Intensity	High	High	High	High	High	High	Moderate	High	High	High	High
Overall Safety	Moderate	Moderate	Moderate	Moderate	Very high	Moderate	High-high	High	High	High	High
Surface Preparation	None	None	None	None	None	Minimal—adjacent areas	Minimal—hardware removal	Minimal	Minimal	Minimal	Minimal
Cost	High	High	High	High	High	High	High	Moderate	Moderate	High	Moderate

Source: Adapted from Dewberry and Davis, HUD Lead-Based Paint Federal Housing Administration (FHA) Abatement Demonstration Project.

Building Component Replacement: How To Do It

1. Prepare the work area by selecting a Worksite Preparation Level (see Chapter 8). Plan how the new component will be installed. Whenever possible use new energy-efficient window, door, and insulating systems.
2. Prepare the hazardous building component for removal. Turn off and disconnect any electrical circuits inside or near the building component to be removed.
3. Lightly mist the component to be removed (unless electrical circuits are nearby).
4. Score all painted seams with a sharp knife.
5. Remove any screws, nails, or fasteners.
6. Use a flat pry instrument (crowbar) and hammer to pry the component from the substrate.
7. Remove or bend back all nails.
8. Wrap and seal bulk components in plastic and take them to a covered truck or secured waste storage area along pathways covered with plastic. Shovel any debris. See Chapter 10 for proper disposal methods.
9. HEPA vacuum any dust or chips in the area where the component was located.
10. Replace component (optional).
11. Conduct cleaning (see Chapter 14).
12. Conduct clearance and reclean if necessary.

Section II

II. Building Component Replacement

Building component replacement is defined as the removal of doors, windows, trim, and other building items that contain lead-based paint hazards and their replacement with new lead-free components. Component replacement is the most desirable abatement method because it offers a permanent solution to the lead-based paint problem. If done properly, it also minimizes contamination of the property and exposure of the workers. In addition, building component replacement can be integrated into general building rehabilitation activities. Components, such as doors and windows, should be replaced with more energy-efficient models, which will help to reduce energy consumption and increase cost efficiency.

Component replacement may be more expensive, however, especially for historic preservation projects, since new building components that match the originals may have to be custom made. For some historic preservation projects, replacement may not be permitted (see Chapter 18).

The skills required to perform building component replacement properly are similar to those of the skilled carpenter. For example, it is important to know how the various building components were joined so that they can be taken apart with minimal contamination and damage to adjoining surfaces.

For certain types of components, the owner may choose to simply remove them without replacement. This is acceptable as long as applicable codes are observed.

A. Worksite Preparation

The appropriate worksite preparation level should be selected based on the size of the building component, its state of deterioration, and the ease of removal. The more deteriorated the component and the larger the surface area to be disturbed, the higher the worksite preparation level should be. Certified risk assessors or certified abatement supervisors or trained planners and designers can determine the appropriate level for a project (see Chapter 8).

1. Security

Security of the premises is an important issue. If windows and doors are removed but not replaced on the same day, it may be necessary to install temporary barriers over window and door openings to prevent vandalism and theft overnight. Therefore, every effort should be made to remove and replace doors and windows on the same day.

2. Waste Storage

While architectural components may or may not be regulated as hazardous waste (see Chapter 10), they still must be properly managed. All building components coated with lead-based paint should be stored in a secure, locked area. They should not be sold or released to anyone who might reinstall them in another dwelling.

B. General Procedures for Building Component Replacement

- Using a garden sprayer or atomizer, lightly mist the component to be removed with water to help keep the dust down during the removal process. Before applying the water, be sure there are no electrical circuits inside the component. (If electrical circuits are present inside the component, they must be turned off and disconnected before removal. No water mist should be applied even if electrical circuits are turned off or de-energized.

- Using a utility knife or other sharp instrument, carefully score all affected painted seams. This will provide space for a pry instrument and will minimize paint chipping and dust generation during removal.

Figure 12.1 Use a Pry Point Pad To Minimize Damage to Adjoining Surfaces During Component Removal.

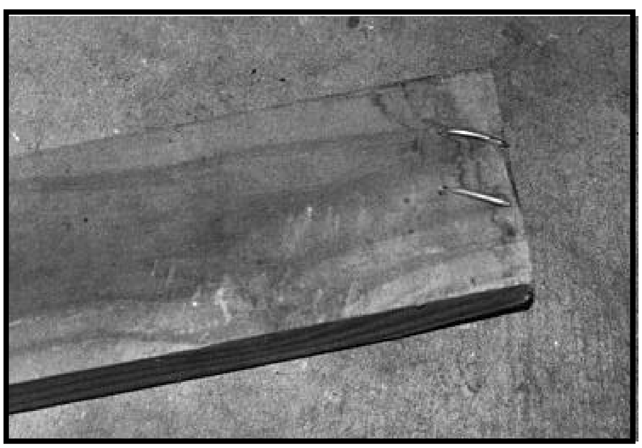


Figure 12.2 Bend Back All Nails on Removed Components.

- Remove any screws or other fasteners. Using a flat pry instrument and a hammer, carefully pry the affected building component away from the surface to which it is attached. The pry bar should be inserted into the seam at the nail (or other fastening device) at one end of the component and pressure applied. This process should be repeated at other fastening locations until the end of the component is reached. By prying in this manner, the component will be removed intact and chip and dust generation will be minimized. A pry point pad or softener may be required to minimize damage to adjoining substrates. Wider replacement trim can sometimes be used to cover adjacent area damage.

- Since there is often a considerable amount of leaded dust underneath or behind the component being removed, begin cleanup immediately after the individual component has been removed.

- Carefully remove or bend back all nails (or other fastening devices) and wrap the component in 6-mil plastic sheeting and seal with duct tape. Wrapping components in plastic may not be necessary if the dwelling is vacant and if the truck and the pathway to the truck are lined with plastic. Use a high-efficiency particulate air (HEPA) vacuum to remove any dust that may have accumulated behind the components as soon as they have been removed. Vacuuming may be performed by another person while the removal is underway. Preparing the area for the new component (e.g., squaring, reducing, or enlarging openings) may also release accumulated dust that should be removed. Dispose of wrapped components properly.

- Bring new lead-free components into the work area only after all dust-generating activity is complete and the dust cleaned up by at least one HEPA vacuuming.

C. Removal and Replacement Procedures for Specific Components

1. Baseboards, Casings, and Other Trim

The term "other trim" applies to such components as window casings, interior sills (stools), aprons, door casings, baseboards (including caps and shoe moldings), chair rails, exterior fascia, soffits, shutters, and crown moldings. Components with lead-based paint should be removed as described in the previous section.

New lead-free components should be installed in a professional manner using standard carpentry practices. In situations where trim is being applied to lead-based painted walls, ceilings and floors that were enclosed, or casings for windows or doors where the jambs have been enclosed, the trim should be back-caulked before installation as an added precaution. "Back-caulking" refers to the application of caulk to the perimeter of the backside of rigid building materials to seal them before installation, preventing leaded dust from entering the living space through cracks and crevices. A high-quality caulk warranted for at least 20 years should be used.

2. Windows

The term "window" applies to the sash, the stop and parting beads, and the window jambs. Affected components should be removed as described in Section B. Window replacement can involve the removal of a wooden or metal unit and the installation of a wood, vinyl, or metal unit in its place. If the jamb is not removed, it can often be enclosed by the new window frame system, which should be caulked and fastened. The remaining exterior portion of the jamb, if any, can be wrapped with coil stock (aluminum or vinyl or equivalent) after back-caulking. In situations where window units must be replaced in kind (e.g., historic preservation), the jambs should be removed and replaced also to make sure that no friction surfaces coated with lead-based paint remain. Generally, friction surfaces should not be painted.

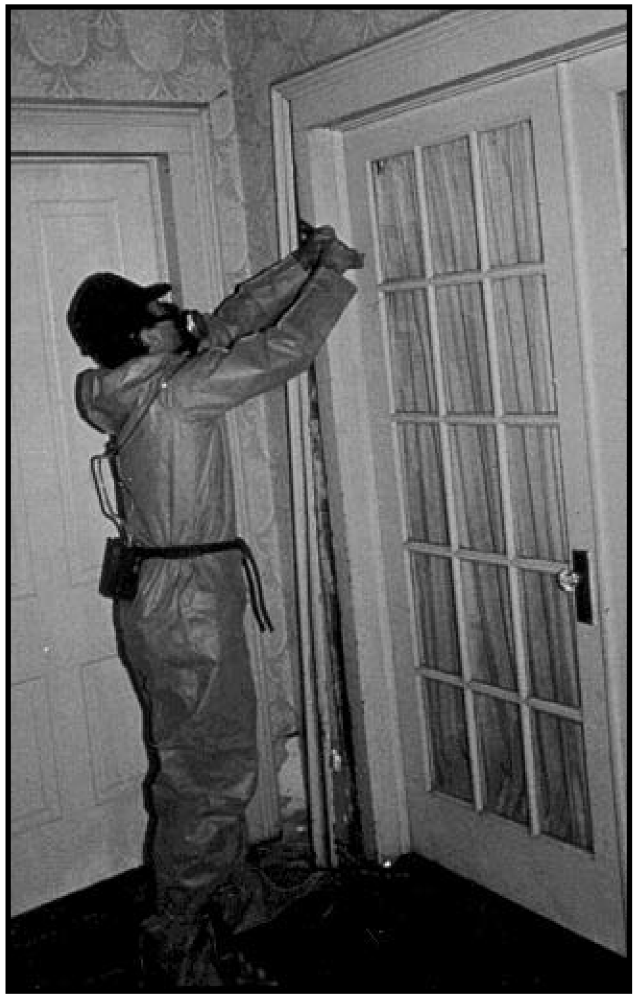


Figure 12.3a Remove and Replace Trim (interior).

Figure 12.3b Remove and Replace Trim (exterior).

Figure 12.4 Window Frame Enclosure System.

Figure 12.5 Window Replacement.

Depending on the building construction, it may be possible to remove the entire window system. The new lead-free components should be installed in a professional manner using standard carpentry practices.

3. Interior and Exterior Doors

Interior and exterior doors include the doorstops and doorjambs. Affected components should be removed as described above. Typical door replacement usually involves the removal of a wooden unit and the installation of a prehung wooden unit in its place. In this type of door replacement, the jamb is rarely removed, but is usually saved and enclosed with the new doorjamb after back-caulking. Wooden jamb extensions or coil stock, properly back-caulked, can be used to enclose any remaining portion of the jamb. In situations where prehung door units are not permissible (e.g., code requirements, historic preservation regulations), the original jamb should also be removed and replaced, if possible, to make sure that no friction surfaces coated with lead-based paint remain. If the jamb cannot be replaced, the stop should be removed and replaced with new material after carefully stripping the old jamb.

Primers on Metal Doors

An exception is provided for certain metal doors and frames. If it can be determined clearly that hazardous levels of lead on metal doors and frames reside only in the primers, and that the primers were factory-applied and are in sound condition, then the primers themselves need not be abated or removed. However, finish coats of paint that cumulatively contain lead of 1 milligram per square centimeter or greater will have to be treated as lead hazards. (The alternative standard of equal to or greater than 0.5 percent by weight may be used.) If laboratory analyses of samples of the field-applied finishes are negative, the metal doors and frames do not require abatement but should be monitored to ensure that the lead-bearing primer does not become defective. If the base metal is exposed while sampling the field-applied finish paint then the existence of a permanent bond cannot be assumed and the entire sample should be analyzed for presence of lead. Any damage to the primer resulting from sample collection should be repaired immediately in a manner that restores the integrity of the primer coat.

For the metal doors and frames under this exception, primers should be intact and doors should be operating properly, free from impact or abrasion between moving parts that will damage any surfaces. If this exception for factory-applied primers is used, risk assessors should advise property owners or building managers of the importance of continued monitoring of the paint surfaces to ensure that subsequent surface deterioration or other factors do not result in exposing defective lead-based paint surfaces (the primers). Under this exception, property owners or building managers must commit to a plan for ongoing monitoring of the condition of the painted surfaces. The subsequent appearance of rust indicates a failure of the paint and primer, and the component must be abated.

Although unlikely, adhesion of the primer could be a problem. A simple “x” cut or cross-hatch test will show if this is a problem. If adhesion is poor, the paint will tend to flake away from a cut. An adhesion test should also give an indication of the number of coats, color of finish versus primer (which would be orange if it was pigmented with red lead or yellow if it was pigmented with lead chromate), and thickness of layers. Or course, other colors of lead-based paint may also be present. Any damage resulting from an adhesion test should be repaired immediately in a manner that restores the integrity of the primer and finish coats to prevent subsequent deterioration.

When it can be determined that lead-based paint is present in a field-applied coating over an intact factory-applied primer, and paint removal is the abatement method of choice, only the finish field-applied coatings need to be removed. An intact primer need not be removed.

4. Kitchen and Bathroom Cabinets

Old lead-based painted kitchen and bathroom cabinets can be removed and replaced. Affected cabinets should be removed as described above. Lead-based paint on walls to which cabinets are attached should not be disturbed during cabinet removal. Applying masking tape around the cabinet perimeter and HEPA vacuuming immediately after removal will help to control leaded dust.

5. Railings

Railings include the railing caps, banisters, posts and spindles (balusters), and newel posts can be removed and replaced. Railings may or may not be part of a stair system. Affected components should be removed as described in Section B. New lead-free components should be installed in a professional manner using standard carpentry practices.

Metal railings and other grillwork can be removed and taken offsite for contained abrasive blasting or other forms of paint removal, then reinstalled after repainting.

6. Exterior Siding

Exterior siding includes any materials used on a dwelling’s exterior walls. Siding of concern is generally painted wood or brick. Under most conditions, siding will have to be abated through enclosure. However, in restoration

Figure 12.6 Exterior Siding Removal and Replacement.

Figure 12.7a Line Walking Surfaces With Plastic.

Figure 12.7b Line Pathways With Plastic.

or historically significant projects, it may be replaced. In such situations, the affected siding should be removed as described above. Care must be taken to avoid contamination of soil, walkways, window air conditioners, and the building interior.

7. Interior Walls

If abatement is performed along with gut rehabilitation, old lead-based painted interior walls and ceilings may be removed and replaced. This activity, unlike those previously described, is more like demolition work. In addition to the layers of 6-mil plastic used to protect the floors from contamination, sheets of plywood should be placed over the plastic to protect it from damage during aggressive demolition, and to make cleanup of debris easier. Prior to demolition, affected areas should be sprayed lightly with water. Workers should wear ribbed rubber boots when walking on slippery, wet plastic. If ladders must be used, the plastic should be punctured to provide secure anchoring of the footings to the surface underneath. Ladder footings should not be placed on top of the plastic, since this will create a slip hazard. Excessive water should not be applied, and the creation of puddles and streams that may flow through breaks or gaps in the containment should be prevented.

Plaster walls coated with old lead-based paint should generally not be removed, since a great deal of dust will be generated. Enclosure is usually a better option.

D. Transportation and Storage of Waste

Building component replacement and demolition generate a considerable amount of waste material. Lead-contaminated building components and demolition debris should be handled carefully, even if they are not regulated as hazardous wastes (see Chapter 10). Bulk debris such as doors, windows, and trim should be wrapped in 6-mil plastic and sealed with tape. Smaller debris should be swept into 6-mil plastic bags after spraying.

All debris should be removed from the site as soon as possible. In larger jobs where a dumpster is being used, it may be possible to eliminate the wrapping and bagging of bulk debris as long as the dumpster has a lockable lid and is lined with plastic and secured with a fence and signs. Pathways to the dumpster should be lined with plastic so as not to contaminate the area.

Contaminated building components and demolition debris should be transported in covered vehicles to an appropriate disposal facility. Old building components coated with lead-based paint must not be recycled. See Chapter 10 for a full discussion of hazardous and nonhazardous waste disposal.

Enclosure: How To Do It

1. Stamp, label, or stencil all lead-based painted surfaces that will be enclosed with a warning approximately every 2 feet both horizontally and vertically on all components. The warning should read: "Danger: Lead-Based Paint." Deteriorated paint should not be removed from the surface to be enclosed.
2. Select a Worksite Preparation Level (see Chapter 8).
3. Attach a durable drawing to the utility room or closet showing where lead-based paint has been enclosed in the dwelling.
4. Plan for annual monitoring of the enclosure by the owner. An independent inspector technician or risk assessor should evaluate the integrity of the enclosure according to the reevaluation schedule in Chapter 6 *and* after any significant damage due to plumbing or roof leaks, tornadoes, hurricanes, floods, earthquakes, etc.
5. Repair unsound substrates and structural members that will support the enclosure, if necessary.
6. Select appropriate enclosure material (drywall or fiberboard, wood paneling, laminated products, ridged tile and brick veneers, vinyl, aluminum, or plywood).
7. Install extension rings for all electrical switches and outlets that will penetrate the enclosure.
8. If enclosing floors, remove all dirt with a HEPA vacuum to avoid small lumps in the new flooring.
9. Seal and back-caulk all seams and joints. Back-caulk means applying caulk to the underside of the enclosure.
10. When installing enclosures directly to a painted surface, use adhesive and then anchor with mechanical fasteners (nails or screws).
11. Conduct cleanup.
12. Have a certified risk assessor or inspector technician conduct clearance testing and provide documentation and a Statement of Lead-Based Paint Compliance.

Section III

I. Enclosure Methods

A. Definition

"Enclosure" is the installation of a rigid, durable barrier that is mechanically attached to building components, with all edges and seams sealed with caulk or other sealant. Surfaces with lead-based paint are enclosed in order to prevent access and exposure and to provide a "dust-tight" system. Unlike encapsulation, the enclosure system is not dependent on the painted surface of the substrate for its durability. Enclosures should have a design life of at least 20 years. While adhesives are frequently used for initial mounting purposes and for assistance in covering the lead-based painted surface with the enclosure material, it is primarily mechanical fasteners that give enclosures their longevity.

Standard construction materials are employed to create a solid and relatively rigid end product (see Appendix 7.2 for a description of materials commonly employed for lead-based paint enclosure). The primary differences between enclosure for lead-based paint and ordinary construction includes careful sealing of all edges, joints, and seams to create a dust-tight (not necessarily airtight) enclosure; site containment; worker safety (particularly during any needed surface or substrate repairs); and special cleanup. There is generally little or no hazardous waste disposal and little degradation of the lead-based paint as part of the enclosure process, unless substrate repairs are necessary. The hazard and expense of removing deteriorated paint can be avoided when the enclosure material is mounted flush to a structurally sound lead-based painted substrate and all the seams are sealed. This method produces little leaded dust (HUD, 1991). These advantages hold down labor costs compared to paint removal and building component replacement, although cleanup and clearance are still required. A lower level of containment can often be used since less dust is generated.

For broad surfaces such as walls, ceilings, floors, and siding, enclosure is often considerably cheaper and less hazardous than building component replacement and paint removal. However, enclosure does not remove lead from the property; instead, it makes the dwelling lead-safe.

B. Longevity of Enclosures

There is little doubt that hurricanes, earthquakes, tornadoes, and flooding can substantially compromise an enclosure's viability. Less dramatic but more common events can also increase the risk of lead exposure, such as damage to the enclosure by the occupant or water damage from a leaking roof, overflowing tubs, or broken pipes. Any type of enclosure is potentially vulnerable to water damage. Future occupants can also be threatened by remodeling endeavors that break through the enclosure.

1. Labeling of Enclosed Surfaces

To prevent the breach of an enclosure, a few simple safety rules are relevant. The surface to be enclosed should be labeled (behind the enclosure), horizontally and vertically, approximately every 2 feet with a warning, "Danger: Lead-Based Paint." The stamp lettering should be done in permanent ink.

A durable drawing of the property floor plan should be mounted on a sturdy metal or wood base and affixed with screws to a wall in the utility room next to the electrical panel or at any other closet location that can be easily seen by maintenance personnel. The drawing should be covered with plastic for protection. Enclosures should be highlighted on the diagram and identified as hazardous (see Figure 12.9 for an example of such a diagram).

2. Monitoring Enclosure Integrity

A visual evaluation of the enclosed surfaces should be conducted by owners or their representative at least every year or whenever water or other damage is reported. Residents should also examine the enclosure periodically. Enclosure integrity should be evaluated professionally by a certified risk assessor according to the schedule in Chapter 6. A signed and dated report of the risk assessor's observations, which

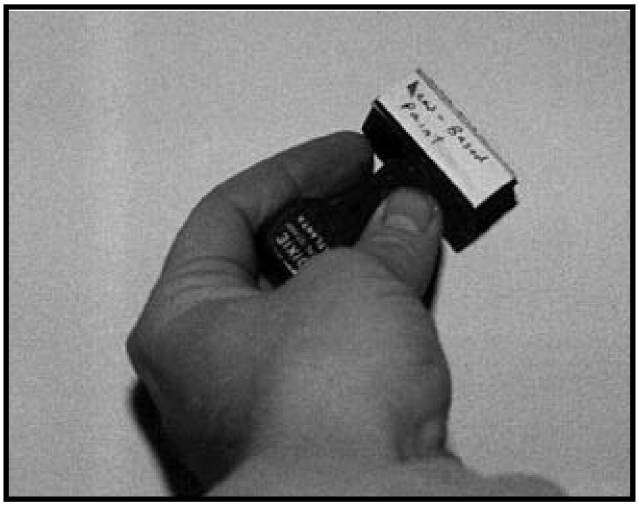


Figure 12.8a Label Surfaces With a Stamp Before Enclosure.

Figure 12.8b Caulk the Seams of a Window Frame Enclosure System.

also indicates the enclosed surface locations, should be retained by the owner, with copies available to the residents.

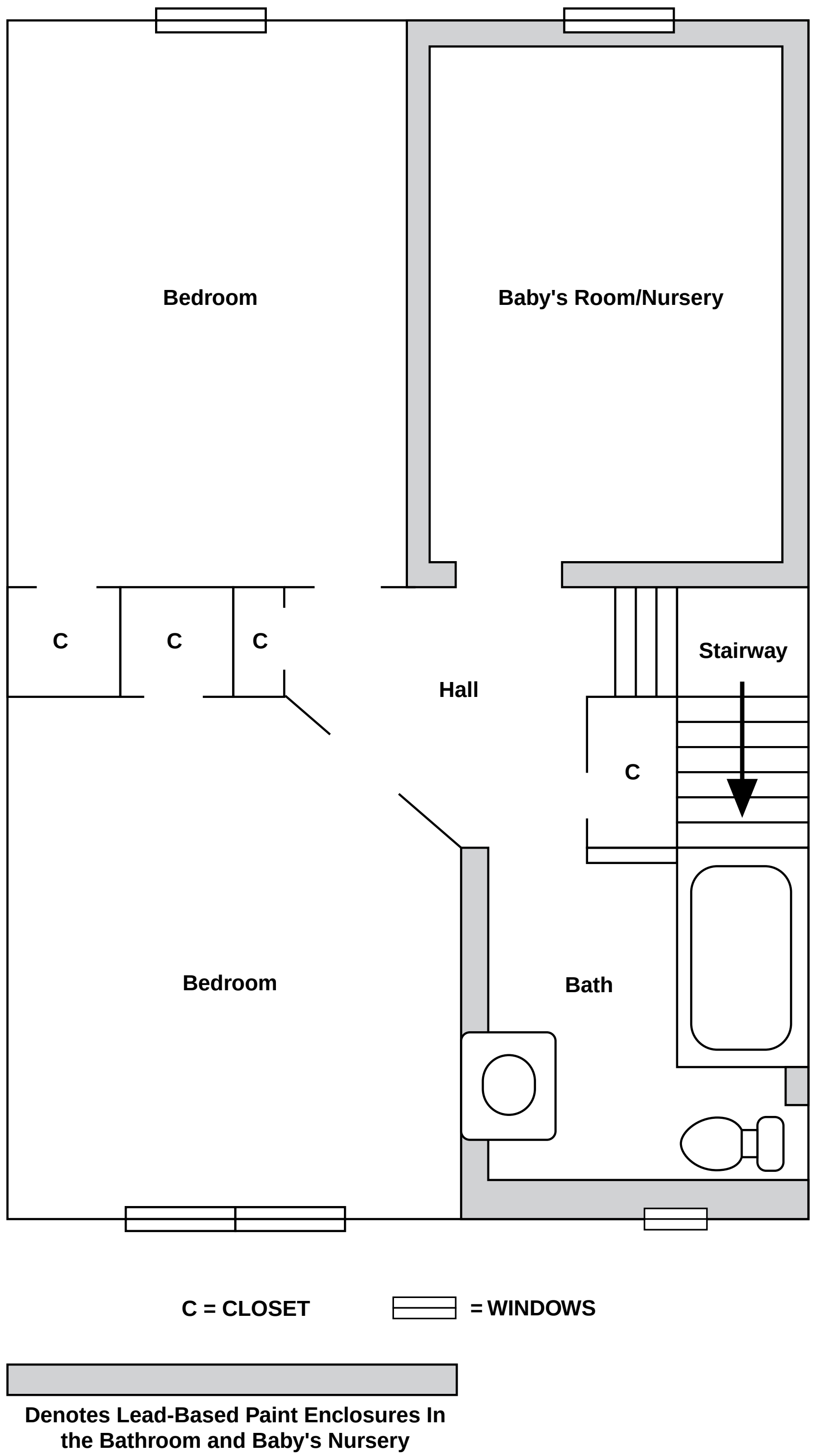
It is a simple matter to repair an enclosure using conventional construction techniques. The repair history of the enclosure should be maintained in the owner's records.

Depending on the jurisdiction, the original lead-based paint risk assessment or inspection report, the clearance report, and a copy of the enclosure drawing may be retained by the municipality as part of its standard records for that property. The reports also may be subject to disclosure requirements during the sale of the dwelling. If a permit is obtained to do renovation work, if demolition of the dwelling is undertaken, or if the title and deed are transferred, the history of the lead-contaminated surfaces hidden behind enclosures will caution future workers and property buyers. Leases should also disclose the location of enclosed lead-contaminated surfaces.

3. Unsound Substrates

Any substrate material can be enclosed, including plaster, concrete block, brick, and concrete. All soft, moveable, or otherwise structurally unsound structural members should be repaired prior to enclosure if they are needed to support the enclosure. If repair is not feasible, then the defective area will need to be removed and enclosure will not be possible. Hazards associated with preparing the site for enclosure increase as more remedial work is needed. Structural repairs may require lead-based paint removal or component replacement, with all the accompanying safety protocols these practices entail. If the substrate is sound but the paint deteriorating, stabilization or removal of deteriorated paint before the enclosure is installed should *not* be done due to dust generation.

Figure 12.9 Example of a Diagram Showing the Location of Lead-Based Paint Enclosures.



C. Interior Surface Enclosure Materials

1. Wood Paneling

Wood paneling is an appropriate enclosure material, except for ceilings. It is of limited use, however, because it is difficult to seal seams around electrical outlets; switch boxes; and heating, ventilation, and air conditioning (HVAC) registers. There should be no gaps in the seams, outlets, boxes, and registers, which should all be screwed directly to the paneling and to any framing behind the panels. All seams should be caulked. Paneling made of composite board backing materials is vulnerable to dampness, particularly in below-grade situations such as basements. In some instances, the use of these materials may violate building and/or fire codes. On the other hand, plywood paneling may be stronger, more impact-resistant, and more water-resistant than other enclosure materials, such as drywall.

Paneling can be glued and mechanically fastened directly to the substrate, but the appearance is improved when the area to be covered is first furred or framed out and the paneling is anchored to these braces. The paneling should not extend past the depth of door or window frames or other trim pieces. Baseboards can be removed and the new cove base then glued directly to the paneling. Even heavy grades of paneling flex and vibrate when receiving mild impact. Over time this could compromise the seal of the seams that join the paneling with other building components. Joints and edges must be fully supported; furring strips should be installed at the appropriate distance from each other, usually 12 inches apart. All seams at these transition points should be caulked before panel trim and corner moldings are installed as finish pieces.

2. Laminated Products

Laminated wall sheeting products, such as Marlite™, are designed to withstand surface moisture and are commonly used in bathrooms and kitchens. Their surfaces have a high sheen and clean easily. However, they may become defective when moisture gets behind the board's placement. This can occur from a leaking pipe or a seam opening in the bathtub/shower area. When a significant leak is detected, the enclosure must be reexamined.

3. Ridged Tile and Brick Veneers

Plastic and ceramic tile, synthetic brick and stone veneers, and other similar products are either glued or cemented directly to the painted surface. These products qualify as rigid encapsulants rather than enclosures, since they are not mechanically fastened to the substrate. Regardless of whether they are enclosures or encapsulants, they tend to be inappropriate for broad application, since the cost associated with labor and materials is often prohibitive for anything more than incidental use.

4. Drywall and Fiberboard

The steps to install drywall and fiberboard are shown in Table 12.3 and detailed specifications are provided by the Gypsum Association (202)289–5440 on the two topics listed below:

- Recommendations for covering existing walls and ceilings with gypsum board (GA–650–86).
- Using gypsum board for walls and ceilings (GA–201–90).

Gypsum drywall or fiberboard is a very common and cost-effective interior finish. It is not difficult to locate skilled workers to install this product. Training materials are available from trade groups (Gypsum Association, 1993a, 1993b). When applied directly to a surface, the drywall is generally glued in place with construction adhesives and then mechanically fastened to the studs or structure behind the plaster. The screws must be long enough to go through the drywall, the plaster, and the wire mesh or lath and extend an inch into the stud or structure. To avoid having dust escape from the screwhole as the drilled screw displaces plaster, a dab of shaving cream can be applied to the area to be drilled.

Moisture-resistant greenboard should be installed in damp areas. It is difficult to completely control the long-term damaging effects of a severe moisture problem without invasive waterproofing and/or water diversion from the exterior of the property. Any type of enclosure is potentially vulnerable to water damage.

Quarter-inch-thick drywall tends to conform to the contours and imperfections of the original substrate or wall, compromising the appearance of the finished product. To avoid this, use of 3/8-inch-thick (minimum) drywall is recommended. The enclosed wall may in fact look much improved over the original wall. If the original wall surface is highly irregular, it may be necessary to install furring strips 12 inches apart and use 1/2-inch-thick drywall to improve the appearance. If 1/4-inch-thick drywall is used, it must be applied in accordance with the manufacturer's specifications (Gypsum Association, 1993a and 1993b).

D. Interior Building Components Suitable for Enclosures

All joints between drywall pieces should be taped and spackled with joint compound. Wherever the drywall meets wood framing or any other finish material (including electrical devices and HVAC registers), the seams should be sealed with a caulk or other sealant that has at least a 10-year warranty. Similarly, where sealed pipes penetrate an enclosure, the opening around the pipe must be sealed. Drywall is painted when installation is complete. Fastening schedules are available from industry trade groups (Gypsum Association, 1993a, 1993b).

1. Wood Trim and Drywall

The profile of the wood trim on windows and doors must be evaluated before overlaying an adjacent wall with drywall; the wall finish should protrude past the depth of the moldings. In homes built before 1960, this problem is less frequent because the trim tended to be more ornate and generally of thicker wood. Regardless of age, the problem is more apt to occur in multifamily public housing and institutional settings where the construction is basic and trim is thin.

If the drywall overlay is too thick, it may be possible to remove the baseboard and run the drywall to the floor. The baseboard can then

Table 12.3 Steps To Install Drywall and Fiberboard on Interior Walls

- Check to make sure the depth of the trim will accommodate the thickness of the drywall (minimum of 3/8 inch preferred). If it does not, this method may not be suitable.
- Set up the plastic containment of the work area (see Chapter 8).
- Remove any trim being disposed of, and install the drywall over any cavity left by the removed moldings, except large cavities over 16 inches in any direction. Repair any structural deficiencies.
- Repair or remove any "soft" wall areas. Removal of painted plaster generates a great deal of leaded dust.
- Use construction adhesive to glue the drywall directly to the surface being enclosed.
- Screw the drywall to the studs behind the existing wall.

  a. Caulk all seams that meet molding.
- Use extension rings to bring out electrical devices flush with the new gypsum-based drywall and retrofit any HVAC registers.

  a. Caulk all seams.
- Tape and finish the drywall.
- Prime and paint the finished area, as well as the unenclosed surfaces in the same room so that all walls match the new installation. (See specifications and recommendations from the Gypsum Association.)

Figure 12.10a Use of Tyvek on Building Exteriors Prior to Enclosure.

be reinstalled over the new drywall (unless the baseboard itself presents a lead hazard, in which case it should be replaced). Obviously, care must be taken to avoid breaking the original baseboard during its removal. The seam at the bottom of the drywall should be sealed with caulk prior to the installation of the baseboard or cove base.

2. Electrical Outlets and Vents

All electrical devices, including switches and outlets, will need extension rings in order to bring those fixtures out flush with the new drywall overlay. A sealant or caulk should be used

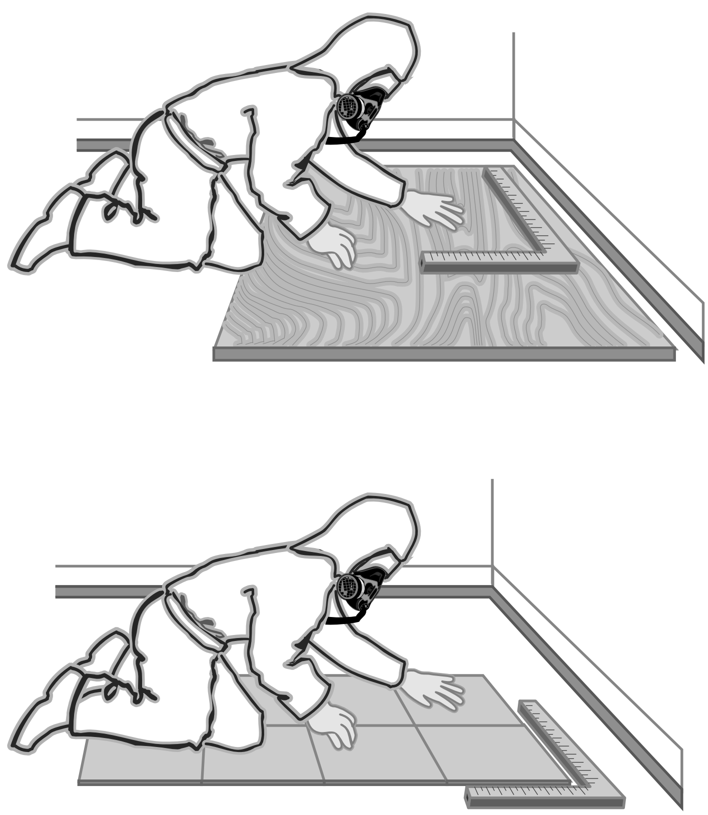


Figure 12.10b Install Underlayment and New Tile as a Suitable Lead-Based Paint Enclosure Method.

at cutouts for electrical boxes. Similarly, all grillwork at openings for heat vents and cold air returns should be retrofitted. These are minor but necessary operations in the drywall enclosure process.

3. Ceilings

Ceilings are more difficult to enclose than walls. Drywall applied directly to the ceiling will frequently result in an uneven appearance because there may not be a smooth transition from one board edge to the next. The solution is to draw a chalk line, usually every 16 inches on center, so that metal hat channels (or metal furring channels) or wood furring strips can be screwed into each ceiling joist. Three- to four-inch screws should be used to ensure that the screw penetrates the hat channel, plaster (or other substrate), and the wire mesh holding the plaster enough to bite firmly into the joist. The hat channel may be shimmed to get a perfectly level finished surface.

Next the drywall should be affixed to the hat channel for an excellent finished product. An extension ring will be needed for ceiling light fixtures. Prior to lowering the ceiling slightly, the contractor should be confident that there is no interference with the top of ornate, oversized window frames, pipes, vent covers, or crown moldings. The overall height of the lowered ceiling should conform with building code clearances.

All screws for furring channels or strips must penetrate into the ceiling joists prior to installation of the drywall. On occasion, some multifamily housing or commercial buildings converted to residential use may have cast-in-place, reinforced concrete ceilings. Anchoring supports for the new ceiling may not be practical in these instances. Though this construction is generally very strong, a structural engineer should be consulted about attaching a drywall system to the concrete. Onsite architectural or engineering advice is needed on a case-by-case basis to determine if this approach is appropriate.

Acoustical lay-in panels (drop-in ceilings) do not constitute lead-based paint enclosures, since they will not adequately guard against the escape of leaded dust into the living space and cannot be sealed.

4. Floors

Lead-based painted floors should be enclosed with 1/2-inch or thicker plywood or other underlayment. The joints in underlayment should be flash patched. Shoe molding running along the baseboard should be removed before plywood installation and reinstalled when the finished floor is completely in place. If the shoe molding contains lead-based paint, new shoe molding should be installed, since new molding is inexpensive and more cost-effective than removing the paint from the old shoe molding. This will ensure that all floor covering runs tight to the baseboard and the joints at vertical surfaces are covered by the quarter-round molding. The plywood should be covered with vinyl tile or sheet goods to provide a cleanable surface. Covering the plywood with wall-to-wall carpeting is generally not recommended because the carpet does not provide a sealed top cover and is harder to clean. Vinyl floor coverings should be finished off with a metal threshold at all doorways or at any access to an uncovered open floor to protect the exposed edge.

When placing tile over old flooring, a row of nails (preferably screws) should be run a few inches apart in a straight line over each joist before putting down the plywood. Old floor nails often lose much of their grip, which results in squeaky floor boards. This movement can in turn cause the edges of floor tile to lift in spite of the plywood underlayment that was installed. It is most important to remember that all the plywood sheets must be installed flush with each other. Gaps must be filled with flash patching cement. Also, a bead of caulk should be run at the edge of every board before it is set in place. All nails must be hammered flush and all dirt HEPA vacuumed thoroughly; otherwise small lumps will eventually appear in the soft vinyl finish goods.

If the floor to be enclosed is poured slab or cast-in-place concrete, the surface will have to be predrilled to accept each screw that anchors the plywood enclosure. A structural engineer should be consulted for situations other than slab on grade construction. Floor adhesive can offer an added measure of reinforcement and sealant. Each screwhead should be just below the level of the underlayment top surface and, along with the seams, should be covered with a smooth coat of flash patching cement to prevent dimples in the vinyl top cover.

5. Stairs

Dirt and loose paint should be removed prior to enclosure. Defective paint should be wet scraped and HEPA vacuumed, protective gear should be worn by the workers, and the work area should be contained with 6-mil plastic (or equivalent). In multifamily housing, common stairways must be accessible to residents and workers during the construction work to avoid a fire code violation.

Wooden steps with lead-based paint should be completely covered with vinyl or rubber treads and risers. These materials should have a minimum specification that would qualify for Federal Housing Administration (FHA) product approval or should be commercial grade. The vinyl should be stapled as well as glued with floor adhesive in order to avoid sagging. Long staples are preferred to reinforce the tread cover at this critical point and prevent the vinyl from being pulled up by the toe of a shoe. Metal bull nosing can also be used at this wear point.

In addition, long staples or metal bull nosing should be used at the end of the vinyl that butts up tight to the wood riser of the next step.

Plywood can be used to cover step risers and squared-off treads. Plywood is also useful as additional protection, supplementing the vinyl covers mentioned above. Precast concrete steps will have to be drilled, screwed, and glued to anchor the covers in place.

6. Pipes

Painted pipes can be enclosed with the same tape used to make plaster casts, which provides a hard-finished end product. Loose paint and dirt should be safely removed first. The wrapped tape should overlap itself so that it is not dependent on adhering to the painted surface.

Pipes can also be enclosed with drywall. However, this type of enclosure will insulate and limit the ability of radiator pipes carrying steam or hot water to contribute to household heating.

7. Door Frames

Preformed metal door buck or frame covers come in standard sizes to accommodate most components, and as such they can be used to enclose both wood and metal door frames, either interior or exterior. All seams must be caulked. Primers on such bucks should be lead free.

8. Plywood Enclosures

Knee walls, painted structural supports, and trim such as baseboards, skirt boards, and stringers can be enclosed with plywood that is cut to fit tightly. These items should be sealed with adhesive and nailed. All joints should be caulked.

E. Exterior Enclosure Systems

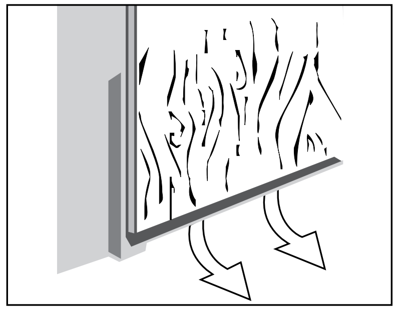
1. Siding

Vinyl or aluminum siding may be used to enclose painted exterior surfaces. In addition, porch columns (both square and round) and porch ceilings can be enclosed with these materials. Aluminum coil stock can be used on soffits, facia, barge board, decorative crown moldings (though original detailing will be lost), door and window frames, parapets, and other moldings. All seams need to be caulked and back-caulked. Soffit coverings under roof areas often need to be vented to prevent dry rot. However, as old paint degrades behind this covering, a small amount may migrate through the vents. Breathable cloth materials such as Tyvek® or an equivalent are available in rolls for this purpose and can be installed prior to the aluminum covering (see Figure 12.10a). Tyvek® will help prevent leaded dust from escaping through gaps in the new siding, although it will be necessary to leave attic vents uncovered to

Figure 12.11 Seal All Seams for Enclosure.

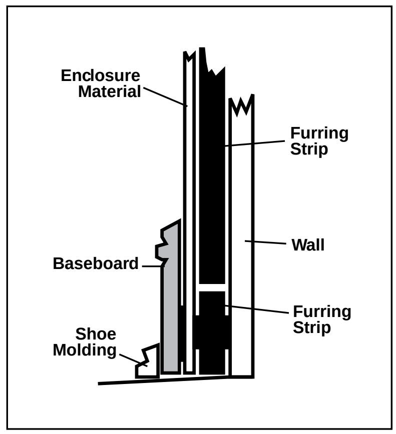
Create a dust-tight seal

Paint deteriorates more quickly behind an enclosure. All edges of an enclosure—especially the bottom—must be sealed well.



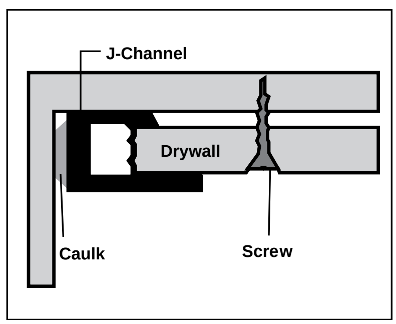
Seal the bottom edge

- Caulk the enclosure material at the bottom.
- Back-caulk and nail the baseboard in place.
- Back-caulk, bottom-caulk, and nail the shoe molding in place.



Seal the seams and other edges

- Back-caulk all the seams that aren't taped and spackled. Use a high quality adhesive caulk.
- Use a "J-channel" where drywall meets a finished surface. A J-channel is a final strip attached to the rough edge of drywall to make a finished edge. It's called a "J-channel" because of its shape. Caulk the outside edge so it seals with the finished surface. Screw the drywall in place.



permit adequate ventilation. Vent openings should not be covered with Tyvek® or other similar covering.

Since siding may not provide an airtight enclosure, rigid or flexible dust barriers like Tyvek® should be installed before broad surface enclosure. Perforated metal stock should not be used to enclose soffits, fascia, or eaves, since the enclosure is not dust tight.

Rotten or loose wood and any other defective substrate must be repaired or replaced to provide a sturdy foundation for the siding installation and edges.

2. Windows

For standard-sized windows, snap-in replaceable aluminum and vinyl tracks are available. These devices help eliminate the painted friction point (and thus the generation of leaded dust) where the moving sash abrades the painted surface. The track covers should be pressed into a bead of caulk at each joint. Painted sashes should be planed to remove lead-based paint and then reinstalled (see Chapter 11, SectionIII). Friction surfaces on windows should not be painted.

Window troughs should be covered with fitted metal and screwed into place. Again, the metal should be pressed into a bead of caulk at the joints and edges.

3. Exterior Walls

Board products made of various materials (e.g., synthetic fiberboard, wood byproduct composites, and cementitious materials) are commonly used in the construction industry for exterior purposes. These heavy, sometimes brittle coverings often have resins, fiberglass, or other durable ingredients that make them resistant to weathering and may require little maintenance, including painting. An added benefit of using these products is that they may have thermal insulation value. The products are best installed over flat surfaces that are not soft, crumbling, unstable, or otherwise defective. A defective substrate must be repaired prior to enclosure. All joints need to be sealed after installation.

Properly installed, natural or synthetic brick and stone veneers can be used to enclose exterior walls. In addition, stucco can be used as a covering material using wire mesh to physically anchor the cement to solid building components. A defective, weak surface needs to be stabilized before covering. Vinyl and aluminum siding are usually the least expensive options.

F. Summary

Enclosures are solid materials that are physically anchored to building components and that cover lead-based paint. Enclosure usually involves common construction techniques and has a 20-year design life. The enclosure abatement option is an effective, stable remedy for minimizing the danger of lead-based paint exposure. Because any barrier can be breached, annual monitoring by the owner and reevaluation by a certified risk assessor or inspector technician, are necessary.

Enclosure may be less hazardous and cheaper than paint and building component removal. There is less dust generated and little hazardous waste disposal. Unlike encapsulation, the enclosure is not dependent on the adhesion of the underlying coats of paint on the substrate surface for its durability, nor does it require deteriorated paint removal or surface cleaning and deglossing before installation.

Drywall is often a cost-effective interior finish, and aluminum or vinyl siding provides an acceptable exterior barrier. Aluminum coil stock is effective for enclosing outside trim. Floors require underlayment and vinyl or other sheet finish goods. Vinyl or rubber tread and riser coverings are recommended for steps.

Paint Removal: How To Do It

1. Do not use prohibited paint removal methods:
   - Open flame burning or torching.
   - Heat guns operating above 1,100 °F.
   - Machine sanding or grinding without a HEPA vacuum exhaust tool.
   - Uncontained hydroblasting or high-pressure wash.
   - Abrasive blasting or sandblasting without a HEPA vacuum exhaust tool.
2. Avoid using the following methods:
   - Methylene chloride chemical paint removers.
   - Dry scraping (except for limited areas).
3. Select the appropriate Worksite Preparation Level (see Chapter 8).
4. For heat gun work, provide fire extinguishers in the work area and ensure that adequate electrical power is available. Use for limited areas only. Train workers to avoid gouging or abrading the substrate.
5. For mechanical removal methods, use tools equipped with HEPA exhaust capability. Be sure workers keep the shroud against the surface being treated. Vacuum blasting and needle guns should not be used on wood, plaster, drywall, or other soft substrates. Observe the manufacturer's directions for the amount of vacuum airflow required.
6. For wet scraping, use a spray bottle or wet sponge attached to the scraper to keep the surface wet while scraping. Apply enough water to moisten the surface completely, but not so much that large amounts run onto the floor or ground. Do not moisten areas near electrical circuits.
7. For chemical paint removers, determine if the building component can be removed and stripped offsite. Offsite stripping is generally preferred to onsite paint removal. Observe all manufacturer's directions for use of paint removers.
8. For offsite stripping, determine how to remove the component. Score the edges with a knife or razor blade to minimize damage to adjacent surfaces. Punch or tag the building component if similar building components are also being stripped offsite (e.g., doors). This will ensure that the individual component is reinstalled in the same location. Inform the offsite paint remover that lead-based paint is present before shipping. Wrap the component in plastic and send to the offsite stripping location. Clean all surfaces before reinstallation to remove any lead residues by HEPA vacuuming all surfaces, cleaning with other lead-specific cleaners, or phosphate detergents, and HEPA vacuuming again. Conduct cleanup and clearance.

9. For onsite paint removal, first test the product on a small area to determine its effectiveness. Chemical paint removers may not be effective or desirable on exterior, deteriorated wood surfaces, aluminum, and glass. Provide neoprene, nitrile, rubber, or polyvinyl chloride (PVC) gloves (or other type of glove recommended by the manufacturer); face shields; respirators with combination filter cartridges for leaded dust and organic vapors (if appropriate); and chemically resistant clothing. Be sure to select the right type of organic vapor filter cartridge, gloves, and clothing for the specific chemical being used. Portable eyewash stations capable of providing a 15-minute flow must be onsite. Apply the chemical and wait the required period of time. Maintain security overnight to prevent passersby from coming into contact with the chemical. For caustic chemical paint removers, neutralize the surface before repainting using glacial acetic acid (not vinegar). Repaint and conduct cleanup and clearance.

10. Dispose of waste properly; most wastes from paint removal projects, such as paint chips and paint remover sludges, will need to be managed as hazardous waste.

11. Conduct cleanup.

12. Have a certified risk assessor or inspector technician conduct a clearance examination and provide documentation and a Statement of Lead-Based Paint Compliance.

Section IV

I. Paint Removal Methods

A. Introduction

"Paint removal" means the separation of the paint from the substrate using heat guns, chemicals, or certain contained abrasive measures, either onsite or offsite. As an abatement technique, paint removal is usually reserved for limited areas and for those surfaces where historic preservation requirements may apply.

While paint removal can be performed safely and effectively, it also demands the highest level of control and worker protection for several reasons. Paint removal usually creates the greatest hazard for the worker, either from the hazards associated with the removal process (e.g., heat, chemicals, and sharp tools) or from the lead that becomes airborne or is left as a residue on the surface after removal. Extensive onsite paint removal should usually have an Interior Worksite Preparation Level 4 and an Exterior Worksite Preparation Level 3. Lower levels are possible if the size of the area to be treated is small (see Chapter 8). Because of the lead residues left behind by all paint removal methods, particularly on porous surfaces such as wood or masonry, more extensive cleaning is usually required to meet clearance criteria. Paint removal methods also generate a significant amount of hazardous waste and may be the most costly of all lead abatement methods (HUD, 1991).

In spite of these limitations, paint removal has the benefit of a low reevaluation failure rate. If some lead-based paint is left in the dwelling, its condition will need to be monitored by the owner and by a certified risk assessor based on the Reevaluation Schedule for the specific property (see Chapter 6).

B. Prohibited Methods

Certain methods of lead-based paint removal are absolutely prohibited, either because of unacceptably high worker exposures to lead or release of lead into the environment through production of dust or fumes or both.

1. Open Flame Burning or Torching

Burning, torching, fossil fuel-powered heat plates, welding, cutting torches, and heat guns operating at temperatures greater than 1,100 °F are prohibited as a means of paint removal because of the high temperatures generated in the process. So-called heat plates (those using propane to heat a grid, which in turn heats the paint) are also prohibited because of the high temperatures generated. At these temperatures, lead fumes may be produced.

Lead fumes are formed when lead is heated into a gas. The gas cools when it comes into contact with the cooler surrounding air and condenses into very small particles. These particles travel easily, are readily inhaled and absorbed into the body, and are difficult to clean up. Several researchers have found that worker exposures are extraordinarily high when doing this kind of work (NIOSH, 1992a; Jacobs, 1991b; Rekus, 1988). The fumes may also travel throughout the dwelling, contaminating all surfaces with which they come into contact. Other hazardous substances may be released from the paint film using heat.

Using cutting torches to remove fire escapes, railings, or other metal components coated with lead-based paint is also prohibited unless the paint is removed first. Similarly, welding of painted metal components (such as preprimed structural steel) is prohibited by Occupational Safety and Health Administration (OSHA) regulations (29 CFR 1926.354(d)).

2. Machine Sanding or Grinding Without a HEPA Exhaust Tool

Machine sanding or grinding is prohibited (regardless of the grit used) because of the large volume of leaded dust generated. As a result of these methods, workers have been exposed to extremely high leaded dust levels, and blood lead levels in resident children have increased (Amitai, 1991; Farfel, 1990; Jacobs, 1991b). However, machine sanding with a HEPA

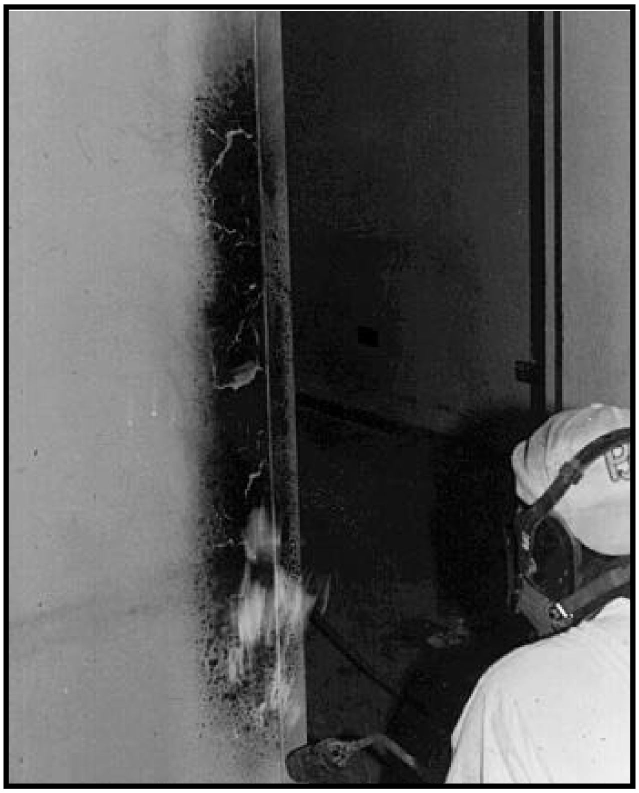


Figure 12.12a Open Flame Burning Is Prohibited.

Figure 12.12b Open-Faced Power Sanding or Grinding Is Prohibited.

exhaust tool *is* permitted and is discussed further below. Extensive dry hand sanding is not recommended, but wet sanding can be done if no electrical outlets are nearby. Limited dry sanding or scraping near electrical circuits is permitted.

3. Uncontained Hydroblasting or High-Pressure Water Wash

Uncontained hydroblasting and high-pressure water washing are prohibited. Because of the potential for widespread environmental contamination, such activities should be undertaken with full containment. All water should be captured, contained, and treated as potentially hazardous waste (contact the local water and sewage agency for guidance on local requirements). Since capturing and containing *all* water is not feasible, this method of paint removal is not permitted for lead-based paint abatement work in housing.

4. Abrasive Blasting or Sandblasting

Traditional abrasive blasting or sandblasting is prohibited in residential structures, regardless of whether the abrasive material is recycled or if the area is fully contained. These methods produce widespread dust contamination; full containment is nearly impossible to maintain and guarantee in a residential environment. Abrasive blasting should only be carried out using HEPA vacuum local exhaust equipment, which is discussed below.

If for some reason abrasive blasting must be done in a residential structure, the area must be sealed and placed under negative pressure with at least 10 air changes per hour. If the exterior must be blasted, the entire building must be covered with a tent and placed under negative pressure with at least 10 air changes per hour. In both cases, all exhaust air must be passed through a HEPA filter. Fresh air should be provided to the containment zone at a lower rate than the exhaust airflow to maintain the negative pressure zone.

C. Methods Not Recommended

1. Dry Scraping

Dry scraping is not recommended because of the large volume of particulate matter that is generated (including high levels of leaded dust).

The two situations where dry scraping is appropriate include scraping surfaces near electrical outlets, which cannot be wet scraped because of the obvious electrocution hazard, and scraping when using a heat gun since this cannot be performed wet. For both of these cases, dry scraping is only appropriate for limited surface areas.

2. Chemical Paint Removers Containing Methylene Chloride

Chemical paint removers containing methylene chloride are not recommended, although they are still widely sold in paint stores. This also applies to methylene chloride paint removers that have waxes or other coatings to retard evaporation. Some local regulations may prohibit the use of methylene chloride. Since methylene chloride evaporates readily and is colorless and odorless at the permissible exposure limit, workers may be unaware of their exposure. Methylene chloride can cause liver and kidney damage and carbon monoxide poisoning (as a metabolite) and is suspected to cause cancer (ACGIH, 1992; IARC, 1990). Air-purifying respirators with organic vapor cartridges *do not provide adequate protection* against methylene chloride. In those projects where methylene chloride must be used, air-supplied respirators (or self-contained breathing apparatuses) are required under OSHA regulations (29 CFR 1910.134).

D. Recommended Methods

1. Heat Guns

Since open flame burning is prohibited, heat removal methods are limited to electric-powered flameless heat guns.

Before beginning work, fuses and an adequate electrical supply should be verified. Larger fuses should not be installed because of the possibility

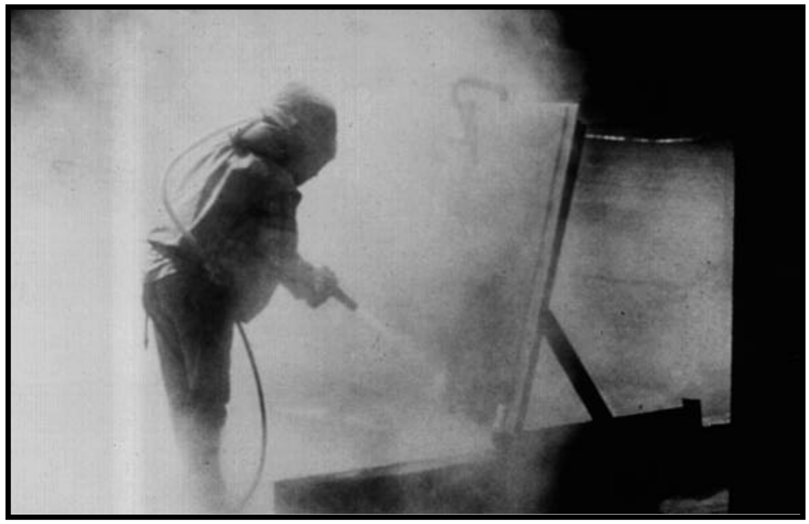


Figure 12.13 Traditional Abrasive Blasting Is Prohibited (note the visible dust surrounding the worker).

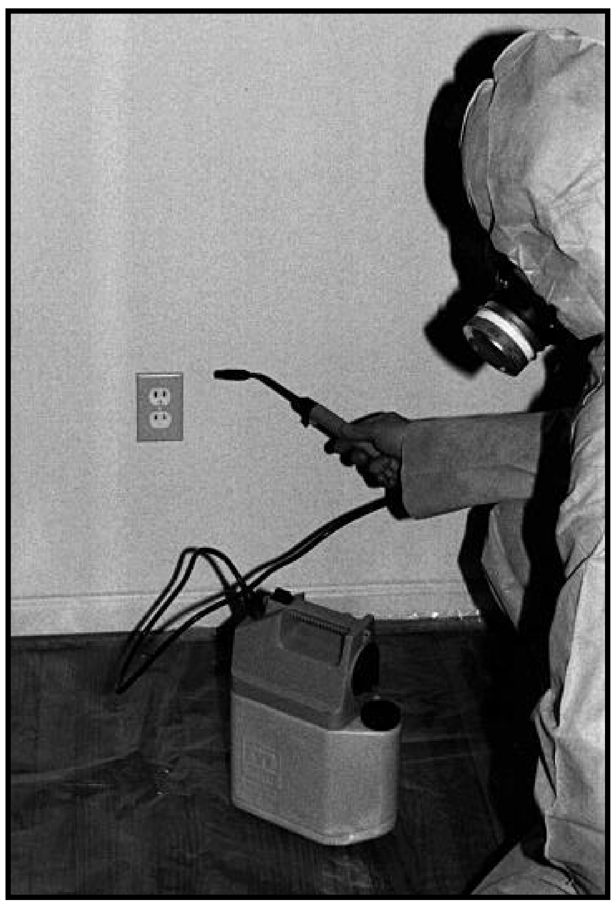


Figure 12.14 Do Not Wet Painted Surfaces Near Electrical Circuits.

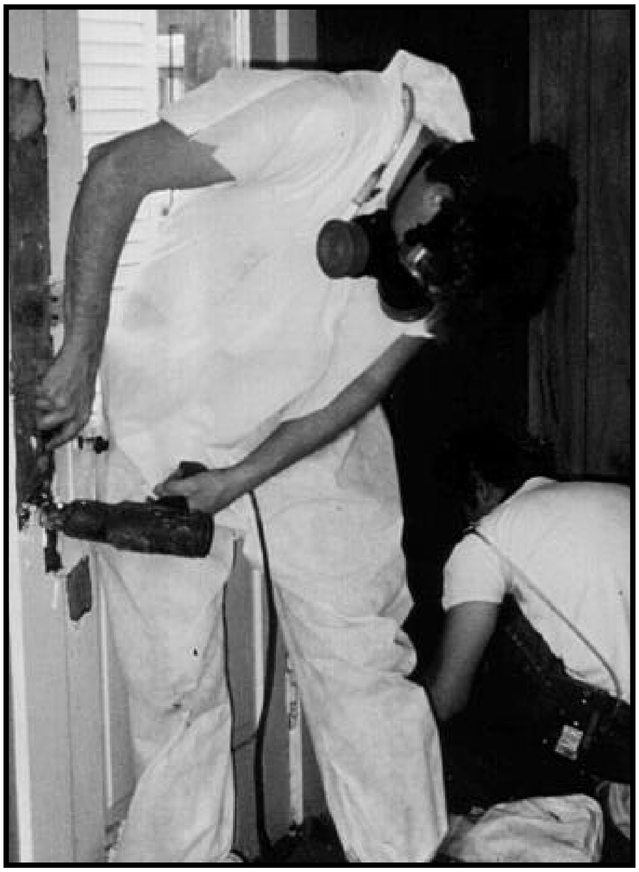


Figure 12.15 Heat Guns Operating Below 1,100 °F Are Useful for Limited Areas.

of creating a fire hazard. A portable electric generator may be needed, especially if several heat guns will be required. Care should be exercised around wallpaper, insulation, and other flammable materials. An accessible garden hose with a pressure-release spray nozzle, a crowbar to remove smoldering wood, and a long-handled sledgehammer to open up walls exposed to smoldering insulation should be readily available. Under OSHA regulations (29 CFR 1926.150), a fully charged ABC-type 20-pound (minimum) fire extinguisher must be available within 100 feet of the work area. Work should be conducted only in well-ventilated spaces, since other hazardous materials may be released when heating old painted surfaces (NIOSH, 1990).

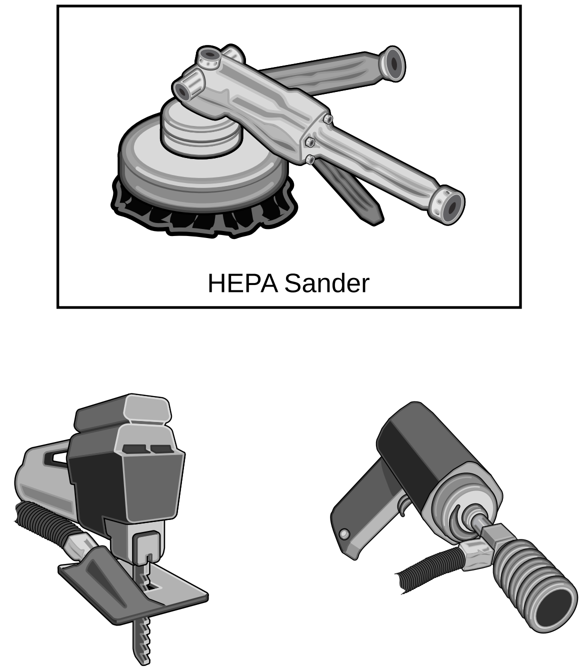
While there is little danger of producing dangerous levels of lead fumes at temperatures below 1,100 °F, significant airborne particulate lead is generated by the accompanying scraping of the paint. Also, significant amounts of potentially harmful organic vapors can be released from the action of the heat upon the paint, even at temperatures below 1,100 °F. For this reason, air-purifying respirators should be outfitted with both a HEPA-filtered cartridge and an organic vapor cartridge. Organic vapor cartridges may not be available for some powered air-purifying respirators.

Depending on the size of the area and the substrate, paint removal by heat gun can be a slow, labor-intensive process and may result in a high final clearance failure rate if used extensively and without proper cleanup. Removing paint completely, particularly from crevices, requires attention to detail. Significant leaded residue may remain on surfaces unless cleanup is thorough. Heat guns do not appear to be particularly effective on metal or masonry substrates, which are too porous to be scraped effectively; the heat may cause small particles to fly up and hit the worker, causing burns or eye damage. Although heat guns work well on wood, they will usually damage drywall and plaster.

Workers may tend to place the nozzle of the heat gun too close to the surface, burning out the heating elements prematurely. One way to prevent this is to attach a small metal wire cage or extension tube to the end of the heat gun to prevent it from being placed too close. For most heat guns, the optimal distance from the surface is 3 to 6 inches. The heat gun is recommended only for limited surface areas in well-ventilated spaces. Other problems with heat guns include additional fire hazards from dry rot, insulation, and dust, especially in window troughs, roof areas, and hollow porch columns. Scraping often leaves the substrate very rough and may singe adjacent wallpaper. Telephone wires mounted on baseboards can melt, and heat can crack glass with a cold exterior or dry glazing.

To use heat guns properly, allow the heat stream leaving the gun to merely soften the paint. Do not allow the paint film to scorch or smoke. At the very first sign of paint softening, blistering, or bubbling, discontinue the use of heat and immediately scrape the loose paint off the surface.

Figure 12.16 HEPA Vacuum Power Tools.



2. Mechanical Removal Methods

HEPA Sanding

HEPA sanders are valuable for surface preparation prior to repainting. Since chemical stripping sometimes raises the grain of the wood and some removal methods are not effective at removing all visible traces of paint, some sanding prior to repainting may be needed. Sanding can cause generation of significant levels of airborne and settled lead dust; therefore, HEPA-assisted sanders are recommended whenever sanding must be done. HEPA sanders do not work well on detailed moldings.

HEPA sanding uses traditional electric sanders, such as disc sanders or orbital or vibrating sanders, equipped with specially designed shrouds or containment systems that are placed under a partial vacuum (also known as local exhaust ventilation). All exhaust air is passed through a HEPA filter (often using an ordinary HEPA vacuum) to reduce the amount of airborne particulate lead. The HEPA vacuum must be correctly sized to provide adequate airflow to permit the system to operate properly. If hoses are longer than normal, a larger HEPA vacuum may be needed to handle the increased pressure drop.

There are two main types of HEPA sanders. The first uses a flexible shroud to surround the sanding head, with the HEPA vacuum hose attached to the shroud. The shroud must be in constant contact with the surface to be effective. If the shroud extends beyond the surface being sanded, large amounts of particulate lead will be released into the air. In addition, this configuration makes it impossible to sand to the edge of protruding surfaces, such as baseboards or window and door casings.

The second type of HEPA sander pierces the sandpaper with holes through which the vacuum draws the dust. This allows the instrument to be used to the edge of protruding surfaces. However, care must be exercised to keep the sandpaper flat on the surface. Neither one of these methods is completely effective; respirators are always recommended. Worker fatigue can also prevent the worker from holding the tool flush with the surface, making it necessary to provide frequent breaks or rotate workers.

Wet Scraping

Wet scraping is feasible on most surfaces and results in lower lead exposures than dry scraping. Since surfaces near electrical outlets should never be moistened (due to the electrocution hazard), these areas should be dry scraped.

Wet scraping can be performed by using a spray bottle or sponge attached to a paint scraper. Wet scraping is often used to remove loose and

Figure 12.17 Scraping Tools.

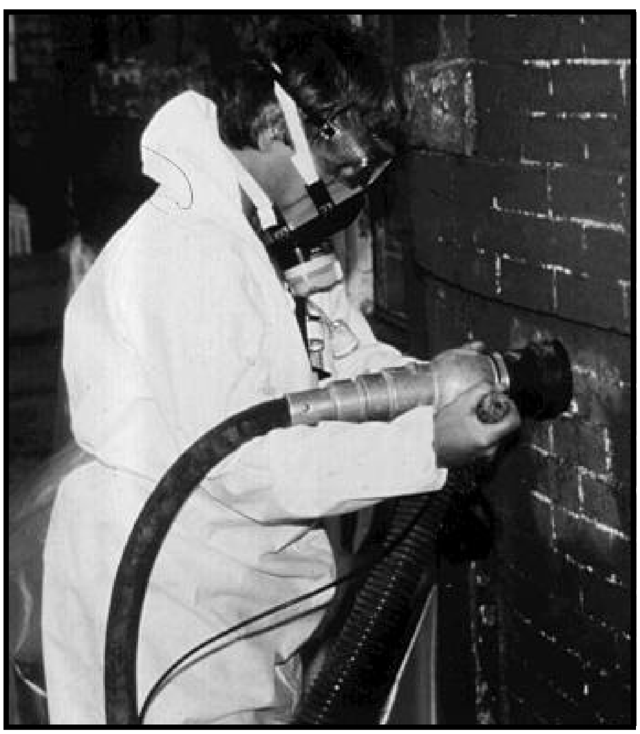


Figure 12.18 Vacuum Blasting.

flaking paint prior to paint film stabilization or encapsulation. If wet scraping is employed as an abatement technique, a more durable covering than new paint is needed.

Working a few square feet at a time, the surface should be lightly misted with water from a garden sprayer or plant mister. Using a paint scraper, loose material should be scraped from the surface and deposited on the containment plastic. Damp paint chips should be cleaned up as soon as possible so that they are not tracked throughout the work area or crushed beneath the feet of workers.

Scraper blades should be kept sharp to minimize abrasion and gouging. Additional scraper blades should be on hand and should be selected for the type of surface being scraped. To obtain a smooth finish, it may be necessary to follow wet scraping with wet sanding. A variety of scraping tools are available from hardware and paint supply stores.

HEPA Vacuum Blasting

HEPA vacuum blasting is simply abrasive blasting with a shroud under a vacuum that is attached to the blast head. All exhaust air is passed through a HEPA filter, using a properly sized HEPA vacuum system. Vacuum blasting is appropriate for metal, brick, concrete, and other masonry surfaces. To date, attempts to use the process on wood, plaster, and other soft materials have not been successful, as they usually cause severe substrate damage.

Various blasting media can be used (e.g., aluminum oxide, metal shot, walnut shells) depending on the type of substrate. Blast heads, usually a brush-type arrangement, come in various sizes and shapes. The blast head must remain in continuous contact with the surface to avoid dispersal of both the blast medium and particulate lead. The equipment can be outfitted with a device that separates the blast media from the paint, effectively recycling the blast material, and dramatically reducing the volume of waste.

This is particularly important, since the blast material will probably be treated as hazardous waste.

Use of the equipment for long periods of time can result in worker fatigue, particularly if working with the arms above the head. Since fatigue can cause a worker to momentarily lose contact with the surface, resulting in the release of leaded dust, the goal is to minimize the degree to which workers must reach above their shoulders. Scaffolding and platforms should be constructed to minimize such stress and frequent work breaks should be taken. Vacuum blasting is not typically used in interior residential work.

HEPA Vacuum Needle Gun

The HEPA vacuum needle gun is similar to vacuum blasting in concept but avoids the use of a blast medium. In the vacuum needle gun, metal needles rapidly pound against the painted surface, dislodging the paint. The HEPA vacuum, which is connected to the gun head, draws paint chips and dust into the vacuum, minimizing the dispersion of the particulate.

The needle gun is appropriate for metal surfaces but may cause significant damage to masonry. Problems of worker fatigue are similar to those encountered in vacuum blasting. Losing shroud contact with the surface can cause the deposition of significant amounts of chips onto the containment surface. Chips should be cleaned up as soon as possible following the work to avoid tracking.

One way of maintaining the seal with the surface is to select the proper shroud for the shape of the surface treated. At least one manufacturer (Penntek) has developed different shrouds for corners, edges, and flat surfaces. Needle guns are not effective in capturing large paint chips, so use of plastic sheeting underneath is required.

3. Chemical Removal Methods

Chemical removal may result in less leaded dust generation than other removal methods. It is often used in situations where historic preservation requirements apply. However, it may leave leaded residues on porous surfaces, which may pose a hazard to resident children in the future.

One study has demonstrated that windows treated with chemical paint removers had high leaded dust levels a few months after treatment, even though cleanup and clearance had been conducted properly (Farfel, 1992).

Other drawbacks to chemical removal include high cost and potential harm to workers from splashes and chemical burns if proper gloves, face shields, and clothing are not provided. Proper ventilation is necessary when using chemical paint removal. Plastic may not be effective in protecting floors and may have to be augmented by paper or cardboard. Chemical residues can be tracked into other areas on workers' shoes if proper decontamination is not conducted. Adjacent surfaces, especially plaster, can also be damaged. High humidity may retard the chemical remover's effectiveness. If protective clothing is penetrated and becomes matted against the skin, it must be removed *immediately*. A full shower is strongly

Figure 12.19a. Needle Gun With HEPA Exhaust Ventilation (without shroud).

Figure 12.19b. Needle Gun With HEPA Exhaust Ventilation (with shroud).

Figure 12.20 Proper Protective Gear, Including Gloves, Faceshield, Goggles, and Eyewash is Required When Working With Chemical Paint Removers.

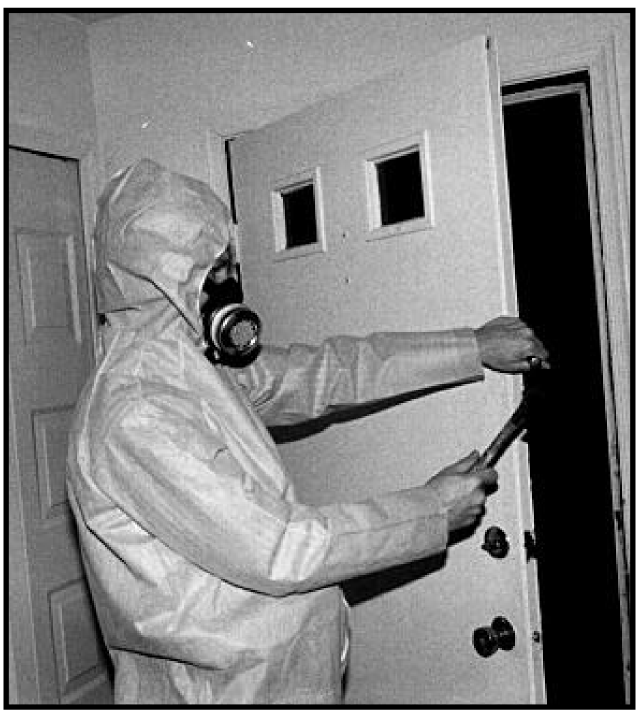


Figure 12.21 Use Punches To Identify the Location of Components Before Sending Them Offsite for Paint Removal.

recommended; the skin must be washed and thoroughly rinsed.

Chemical paint removal can be broken into two broad categories: offsite paint removal and onsite paint removal.

Offsite Paint Removal

Offsite paint removal is preferred, since most of the contamination and residues are generated away from the dwelling. The general approach is as follows.

Building components to be stripped must first be removed from the building. Misting with water prior to removal will help minimize the amount of airborne lead. The painted seam between the component and the wall should first be cut with a utility razor knife to minimize damage to the adjacent plaster. If there is more than one similar component, they should be labeled using a punch system in an obscure location (e.g., the bottom or side of a door), then wrapped in plastic and sealed with tape to avoid the spread of contamination during transport. Tag systems are not recommended since they must be removed when the component is dipped. Markers should not be used since they will dissolve during stripping. The punch will identify exactly where the component came from, eliminating the need for changing doors or other retrofitting problems.

Potential damage to components during stripping includes damage to hardware (this should be removed before stripping), broken glass, loss of glue joints and fillers, damage to wood fibers (wood swelling), and raising of the wood grain. The component may even fall apart and have to be blocked and reglued. Old glazing compounds on windows may also be weakened. The stripping firm should be instructed to *thoroughly* wash and neutralize the components after stripping.

Before materials are returned from the paint stripper, they should be wrapped in 6-mil plastic and sealed with tape. This will minimize contamination of those handling the materials since leaded residue may remain on the surface. Materials should remain sealed in plastic until other onsite dust-generating activities are concluded and the dust cleaned up.

Before reinstallation, the treated components should be cleaned using the standard HEPA/wet wash/HEPA cycle to remove any residues left by the paint stripper. Components must be completely dry before repainting. Always check the pH after cleaning and *before* repainting.

Onsite Paint Removal

Many paint removers must be allowed to remain on the surface anywhere from 1 hour to a day or more to accomplish effective stripping. Most paint removers are efficient within a limited temperature range and may be completely ineffective in cold weather. The contractor must therefore be certain of weather conditions prior to outdoor application. Also, rain can cause environmental contamination from the lead and the chemical remover.

Paint removers are either caustic or noncaustic. The noncaustic chemical removers are generally safer to use than the caustic ones (assuming the former do not contain methylene chloride). Material Safety Data Sheets should always be consulted to determine potential chemical hazards.

When using chemical strippers, security is important, particularly with the caustics. Caustic paint removers can cause severe skin burn and eye damage to workers and children who may gain access to the work area. Pain receptors in the eyes are not as sensitive to caustic substances as they are to acids, so workers may suffer damage without immediately realizing it.

The use of chemically resistant clothing; long neoprene, nitrile, rubber, or PVC gloves; and face shields is mandatory under OSHA regulations. OSHA also requires a portable eyewash station whenever eye-irritating paint removers are used in housing.

An abundant source of running water in the abatement area for flushing chemicals from skin or eyes is required by OSHA regulations. The water should come from a nearby tap or portable eyewash stations. If contact with the eyes occurs, a full 15-minute rinse of the eyes is necessary onsite, *before the individual leaves to seek medical attention*, since permanent damage to the eyes occurs quickly. While 15 minutes may seem excessive, a quick rinse is ineffective, and permanent damage usually occurs on the way to seek medical attention.

Usually, noncaustic strippers are not as effective at removing multiple layers of paint in a single application, compared to the caustic products. When using noncaustic removers, small areas should be tested before full-scale treatment to determine their efficacy. For vertical surfaces, adhesion of the liquid or gel-type paint removers should also be tested to determine runoff potential (particularly a problem in warm weather). Most caustic paint removers work best on nonporous surfaces such as steel. They generally should not be used on aluminum or glass surfaces.

Paint removers that contain volatile substances should be used only in areas equipped with mechanical ventilation and only when workers are properly equipped with gloves, face shields, protective clothing, and respirators, as needed.

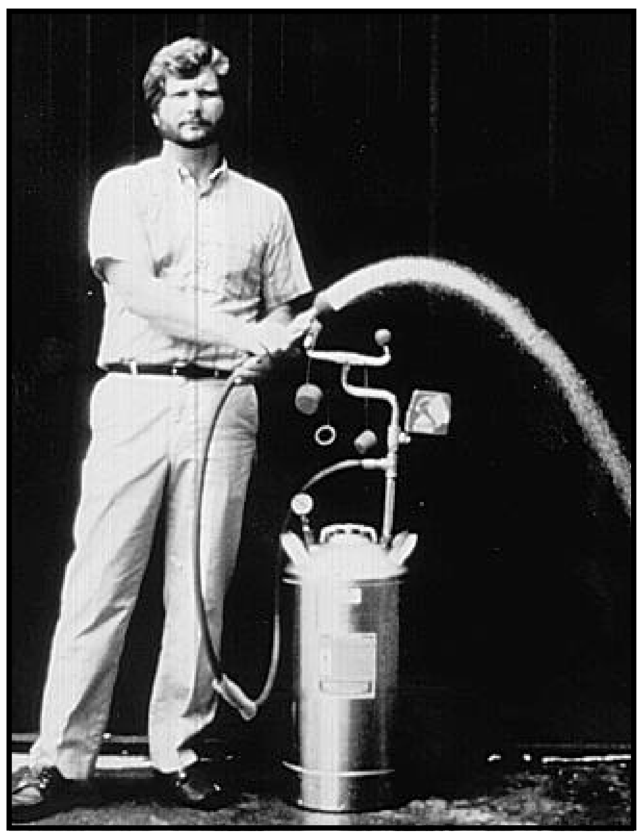


Figure 12.22 Eye Wash Stations Are Required When Caustic or Chemical Paint Removers Are Used.

Figure 12.23a Neutralize Surfaces When Using Caustic Paint Removers.

Figure 12.23b Neutralize Surfaces With a Glacial Acetic Acid Wash When Using Caustic Paint Removers.

The paint remover should be applied with a spatula, trowel, brush, or spray gun. Spray gun use should be minimized since worker exposures are greater. The time the remover must stay on the surface will depend upon the number of layers of paint, the type of paint, the temperature, and the humidity, and can range from a few hours to a day or more. The paint remover should not be allowed to dry out. Some manufacturers provide a polyethylene or paper blanket that is pressed into the surface to retard drying; others contain a film that is formed on the surface of the paint remover as it sits to prevent drying. Caution must be used when applying the paint remover overhead in order to avoid dripping onto workers below.

After the appropriate period of time, the softened paint should be removed using a scraper or putty knife and the material deposited in a watertight and corrosion-proof container (usually supplied by the manufacturer). The waste should be submitted for "Toxicity Characteristic Leading Procedure" (TCLP) tests to determine if it qualifies as hazardous waste. Alternatively, the owner can assume that it is hazardous waste and manage it accordingly (see Chapter10). Chemical stripper waste is almost always hazardous waste. The stripped surface must be thoroughly cleaned to remove lead and paint remover residues.

With wood surfaces, it is important to complete the entire neutralization and cleaning process without letting the surface dry. If the wood dries before cleanup is complete, the pores in the wood may close, locking potentially significant leaded residues inside. When repainting, some of the leaded residue may leach into the new paint.

Alkali neutralization and residue removal are accomplished as follows. Immediately after paint removal (while wood surfaces are still damp), the surface should be thoroughly scrubbed with a solution of glacial acetic acid. Use of vinegar to neutralize the alkali should be avoided since vinegar may be inadequate as a neutralizing agent and will also result in a significantly larger volume of liquid (and potentially hazardous) waste.

Glacial acetic acid is hazardous and can cause skin burns and eye damage. It should be used carefully and only with neoprene, nitrile, rubber, or PVC gloves; chemically resistant clothing; eye shields; a NIOSH-approved acid gas cartridge; and a HEPA filter on air-purifying respirators.

The damp, stripped surface should be thoroughly scrubbed with the acetic acid solution. The solution should be monitored with pH litmus paper and discarded if the pH exceeds 6. After use, the solution should be placed in corrosion-proof containers and treated as potentially hazardous waste. Sponges and other cleaning materials should not be reused but deposited in double 4-mil or single 6-mil trash bags that are sealed, labeled, and put in a secure waste storage area.

Following neutralization, the damp surface should be thoroughly scrubbed with a high-phosphate detergent or other cleaner. Scrubbing should continue until no residues are visible. The cleaning solution should be changed when it becomes dirty. Following the detergent scrub, a clean water wash should be performed to remove residue. The pH of the water wash should be checked after use. If the pH exceeds 8, further neutralization of the surface with the acetic acid solution is necessary prior to repainting since an alkaline surface will cause the new paint to fail in a matter of days or weeks.

Surfaces should be completely dry before repainting. For wood surfaces, this may take several days to a week. If the moisture has raised the grain and sanding of wood surfaces is required before repainting, a HEPA sander should be used.

Since porous surfaces such as wood or masonry may still have slight alkali residues, some types of oil paints should not be used after caustic paint remover application. To do so may result in saponification (a "soap-making" reaction between the paint and the substrate, leading to rapid paint failure). Therefore, latex paints are probably most appropriate. Wood surfaces (especially exterior ones) can deteriorate after paint removers have been applied, making new paint difficult to apply. Also, the new paint may not last long on deteriorated substrates. Some old plasters with a high pH may require special primers, which are no longer manufactured. A special sealant may be needed on such surfaces. The specific paint remover manufacturer should be contacted for further guidance on appropriate paints to use.

High-pressure water removal of caustic paint removers should be avoided since control of solid and liquid contamination is difficult. Release of solids or liquids into the soil is likely to result in costly cleanup. Care must be used when applying caustic paint removers to friction surfaces, such as window jambs. Such surfaces are often weathered, making residue removal even more difficult. If these residues are embedded in a coat of new paint, the friction caused by opening and closing the windows can lead to the release of leaded dust.

E. Waste Disposal

Wastes produced during paint removal are highly concentrated, but low in volume. The waste may be exempt from some hazardous waste regulations if less than 220 pounds is generated per month (see Chapter 10). Many local jurisdictions pick up small amounts of hazardous waste on certain days. If offsite paint removal is performed, the waste is the responsibility of the facility performing the removal.

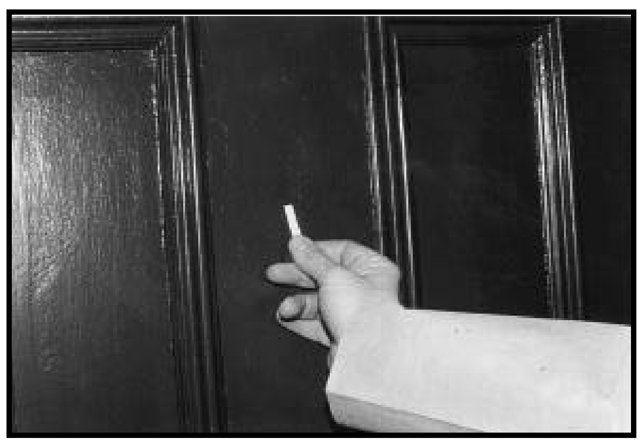


Figure 12.24 Use Litmus Paper on a Bare Stripped Surface Before Repainting.

Soil and Exterior Dust Abatement: How To Do It

1. Determine if a soil lead hazard exists. For a hazard to exist, a total of at least 9 square feet of soil in a single yard or area must be bare and soil concentrations must exceed either 2,000 µg/g of lead for the yard or building perimeter or 400 µg/g of lead for small, high-contact play areas (pending the development of an EPA soil standard). Bare soil above these levels should be treated by either interim controls or abatement. Soil abatement is most appropriate when levels of lead are extraordinarily high (greater than 5,000 µg/g) and when use patterns indicate contact frequency and exposure will be high.

2. Collect preabatement soil samples to determine baseline levels. These samples need not be analyzed if postabatement soil samples are below applicable clearance levels.

3. Determine the method of soil abatement (soil removal and replacement, soil cleaning, or paving). Soil cultivation (rototilling or turning over the soil) is not recommended.

4. If paving, use a high-quality concrete or asphalt. Observe normal precautions associated with traffic load weight and thermal expansion and contraction. Obtain any necessary permits. Keep soil cultivation to a minimum.

5. If removing and replacing soil:

    a. Determine if waste soil will be placed in an onsite or offsite burial pit. Prepare vehicle operation and soil movement plan. Test new replacement soil (should not contain more than 200 µg/g lead).

    b. Contact the local United Utilities Protection Service (UUPS), Miss Dig, Miss Utility, or the American Public Works Association at (816) 472–6100, ext. 584, to determine location of underground utilities, including water, gas, electric, cable TV, and sewer, or contact each utility individually. Mark all locations to be avoided.

    c. Remove fencing if necessary to allow equipment access and define site limits with temporary fencing, signs, or yellow caution tape.

    d. Tie and protect existing trees, shrubs, and bushes.

    e. Have enough tools to avoid handling clean soil with contaminated tools.

    f. Remove soil.

    g. Clean all walkways, driveways, and street areas near abatement area.

    h. Replace soil at proper grade to allow drainage. Replacement soil should be at least 2 inches above existing grade to allow for settling.

    i. Install new soil covering (grass or sod) and maintain it through the growing season.

    j. Have enough workers and equipment available to complete the job in 1 day.

6. Determine if soil waste is hazardous and manage it accordingly (see Chapter 10).
7. Conduct final cleanup and clearance.
8. Provide walk-off doormats to residents and educate them on the benefits of removing shoes at the dwelling entryway.

Section V

I. Soil and Exterior Dust Abatement

A. Introduction

Lead-contaminated soil and exterior dust have been shown to cause elevations in blood lead levels of children in a number of studies (EPA, 1993c). Exposure to lead in soil and exterior dust can occur both outside during play and inside from soil and dust carried into houses on shoes, clothing, pets, or other means.

Soil can become contaminated over a period of years from the shedding of lead-based paint on nearby buildings, windblown leaded dust from adjacent areas, and fallout of leaded dust from the atmosphere (either from a local point source or from leaded gasoline emissions in the past). Uncontrolled paint removal from nearby houses or painted steel structures can also result in contaminated soil (controlling soil lead levels should be a consideration in every exterior lead-based paint abatement project).

Soil lead hazards are determined by measuring the concentration of lead in the soil, examining the location and use of the soil, and determining the degree to which the soil is "bare" (see Chapter5). For a yard or area to require hazard control, a total of at least 9 square feet of bare soil must be present. Any size bare area in a play area containing more than 400 µg/g of lead is a hazard. Appendix 13.3 contains details on a sampling method to measure lead in soil. When assessing the condition of the surface cover, it is important to determine why the soil is bare. Bare soil is common in the following areas and circumstances:

- Heavily used play areas.
- Pathways.
- Areas shaded by trees or buildings.
- Areas with damaged grass.
- Drought conditions.

Measuring the lead content of soil will aid in the selection of an appropriate abatement method that has a reasonable likelihood of being maintained. Soil *abatement* (as opposed to interim controls) is generally appropriate when lead is present in extraordinarily high concentrations (more than 5,000 µg/g), use patterns indicate exposures are likely, or interim controls are likely to be ineffective (e.g., planting grass in high-traffic areas). Soil interim controls were covered in Chapter 11, Section V. This section describes soil treatments that should be effective for at least 20 years.

Preabatement soil samples should be collected but not necessarily analyzed until postabatement soil samples have been collected, analyzed, and compared to clearance standards. If postabatement soil levels are below applicable limits, the preabatement samples need not be analyzed (see Chapter 15).

B. Soil Abatement Methods

Soil abatement methods include:

- Soil removal and replacement followed by offsite or onsite disposal.
- Soil cultivation (rototilling).
- Soil treatment and replacement.
- Paving with concrete or asphalt.

Soil removal is discussed in detail below; however, before choosing to remove contaminated soil, other treatment options should be considered. The advantages of using soil treatment methods (as opposed to soil removal) are threefold (Elias, 1988):

- The costs of hauling large quantities of contaminated soil are eliminated or greatly reduced.
- Disposal sites for soil are not needed except for a much smaller volume of wastes generated during the treatment process.
- The need for uncontaminated replacement soil is greatly reduced.

1. Soil Removal and Replacement

For most soil removal projects, removal of 6 inches of topsoil is adequate. The depth of soil lead contamination is usually restricted to the top of the soil, with contamination decreasing markedly below the top few inches. However, in urban areas it is not uncommon for the contamination to extend to up to 1 or 2 feet in depth. This may be because these areas were once the location of buildings contaminated with lead-based paint. Alternatively, past practices may have resulted in a gradual buildup of the elevation of the soil grade over time. In such circumstances, the removal of the top layer of soil may leave behind contaminated soil at lower depths. In mixed residential/industrial areas, or where industry once existed, the depth of the contamination may vary widely. The desired decision on the depth of removal should also consider the depth of soil disturbance during the course of usual activities, such as gardening. If the top layer of soil will not be penetrated, then it should not be necessary to remove lead-contaminated soil at deeper levels, since there will be no exposure.

In the EPA Urban Soil Lead Abatement Project (EPA, 1993c), the depth chosen for demonstration purposes was 6 inches. In residential areas in Canada, where secondary lead smelters are the primary source of contamination, soil also was removed to a depth of 6 inches (Stokes, 1988). Guidelines for soil removal developed by the Ontario Ministry of the Environment (1987) recommended removal of the top 12 inches. The 12-inch recommendation was based in part on earlier experiences where considerable recontamination was observed 7 to 8 years after soil was removed to a 6-inch depth (Stokes, 1987). However, the reason for the recontamination was thought to be due to contamination of the replacement soil by adjacent polluted soil that had not been removed (Jones, 1987), not by contaminated soil from deeper levels.

For practical purposes, properly conducted soil removal to a depth of 6 inches should suffice in urban residential areas that are restricted to grass, shrubs, or shallow gardens. However, the depth of soil contamination should be assessed at each site, and the decision regarding depth should be made based on the results of the soil sampling and anticipated use of the land. For most residential areas, the depth of removal will not exceed 6 inches. Records of the soil sampling and abatement that occurs should be maintained with the permanent records of the property. These records will alert property owners who are planning excavations to depths below the abatement depth, such as for water or sewer line work, to use caution to avoid contaminating the surface soil with excavated soil. The owners should be advised to sample the soil below the abatement depth to determine the lead concentrations so that procedures can be implemented to segregate this deeper soil, if contaminated, and to use it as fill for the deeper areas of the excavation when the work is completed. The maximum allowable lead concentration in replacement soil shall not exceed 200 µg/g.

Types of Equipment

Removal and replacement of soil in residential abatement situations may take place in both large and small sites. Some urban yards are very small, consisting of only a few square feet; others are larger, but are sometimes surrounded by buildings. Therefore, residential soil abatement will often require the use of extensive manual labor in addition to mechanical soil removal. When soil is removed by hand, it generally can be loaded into wheelbarrows and then offloaded to other vehicles to be transported to the disposal site. Rather than offload the wheelbarrows to dump trucks, it is usually more efficient to dump the soil directly into rolloff containers, which are then loaded onto trucks for transport to the disposal site.

Sod and Seeded Grass Maintenance

All grass sod planted as part of the abatement operation should be maintained until the end of the growing season. This maintenance should include initial frequent watering to establish the rooting of the sod and germination of the grass seed, followed by watering on a regular basis to keep the grass in a healthy state. Under some conditions, seeding the soil may be practical, but often it is not realistic to restrict use of the soil area for the length of time needed to establish newly seeded grass.

Utilities

The owner or contractor should contact the local United Utilities Protection Service (UUPS), "Miss Dig," or "Miss Utility" (coordinated information sources for all utilities) before beginning work to obtain exact locations of all underground utility lines. If a utilities information service does not exist in the community, the individual utilities should be contacted directly. The American Public Works Association (APWA)—(816) 472–6100, ext. 584—can also provide local phone numbers for utility line identification services (APWA, 1993).

Care should be taken to protect existing utilities during abatement to prevent any damage to existing underground and overhead utilities and to prevent any harm to human life and property. If a contractor is used, the owner should require the contractor to protect the existing utilities and to make good any damage to these utilities as quickly as possible.

Existing Fences

Care should be taken while removing existing fencing for worksite access. Such fencing should be salvaged and reinstalled (if it does not contain lead-based paint) to the satisfaction of the owner. In some cases, fencing may have to be replaced.

Protection of Adjacent Areas

When working adjacent to excluded areas, including sidewalks, fences, trees, and patios, the soil should be excavated at a 45° (1:1) slope away from the excluded areas so that contamination does not wash or roll into the excluded area.

Inclement Weather

Removal and/or replacement operations should be suspended at any time when satisfactory control of the overall operation cannot be maintained on account of rain, wind, or other unsatisfactory weather or ground conditions. Determination of such conditions should be made by the owner or project consultant. When such conditions exist, the work area should be cleaned up immediately and work suspended. High winds can disperse contaminated soil and dust to offsite areas and runoff from rain can carry contamination outside the abatement area.

Vehicle Operation

Prior to hauling contaminated soil, a vehicle operation plan should be prepared for the equipment and hauling vehicle operators, which includes but is not limited to information on the cleaning of vehicles, securing of tarps and tailgates, ticketing of trucks, unloading of material, and handling of spilled soil.

All trucks, hauling vehicles, and containers loaded with contaminated soil should be inspected for loose material adhering to the outside of the body, chassis, or tires before departure from the worksite. Such material should be cleaned up before the vehicle leaves for the disposal site. If the truck tires made contact with the contaminated soil, they should be cleaned before the trucks leave the work area. The tires should be brushed off on a plastic sheet and the contaminated soil loaded onto the truck or returned to the lot being excavated.

Soil should be loaded directly into dump trucks or disposal containers from the worksite. If possible, there should be no "double handling" of contaminated material, such as shoveling the soil into a wheelbarrow, moving it to another location, dumping it, and shoveling it again into another container. This double handling not only wastes time but also increases the likelihood of spreading the contamination and tends to make site cleanup more difficult.

All soil removed from the worksite should be placed in dump trucks for transport to the disposal site. The trucks should have secure fitting tarps and sealed tailgates to reduce leakage as much as possible.

Loaded trucks or containers may be left onsite overnight provided they are secured to prevent access or leakage. It is not advisable to leave loaded trucks or containers onsite over the weekend. Any piece of equipment, whether a dump truck or excavation equipment, should be cleaned before it is removed from the site. Before decontamination, the equipment should be placed on 6-mil polyethylene plastic. Decontamination of equipment can be achieved by first scraping soil from all surfaces and then brushing to remove all visible soil, using water spray to prevent dispersion. The soil removed must be contained for appropriate disposal.

Final Grade

The final grades of replaced soil should be 2 inches above existing grades to allow for settling and to ensure that all drainage is away from existing structures.

Existing Vegetation

A number of precautions are needed to protect existing vegetation, such as bushes and trees. It is advisable to tie trees and shrubs to ensure stability.

Hand tools are needed to scrape soil from around roots without undermining or damaging them. Any large roots should be left undisturbed.

Tool Contamination

To minimize the cross-contamination between excavation and replacement worksites, separate tools should be provided for the excavation and replacement operations. A less expensive alternative is to employ an acceptable method for decontamination of tools, workers' clothing, and footwear. The decontamination should include physically removing as much soil as possible and then washing and rinsing the contaminated items with water.

All workers should clean their boots thoroughly before leaving the work area. The soil removed from boots should be disposed of either in a truck used for hauling contaminated soil or left in the worksite.

Soil Replacement and Cleanup

Prior to soil replacement, all walks, driveways, lanes, and streets adjacent to the excavation area should be cleaned of all contaminated soil. All loose soil should be scraped, washed, and swept from the above-mentioned surfaces. No clean soil should be placed down until all contamination has been removed from these areas.

At the completion of the workday, all loose contaminated soil within the limits of the work area should be collected. The collected soil should be transferred to a dump truck or other container for subsequent disposal.

All hard surfaces, such as sidewalks, paved driveways, and patios, should be cleaned at the completion of each workday. This daily cleanup should consist of scraping, washing, vacuuming, and wet sweeping all soil from the above-mentioned surfaces.

Cleanup procedures should begin early enough so that they can be completed before the end of the workday.

Prevention of Contamination From Underlying Soil

Regardless of the depth of removal, the possibility of contamination of the replacement soil from the underlying unexcavated soil exists, particularly from future activities. One way to minimize this occurrence is by laying a water-permeable fabric (geotextile) or similar lining at the bottom of the excavated areas to provide a visual demarcation between replaced soil and original soil (Weitzman, 1993). This liner can serve as a warning for persons digging in the future to exercise caution so that contaminated soil beneath the liner does not become mixed with the replacement soil.

Contaminated Soil Load Manifest System

In order to keep track of the contaminated soil being hauled away from the site, a load manifest system should be used to keep an exact record of the time and location of disposal. The manifest should consist of a two-part ticket, with one ticket given to the owner at the time of truck departure and the other held by the hauler. The disposal site ticket should be presented to the site owner or inspector technician before the end of the workday on which the material was deposited in the dump site. The purpose of the manifest system is to ensure that the contaminated soil is not used as fill in other residential areas.

If the soil is considered to be hazardous waste, the EPA manifest system must be used before any transportation or disposal offsite occurs (see Chapter 10). Even if the soil is not hazardous waste, it should be manifested using an alternative system such as the one described above.

Prevention of Offsite Movement of Contaminated Soil

Contaminated soil should be removed from the site as soon as possible to prevent wind and water erosion. To prevent offsite migration and to avoid the possibility of tampering by children, piles of contaminated soil should not be left onsite overnight. Wind erosion can occur on any site. Water erosion is more likely on hilly sites or during heavy precipitation. Exposed sites can be covered with plastic and secured in place to prevent offsite migration of contaminated soil. An alternative method is to wet down the site at the end of the workday to prevent wind erosion. Similar problems will be encountered when contaminated soil is stockpiled during the day prior to disposal at the end of the day. In this case, wind and water erosion should be controlled by using a combination of plastic sheeting and silt fencing.

Site Control

The following precautions should be taken:

- To prevent the spread of contaminated soil, secure working limits should be defined for each area of excavation. Access to this area should be restricted to authorized personnel with entrances and exits controlled.
- The abatement work area should be enclosed with temporary fencing or adequate barricades to prevent unauthorized personnel or animals from entering the work area.
- Yellow caution tape should be installed across doors leading to abatement areas.
- Access routes to homes should be maintained at all times. Such routes should not require passing through the area of excavation.
- The removal of a partial grass cover in preparation for the laying of sod or grass seeding may *temporarily* increase the amount of bare contaminated soil. Onsite exposure could result from children playing on the exposed soil. Abatement workers can control this during the day by means of adequate site control. However, control is difficult, if not impossible, after the end of the workday. Lead hazard warning signs should be posted to warn residents.
- In order to minimize inconvenience to residents and neighbors and to minimize exposure, abatement of a particular site should be completed within 1 workday.

2. Soil Cultivation

Since soil lead concentration often decreases with increasing depth, soil mixing can be considered to be an abatement strategy. If the average lead concentration of the soil to be abated is below 1,500 µg/g, thorough mixing is an adequate abatement method. Pilot testing may be necessary to determine the type of mixing process needed. Rototilling may not be effective.

3. Soil Cleaning

The following soil treatment methods are being investigated for possible use on residential sites:

- Magnetic separation.
- Froth flotation.
- Washing.

Magnetic separation and froth flotation are currently under development and are not addressed in these *Guidelines*. The method that has received the most attention thus far is soil washing. Soil washing is a waterborne process for mechanically scrubbing soils to remove lead and other contaminants (EPA, 1990b). The soil is removed from the yard but usually washed onsite. The process removes contaminants in one of two ways: by dissolving or suspending them in the wash solution (which is later treated by conventional wastewater treatment) or by concentrating them into a smaller volume of soil through simple particle size separation techniques. Soils containing coarse sand and gravel are more responsive to cleaning techniques than soils containing a large amount of clay and silt. If the washing process involves the addition of surfactants or other chemicals to separate the lead-containing particles, care must be taken to ensure that amounts remaining in the remediated soil do not interfere with reuse of the soil at the site. Most soil washing in the United States has been done at Superfund sites. Soil washing has not yet been attempted at residential sites. EPA is currently investigating the applicability of soil washing to residential soil abatement.

4. Paving

If contaminated soil is present in high-traffic areas, the soil can be covered by a high-quality concrete or asphalt. In this case, contaminated soil need not be removed before paving. Normal precautions associated with thermal expansion or contraction and traffic load should be considered. Hard surfaces are not appropriate in play areas where falls are possible from slides, jungle gyms, etc. The Consumer Product Safety Commission has developed recommendations for fall surfaces in public play areas (CPSC, 1991).

C. Exterior Dust Control

Lead in exterior dust can be a source of exposure to children because it can be tracked inside and carried on the skin, especially the hands (Bornschein, 1986). For example, in older urban areas in Cincinnati, exterior leaded dust concentrations are on average about four times higher than interior leaded dust concentrations, and exterior lead surface loadings are much higher than for interior dust (Clark, 1993).

Just as children can be directly exposed to leaded soil, they can also be exposed to exterior leaded dust. Exterior dust can also migrate by various means (children, adults, pets, or wind) to the interior of homes where there are many opportunities for exposure to children. Exterior leaded dust concentrations up to 50,000 µg/g (equivalent to 5 percent lead in dust) have been measured in urban areas in the EPA Soil Lead Abatement Demonstration Project (EPA, 1993c).

If only an individual property is involved in the exterior dust control activity, the type of equipment that can be used will be limited by the size of the area involved and the person responsible for the area. Owners are not required to clean streets, for example. Because of the mobility of exterior dust, the length of time that the dust cleanup remains effective will be limited by the size of the abatement area and therefore may need to be repeated periodically.

Exterior dust control consists of two components:

- Controlling sources of lead-contaminated dust.
- Removing lead-contaminated dust from paved areas.

Without adequate control of the sources of lead in exterior dust, recontamination of the exterior areas will occur. Studies of a schoolyard area indicated that leaded dust concentrations equalled preabatement levels within 1 year in Winnipeg, Ontario (Stokes, 1988). Recontamination of some paved areas in Cincinnati occurred within a few days (Clark, 1991) indicating that repeated cleaning and control of the *sources* of the lead are necessary.

1. Types of Equipment

Exterior dust cleanup consists of removing as much dust and dirt as possible from all paved surfaces on the property or properties involved. Lead-contaminated dust can be found on paved surfaces such as sidewalks, patios, driveways, parking areas, etc. For multiple adjacent properties that are being abated, cleanup of streets, alleys, or other common areas should be considered, although this is normally a municipal responsibility. Brick-paved areas present the biggest challenge in removing exterior dust because they contain numerous cracks. For individual properties, hosing off walkways and play areas periodically may reduce exterior leaded dust levels.

In order to meet this cleaning challenge, it is necessary to have available the most efficient hard-surface vacuum cleaning equipment. Many commercial contract cleaning firms located in urban areas have such equipment.

There are at least three different types of suitable paved-surface cleaning machines:

- Hand-pushed HEPA vacuum cleaners.
- Vacuum-assisted sweepers, which are similar to the traditional broom sweeper, with the added feature of a slight vacuum that assists in controlling dust and transporting material from the broom bristles to the hopper.
- Vacuum sweepers, which lift material from paved surfaces—some are equipped with curb brushes to assist in transporting the material from the edge of the cleaning area to the vacuum head and into the hopper.

EPA research has found that regenerative air machines, which depend on rapidly moving air to capture particles from the source of the pavement, frequently remove only a small fraction of the dust and thus may not be suitable for lead abatement work (Pitt, 1985).

2. Evaluation of Equipment

A number of pavement cleaning machines were tested as part of the Cincinnati Soil Lead Abatement Demonstration Project (Clark, 1993). The machines tested were the vacuum-assisted sweeper, the vacuum sweeper, and the regenerative air machine. Initial tests demonstrated that several machines operated above the 90-percent efficiency level. A machine performing at the 90-percent efficiency level will pick up 90-percent of the available dirt after two passes. Equipment tested involved both large machines suitable for streets and parking lots and some walk-behind, vacuum-assisted broom sweepers suitable for sidewalks and other smaller areas. Several larger machines performed at or above the 90-percent efficiency rate. Some of the smaller walk-behind sweepers did not perform at an acceptable level of efficiency.

Figure 12.25 Paving Bare Soil May Be the Best Option for High-Traffic Areas.

Care must be taken when emptying the collected dust from the machines. The most appropriate method to minimize dust release is to dampen the contents of the hopper using an accessible hose. If water is to be used for dust control, it will be necessary to devise a means of containing excess water. This can be achieved by placing 6-mil polyethylene plastic on the ground where the equipment is being emptied and carefully collecting the water after the hopper has been emptied. It is also necessary to perform this operation in a secure area so that children are not exposed.

3. Removal of Heavy Accumulation

The first step in cleaning an area should be the removal of heavy accumulations of dust and debris. The heavily accumulated areas can be cleaned either by manually removing the material with scrapers, shovels, or brooms or by vacuuming the heavily accumulated areas if vacuuming proves to be adequate in removing the contamination. Just as in handling lead-contaminated soil, the heavy accumulations of exterior dust should be dampened.

4. Vacuum Cleaning

Small areas, such as sidewalks and patios that are inaccessible to larger cleaning machines, may be cleaned with an acceptable HEPA filter-equipped vacuum cleaner. Surfaces should be vacuumed continuously until no additional visible dust is being removed by further vacuuming.

CHAPTER 13: ENCAPSULATION

Encapsulation: How To Do It

1. Determine if encapsulants can be used. Do not encapsulate the following surfaces:
   - Friction surfaces, such as window jambs and door jambs.
   - Surfaces that fail patch tests.
   - Surfaces with substrates or existing coatings that have a high level of deterioration.
   - Surfaces in which there is a known incompatibility between two existing paint layers.
   - Surfaces that cannot support the additional weight stress of encapsulation due to existing paint thickness.
   - Metal surfaces that are prone to rust or corrosion.
2. Conduct field tests of surfaces to be encapsulated for paint film integrity.
3. Consider special use and environmental requirements (e.g., abrasion resistance and ability to span base substrate cracks).
4. Examine encapsulant performance test data supplied by the manufacturer.
5. Conduct at least one test patch on each type of building component where the encapsulant will be used.
6. For both nonreinforced and reinforced *coatings*, use a 6- by 6-inch test patch area. Prepare the surface in the manner selected for the complete job. Prepared surfaces for patch testing should be at least 2 inches larger in each direction than the patch area.
7. For fiber-reinforced wall *coverings*, use a 3- by 3-inch patch. For rigid coatings that cannot be cut with a knife, use a soundness test.
8. For liquid coating encapsulants, allow coating to cure and then visually examine it for wrinkling, blistering, cracking, bubbling, or other chemical reaction with the underlying paint. For all encapsulants, carry out the appropriate adhesion tests.
9. Record the results of all patch tests on Form 13.1.
10. Develop job specifications.
11. Implement a proper Worksite Preparation Level (see Chapter 8).
12. Repair all building components and substrates as needed, e.g., caulk cracks and repair sources of water leaks.
13. Prepare surfaces. Remove all dirt, grease, chalking paint, mildew and other surface contaminants, remnants of cleaning solutions, and loose paint. All surfaces should be deglossed, as needed.
14. Ventilate the containment area whenever volatile solvents or chemicals are used.
15. During encapsulant application or installation, monitor temperature and humidity. For liquid coatings, monitor coating thickness to ensure that the encapsulant manufacturer's specifications are met.

16. Conduct cleanup and clearance.
17. The owner should monitor the condition of the encapsulant after the first 6 months and at least annually thereafter. Repairs should be made as necessary. Reevaluations should be completed according to the schedule in Chapter 6.
18. Provide information to residents on how to care for the encapsulation system properly and how to contact the owner to get repairs completed safely and quickly.
19. Maintain records on the exact detailed locations of encapsulant applications, concentration of lead in the paint underneath the encapsulant, patch test specifications and results, reevaluations, product name, contractor, and date of application or installation, along with a copy of the product label and a material safety data sheet (MSDS) for the product. Record failures and corrective measures, signs of wear and tear, and the identity of the certified risk assessor.

Chapter 13: Encapsulation

I. Introduction

This chapter provides information on (1) assessment of the suitability of a surface (i.e., the existing paint film) and the building component substrate for encapsulation; (2) types of encapsulant systems; (3) considerations for selection and use of encapsulants; (4) field patch testing; (5) general surface preparation and application procedures; and (6) procedures for ongoing monitoring by the owner and reevaluation by a risk assessor.

A. Definition

Encapsulation is the process that makes lead-based paint inaccessible by providing a barrier between the lead-based paint and the environment. This barrier is formed using a liquid-applied coating (with or without reinforcement materials) or an adhesively bonded covering material. While encapsulant systems may also be attached to a surface using mechanical fasteners, the primary means of attachment for an encapsulant is bonding of the product to the surface (either by itself or through the use of an adhesive).

Encapsulants should not be confused with enclosures, which are rigid barriers fastened by mechanical means to the base substrate (or the structural members). Enclosures rely on mechanical fasteners as the primary method of attachment. Enclosures are addressed in Chapter 12, SectionIII.

Encapsulation depends upon a successful bond between the surface of the existing paint film and the encapsulant for performance. However, this condition alone is not sufficient for encapsulation system success. All layers of the existing paint film must adhere well to each other, as well as to the base substrate. If not, the encapsulation system may fail. Thus, proper assessment of the suitability of the surface and substrate for encapsulation is essential prior to the application and installation of the product.

The success of an encapsulation application also depends on successful patch testing in the field, proper completion of surface preparation and application procedures, ongoing monitoring by the owner and resident, and periodic reevaluation by a risk assessor. These procedures are discussed in detail in subsequent sections of this chapter.

B. Standards and Acceptance

At this time, there are no approved or prohibited encapsulants and no standards for their use. Standards for minimum performance characteristics are now being developed under the auspices of the American Society for Testing and Materials (ASTM) Committee E06.23.30. At least one State (Massachusetts, 1994), already has such lead standards in place. Title X requires that encapsulant standards be completed by April 1996. In the interim, until such standards are developed, encapsulation is considered an acceptable method of federally supported lead-based paint abatement or federally supported lead-based paint hazard abatement, provided the following conditions, procedures, and precautions exist or are followed:

- The encapsulation product or system is warranted by the manufacturer to perform for at least 20 years as a durable barrier between the lead-based paint and the environment in locations or conditions similar to those of the planned application.
- Selection and use of encapsulation products or systems follow the manufacturer's recommendations and the procedures and precautions described in this chapter of the *Guidelines* and in other relevant chapters, including those on occupant protection, worker protection, cleanup, clearance, and waste disposal.
- Patch testing is completed successfully.
- The property owner or local government agency conducts surface-by-surface visual

monitoring of all encapsulant applications 1 month and 6 months from the date of completion of the application and at other times as specified for encapsulation in Chapter 6 of these *Guidelines* and records those results.

- Failures are repaired as soon as possible, and repairs are made according to manufacturers' recommendations and the procedures and precautions recommended in this chapter and other relevant chapters of these *Guidelines*, including those pertaining to resident protection, worker protection, cleanup, clearance, and waste disposal.

C. Background

Encapsulation technologies can offer safe and effective control of lead-based paint hazards. Encapsulation can be less expensive than other options and may be one of the only alternatives that can be used in certain situations. Encapsulants may also be used in combination with other methods. Encapsulants can be applied with only a moderate degree of training and, unless there is significant surface deterioration, may generate low amounts of leaded dust. However, if the encapsulation system fails, repairing the damage, as well as covering the exposed lead-based paint surfaces, may result in high maintenance costs. The advantages and disadvantages of using encapsulants are listed in Table 13.1.

A number of products currently being marketed specifically for lead-based paint abatement have been used as specialty coatings and coverings for many years. However, there is limited field experience in their use as lead-based paint encapsulants. Ongoing, but limited, field reexamination and evaluation of coating systems are being conducted by the Massachusetts Department of Public Health and the Maryland Department of the Environment with funding from the U.S. Environmental Protection Agency (EPA). Some sites with interior and exterior coatings have been found to remain intact for up to 3 years. On the other hand, the same systems have been observed to fail immediately after application or within a period of months due to inadequate surface preparation or improper selection. Some failures have been widespread, in which the coating system separates completely from the substrate. Some have been more limited, in which cracks appear in the coating or the product is abraded (rubbed away) through normal wear and tear. The limited failures have been attributed to use of encapsulants on surfaces that were not suitable for encapsulation, inadequate surface preparation, or improper selection of product type.

The standards for minimum performance now being developed by ASTM involve laboratory testing of products applied to bare substrates under controlled settings. Most commercial products have not been tested using the ASTM protocols. Consequently, encapsulant systems have not yet been subjected to rigorous performance testing. The ASTM standards, when they become available, specify minimum performance requirements. Specific use situations may warrant more stringent performance requirements for certain properties. The encapsulant user will need to determine whether more rigorous performance is needed. Product selection and use considerations are addressed later in this chapter.

II. Assessment of Surfaces and Components for Suitability

Some surfaces and components are not suitable candidates for encapsulation. In these situations, a decision not to encapsulate can be made without further consideration or testing. For all other surfaces and components, more extensive field testing is recommended for encapsulation. Once the determination is made that encapsulation is suitable, patch testing of candidate encapsulant systems (including use of the manufacturer's recommended materials, surface preparation procedures, and application procedures) is essential.

A. Specific Surfaces and Components Not Suitable for Encapsulation

Friction surfaces. These surfaces include window jambs and exterior wood flooring or stairs

Table 13.1 Advantages and Disadvantages of Using Encapsulants

Advantages	Disadvantages
Residents may not need to be relocated. Minimal generation of leaded dust if surface preparation is minimal. Moderate application training requirements. Less costly and more timesaving than some other control techniques if surface preparation is minimal. Wide range of product types available to meet special needs. Finish carpentry work may not be required.	Experience and information on long-term durability is limited. Use on friction surfaces is inappropriate. Durability depends on condition of previous paint layers. Field compatibility testing of encapsulant with particular lead-based painted surface is essential (patch testing). Encapsulant system success depends on proper surface preparation. Periodic monitoring and maintenance by the owner is required, since lead has not been removed. Susceptible to water damage; system failure can be extensive. Application may be weather- and temperature-dependent and may require several coats. Some systems may contain toxic ingredients.

covered with lead-based paint. Some interior floor and stair surfaces may be suitable for encapsulating with a rigid floor covering (e.g., vinyl tile) that is adhesively bonded to the surface.

Deteriorated components or paint films. Components must be sound and essentially free of deterioration to be suitable for encapsulation. Deteriorated components include rotten wood, rusted steel, spalled plaster, and masonry in need of repointing. Use of encapsulants on steel structures is especially difficult, since most do not have corrosion inhibitors and will fail if the steel underneath rusts. Also, components affected by water leaks, poor moisture venting, or other moisture-associated problems should not be encapsulated unless the moisture problem is corrected first. Additional information on inspection of components for damage associated with water penetration can be found in Chapter 11.

Severely deteriorated paint films. Lead-based paint films that are severely deteriorated (e.g., cracked and peeling over most of the surface) are not suitable for encapsulation.

Surfaces in which there is a known incompatibility between two existing coating layers. Usually this determination cannot be made without field testing. However, if available, historic records may reveal conditions known to cause poor interlayer adhesion. For example, use of a flat latex paint over an improperly prepared, glossy oil-based enamel will likely result in an existing paint system that is not suitable for encapsulation.

B. All Other Surfaces

Surfaces of nondeteriorated substrates having reasonably stable lead-based paint films can be considered for encapsulation. However, a decision to encapsulate should be made only after a field evaluation of the condition of these films is conducted, using patch tests. A patch test is a field test procedure in which a small area of the existing lead-based paint film is prepared and the encapsulant product is applied or installed and cured in the manner intended for the large-scale job. A field evaluation should determine the extent of deterioration, the condition of the surface, and the integrity of the underlying paint layers. These factors should be considered because an encapsulant is not mechanically fastened to the underlying base substrate. Some paint films cannot support the additional weight or stress of an encapsulant, because of existing film thickness, poor adhesion between paint layers, or low cohesive strength within a layer. Existing film thickness can be measured using a dry film thickness gauge, such as a Tooke gauge or a micrometer. Information on the thickness of existing coatings can be provided to an encapsulant manufacturer's or distributor's technical representative to help in making appropriate recommendations.

The visual extent of deterioration, surface deterioration, and interfacial or cohesive film weaknesses should be evaluated, before use of encapsulants, in the following ways:

Visual Evaluation. Visual deterioration includes peeling, flaking, blistering, and cracking of paint films. The level can be rated based on ASTM photographic standards, such as ASTM D 610 for rusting, D 770 for blistering, etc. An entire surface can usually be inspected for these defects. Often, both the extent of the surface that is deteriorated and level of deterioration are assessed. For example, 5 percent of the surface may be deteriorated to a rating level of one (i.e., severe) or the entire surface may have slight deterioration. Quantitative rating in this fashion may be required by the encapsulant manufacturer, but not by HUD at this time.

Surface Deterioration. Surface deterioration includes chalking, mildewing, and soiling. Standard ASTM procedures can be used to rate the degree of these conditions. Enough determinations need to be made to properly characterize the surface. However, since this type of deterioration tends to be widespread and is usually rather uniform over large surface areas, determination of two or three locations may adequately describe the condition.

Interfacial and Other Film Integrity Properties. Since most lead-based paint films are made up of many paint layers, up to 1 or more millimeters in thickness, a measure of how well the layers are adhering to each other and the base substrate is needed prior to the use of an encapsulant. Also related to interfilm adhesion is cohesive strength within films. These properties are usually assessed using a field adhesion test, such as a crosshatch or "x-cut" test with tape, a pulloff adhesion test, or a probe of the film with a knife. Interfacial deterioration may not be uniform over a large surface area (since it may be defect-related) and will vary from location to location across a surface. Thus, it is important to conduct enough interfacial integrity tests to obtain a representative sampling of the entire area.

Surfaces with intact paint and good interfacial adhesion are good candidates for nonreinforced encapsulants. Surfaces with peeling, flaking, or cracking paint films are usually not good candidates for nonreinforced encapsulants unless the loose coating can be removed. However, reinforced encapsulants may be suitable if the areas of deterioration are localized and reasonably small. In these cases, the reinforced coating can span the deteriorated areas. Adhesively bonded encapsulants may be suitable for either surface type.

III. Encapsulant Classification

Encapsulation technology is developing rapidly, and new material types and systems are continually being introduced commercially, making it difficult to classify encapsulants (Table 13.2). Within each of the three general classifications, there is a wide range of material types and properties. Manufacturer's data must be consulted to obtain specific information.

Residential paints, such as latex and alkyd-based paints and canvas-backed vinyl wallpaper, do not constitute encapsulant systems unless they pass the patch test and meet the performance requirements of this chapter and any quantitative performance standards defined by ASTM or other local, State, or Federal agency.

IV. Minimum Performance Requirements for Encapsulants

Four general performance requirements for encapsulants are as follows:

- The encapsulant must be capable of being applied safely and must not contain toxic substances.
- The encapsulant must adhere to existing paint films.
- The encapsulant must have the ability to remain intact for an extended period of time when exposed to the expected environmental conditions and use patterns.
- The encapsulant and its application procedure must comply with fire, health, and environmental regulations.

A. Safe Application

All encapsulants must be able to be applied safely, without excessive worker or occupant exposure to hazardous solvents, curing agents, or other chemicals in the encapsulant, either by inhalation or by contact with the skin.

B. Adhesion

An encapsulant must adhere to the existing paint film. Adhesion can be measured using peel, tensile, or shear tests. However, adhesion of an encapsulant to the lead-based paint film is not sufficient for success of the encapsulant system; the integrity of the underlying paint layers is also crucial. Each of these layers must adhere well to other layers *and* the base substrate. In addition, each layer must have sufficient cohesive strength to support the increased internal stresses caused by the addition of an encapsulant layer.

Table 13.2 Categories of Encapsulants

Encapsulant Category	Application and Installation Method	Characteristics
Nonreinforced liquid coatings.	Usually applied with brush, roller, or spray.	Interior and exterior products. Some properties vary widely, such as elongation (e.g., elastomeric with high elongation to rigid with limited elongation), dry film thickness (0.05 mm to greater than 0.5 mm), hardness, dry/cure time, and compatibility with existing painted surfaces.
Liquid coatings reinforced with cloth, mat, fibers, etc.	Applied with brush, roller, spray, or trowel. Usually applied in two steps.	Interior and exterior products. Properties vary widely.
Materials adhered with an adhesive (e.g., fibermat, vinyl floor tile).	System is usually installed in two steps: (1) adhesive application and (2) encapsulant product installation.	Classification includes sheet vinyl systems, floor tile, wall systems, and other adhesively bonded systems.

C. Ability To Remain Intact

The ability of a film to remain intact depends on many factors, some of which are specific to the conditions in which the encapsulant is used. For example, an encapsulant may suffer impact and abrasion damage. It may also be exposed to water and other household chemicals, changing temperatures, changing substrate dimensions, and other degrading environmental conditions. Laboratory procedures used to investigate these properties are loosely grouped into tests for mechanical, chemical resistance, and durability properties.

1. Mechanical Properties

Mechanical properties include tensile properties (elongation, tensile strength, modulus), flexibility, abrasion resistance, and impact resistance. Most of these properties are interrelated and may depend on temperature.

Mechanical properties of coatings should be considered in selecting an appropriate material. For example, more flexible materials may be more likely to resist cracking when the substrate moves because of vibration, changes in temperature, changes in moisture content, or settling. If this mode of performance is important, the encapsulant must remain flexible over the complete range of exposure temperatures. Some elastomeric encapsulants have failed by cracking because they became brittle at low temperatures. Reinforced encapsulants may be more likely to resist cracking over existing substrate cracks or new substrate cracks than nonreinforced encapsulants. This is because stresses produced in a reinforced encapsulant as a result of substrate cracking or other movement are distributed over a larger area than for nonreinforced materials.

Abrasion resistance refers to the ability to resist wearing, such as from rubbing against a surface or from cleaning with abrasives. Examples of surfaces where abrasion is likely to occur include railings, walls, moldings around door and window openings, and interior window sills where air conditioner units are installed and removed.

Impact resistance is the ability of a coating to resist cracking or loss of adhesion upon direct impact by an object, such as a toy or tool. Good impact resistance is needed for surfaces adjacent to door openings and for walls in recreation rooms and entryways.

2. Chemical Resistance Properties

Chemical and water resistance is essential for long-term stability of an encapsulant. Interior encapsulants may be exposed for extended periods of time to both water (steam, vapor, and liquid) and, in limited situations, chemicals. For example, on horizontal surfaces, water or chemicals (e.g., cola, cleaning solutions) may stand until evaporated. An encapsulant must be able to withstand such exposures without blistering, peeling, cracking, or losing film integrity.

3. Durability

For all encapsulants, it is essential that the mechanical and chemical properties of the material remain essentially constant over time. For exterior exposures, this means that an encapsulant must also be resistant to degradation by sunlight, moisture, and temperature variations. Until specific criteria are available, manufacturers should be asked to supply information and warranties on the durability of their products.

D. Fire, Health, and Environmental Requirements

Encapsulants must meet all local fire code requirements. Since their film thicknesses are often much greater than that of paints, there may be additional fire-related requirements. Building codes and material safety data sheets (MSDS) must be consulted to ensure safe application and to provide information on when residents can safely reenter the area. The MSDS will also provide information on toxic substance content. In addition, environmental volatile organic compound (VOC) regulations limit the VOC content of paints in many local regions.

V. Factors To Consider in Selecting and Using Encapsulant Systems

When encapsulation is suitable and is the desired control strategy, a user has a wide range of systems from which to select. In addition to the requirements of Section IV, the decision to select a specific type or system should take into account several other factors, including those related to the type of lead-based paint film and base substrate, service conditions, cost, liveability, and health and safety issues.

A. Base Substrate

The base substrate can be wood, plaster, steel, cement, masonry, stucco, or some other material. Thus, the movement and possible deterioration of the substrate vary and should be considered. For example, wood will expand and contract with changing water content and perhaps check and crack as it ages. Wood rot could also occur if water leaks or other moisture problems are ignored. Stucco may develop cracks as it ages or the building settles. An encapsulant must be able to move with the base substrate without cracking or otherwise deteriorating.

Walls with extensive cracks and gaps that cannot be bridged by nonreinforced coatings may be good candidates for reinforced coatings or wall coverings. For situations in which nonreinforced coatings can be used, cracks must be filled with a caulking or sealing compound compatible with the encapsulant and the substrate to which it is applied.

Corrosion of metal substrates must be controlled by a proper primer prior to the use of an encapsulant. Uncontrolled rusting will quickly lead to delamination of an encapsulant. Thus, a corrosion-control primer is an essential part of an encapsulant system for metal.

B. Lead-Based Paint Film Properties

An encapsulant must be compatible with the existing lead-based paint film. Both chemical and physical properties of the film are important. A compatible encapsulant must form a strong bond with the lead-based paint film but not degrade the existing paint layers. Epoxies, polyurethanes, and other coatings having strong solvents are often incompatible with oil/alkyds and latex paint films.

Physical properties of old films also affect performance of coatings and adhesives applied over them. Water-based products tend to bond less successfully to glossy, smooth, chalky, dirty, or oily paint film surfaces than do compatible solvent-based materials.

Field patch testing is the best procedure for determining compatibility with the existing lead-based paint surface and early performance properties of the encapsulant.

C. Application and Installation Constraints

Application constraints include the skill required for application, the method of application and acceptable range of environmental conditions, and regulations for worker safety and environmental protection.

1. Skill Level

Different levels of skill are required for application of the various classes of encapsulants. Generally, liquid nonreinforced coatings require the lowest skill level. Coatings having two components (requiring rapid, efficient application), or those incorporating a mat, require more experience and skill. Use of adhesively bonded materials, such as tile and flexible wall coverings, also require an intermediate skill level for application (HUD, 1990b). Overall, skills required for encapsulation are lower than those for enclosure and replacement. Nevertheless, specific knowledge and skills are critical for success in the application of any encapsulant.

2. Method and Environmental Conditions

Depending on the specific encapsulant, application of the coating or adhesive may be by brush, roller, spray, or trowel; however, in certain situations, some of these methods may not be feasible. For example, if spraying is not practical; an encapsulant that can be applied by another technique will be required. The acceptable environmental conditions vary depending on the type of encapsulant. For instance, temperatures above 40 °F and below 95 °F and relative humidity less than 85 percent are generally required for water-based coatings. Moisture-cure polyurethanes may require a minimum relative humidity. A manufacturer's technical specifications should be consulted for specific requirements.

3. Regulations

Worker safety requirements vary depending upon the material being applied. The manufacturer's MSDS should be consulted for appropriate controls. The VOC content of coatings is regulated in many regions of the country. In addition, a national EPA VOC rule for all architectural coatings is expected to become effective in 1996. Consequently both local and national rules may place VOC limits on encapsulants.

D. Environmental Service Conditions

The conditions under which the encapsulant will be used are important when selecting an encapsulant. For exterior exposures, consideration must be given to an encapsulant's ability to withstand varying weather conditions, including temperature changes, temperature extremes, water, moisture vapor, air pollutants, and ultraviolet radiation. For example, some elastomeric products can become brittle when exposed to cold temperatures and may shatter on impact. Other materials, such as epoxies, prematurely chalk and erode because of ultraviolet deterioration.

Since some exterior—and even some interior—environments may be quite wet, encapsulants must not fail due to moisture. The water vapor permeability should be considered, along with the permeability of the component to be encapsulated. An encapsulant with a low water vapor permeability may peel because of a moisture gradient across the component. For example, in climates with cold winters, an impermeable encapsulant applied to exterior walls lacking an internal vapor barrier may blister and fail because of interior moisture passing through the building envelope.

E. Use Conditions

If a lead-based paint surface is subject to frequent abuse (e.g., abrasion, impact, and rubbing), especially careful consideration must be given to selecting an encapsulant product. Also, the tolerance for increased coating thickness varies depending upon the component type. For example, reinforced coatings or fiber-reinforced wall coverings having high abrasion resistance are potential candidates for walls subject to extensive abrasion and impact wear, such as in entrance hallways. Coatings having excellent chemical resistance (e.g., some epoxies) can be good candidates for surfaces containing large amounts of hand oil, such as handrails and surfaces around doorknobs. When use factors are not considered, premature failures are likely. For example, elastomerics, which typically have poorer chemical resistances than two-component coatings, have been reported to fail prematurely when used on handrails (Maryland, 1993).

F. Encapsulant Service Life

Epoxy paints, cementitious encapsulants, floor tile, and flexible adhesively bonded wall coverings have been used for other purposes and tend to have relatively long lifespans. Some coatings have qualities that may make them more durable than ordinary residential paints, e.g., a polyurethane binder is usually more abrasion-resistant than an oil binder. Since some encapsulants have been in use for a few years, field data may be available for some products. Also, the manufacturer's warranty or guarantee is an important consideration in product selection. When the product is used for lead-based paint encapsulation, conditions of the warranty may require prework inspections, surface preparation inspections, in-process inspections, and a final inspection.

G. Safety Constraints and Information

Each encapsulation product has an MSDS available from the manufacturer, which should be obtained, reviewed, and filed as part of the recordkeeping procedure. The MSDS provides information on hazardous ingredients (specific chemical identities and common names); physical and chemical characteristics (boiling point, water solubility, melting point, evaporation rate, specific gravity, vapor pressure); fire and explosion hazard data (flashpoint, extinguishing media and firefighting procedures, and any unusual fire/explosion hazards); reactivity (stability and incompatibility, hazardous decomposition, or products); health hazard data (routes of entry, acute and chronic health hazards, carcinogenicity, signs and symptoms of exposure, medical conditions generally aggravated by exposure, and emergency and first-aid procedures); precautions for safe handling (waste disposal, handling, and storing); and use and control measures (respiratory protection, eye protection, protective gloves, ventilation, and other protective measures and hygiene practices).

Some MSDSs do not disclose the presence of toxic substances under trade secret provisions. If an MSDS does not show chemical ingredients and claims no hazardous ingredients are present, but still indicates eye and skin protection or ventilation is necessary, the MSDS may be deficient. Occupational Safety and Health Administration regulations require employers to maintain current MSDSs for all products containing hazardous chemicals that are used by employees.

Until there are national performance standards, it may be useful to have a toxicologist or industrial hygienist review the MSDS and/or consult any of the available toxicology database systems, such as the Hazardous Substance Database, Integrated Risk Information System (EPA), and Registry of Toxic Effects of Chemical Exposures National Insitute of Occupational Safety and Health (NIOSH). Both worker and resident safety should be taken into consideration. For example, residents and pets may be exposed to VOCs during the drying or curing process.

H. Esthetics

To maintain an acceptable appearance, the finished product should be capable of being painted, or otherwise coated, and maintained. Consideration should also be given to the importance of having a finished surface that is smooth or rough (textured) or soft or hard. For example, encapsulants that are either soft or have a rough finish are not appropriate for handrails and floors and may make cleaning of wall surfaces more difficult. Also, soft coatings have a greater tendency to adhere to or be imprinted by objects placed on them than do harder coatings. The final thickness of the encapsulant also affects the appearance of the product. For example, the final thickness of many elastomeric encapsulants (10 to 20 mil) is about 10 times greater than a single layer of paint and can conceal desired detail on wood trim and moldings.

If the existing coating is not intact or smooth and requires substantial sanding and feathering, then a nonreinforced liquid encapsulant may not be the appropriate product type. Nonreinforced liquid encapsulants are less likely to hide surface imperfections than reinforced liquid coatings or adhesively bonded wall coverings.

I. Repairability

Repairability refers to the ease of repairs and the appearance of the affected areas. It is important to determine if repairs can be performed only by outside contractors with special equipment or skills or if they can be done by typical maintenance workers. Generally, all encapsulants are repairable, although some types may be more difficult to repair than others.

J. Cost

Depending upon the type of substrate to be treated, the life-cycle costs of encapsulation methods may be less than for enclosure methods (HUD, 1991). Life-cycle costs include both the initial costs and reexamination and maintenance costs. Initial per-unit costs (material plus labor) associated with the various encapsulant products vary. Since labor may be a major part of the cost, encapsulant systems requiring more than one layer or step may be more expensive than those completed in one operation. In addition, the total time required for application and cure is a cost-related factor if occupants need to be housed away from the worksite during this time. The length of time needed for the encapsulant to remain effective should also be included in life-cycle cost considerations.

K. Technical Assistance

For large projects, a technical representative from the product supplier or manufacturer should be involved in the choice and inspection of the surface preparation procedure and the application processes. It is important to clarify the nature and extent of any support that is being offered. If no technical support is offered, consideration might be given to other products where support is available. The manufacturer's involvement in quality assurance activities is desirable, and every effort should be made to cooperate with those involved.

VI. Specific Encapsulant Products and Surface Preparation Procedure

A. Encapsulant Product Selection

Once a surface has been found suitable for encapsulation and a decision has been made to encapsulate, a specific product or product type is selected, together with appropriate surface preparation and application procedures. The procedure for selecting a specific encapsulant product is to (1) obtain information from the manufacturer's literature, users' experiences, and any other credible knowledge base on the products' ability to meet the general performance requirements and the factors listed previously in this chapter; (2) select a group of candidate encapsulant products and surface preparations using this information; and (3) conduct field patch tests with the candidate products on the surfaces to be encapsulated.

B. Surface Preparation

After an encapsulant product or type has been selected, surface preparation procedures need to be identified. All encapsulant manufacturers provide surface preparation recommendations for their products. In some instances, manufacturers provide more than one specific recommendation. Thus, it is essential to select one or more suitable specific procedures prior to application of the encapsulant. Consideration should be given to identifying and testing more than one specific surface preparation procedure because the same encapsulant may be successfully used with one procedure and not another. Cost and time savings may be significant for some encapsulants if more than one surface preparation is tested at the same time. The cure time, and thus the test time, may be long.

General surface preparation requirements, which are similar for all encapsulants, are presented below. Materials used and debris generated during surface preparation may be hazardous and must be treated appropriately.

1. Cleaning

Encapsulants should not be applied over dirt, rust, oil, grease, mildew, chalk, or other surface contaminants. Surfaces should be cleaned with nonsudsy degreasers, such as trisodium phosphate or other appropriate materials. Additional cleaning agents may be needed for mildew or chalk removal. Cleaning can be done by hand with a sponge or rag or with the aid of power washing equipment. In either case, it is essential to rinse the surface thoroughly with water to remove cleaning residue. Job specifications may require that specific standards be met for removal of surface contaminants, e.g., ASTM D 4214 for chalk. In situations where chalk cannot be removed to an acceptable level, the use of a primer or stabilizer may be needed. If a special primer is used, it is essential that it is one recommended by the encapsulant manufacturer.

2. Deglossing

The surface of some lead-based paint films is smooth and glossy. Deglossing to roughen the surface is usually recommended by manufacturers to improve adhesion of the encapsulant coating. Often, specific deglossing materials will be recommended, since they must be compatible with the encapsulant. For some very hard, chemically resistant surfaces, deglossers may not work, and wet sanding may be needed. Since the choice of deglossing materials or methods affects encapsulant adhesion, separate patch tests using different deglossers or methods should be considered.

3. Removal of Loose Paint

Loose paint should be removed by wet scraping.

4. Preparing Exposed Base Substrates

These substrates can warrant different surface preparation requirements than lead-based paint surfaces. For example, the surface of bare wood exposed to sunlight should be wet sanded to remove the degraded surface layer. Corroded metal should be cleaned using HEPA-assisted power tools or HEPA-vacuum blasting to remove surface rust and contaminants. Bare concrete and masonry materials should be washed to remove loose dirt, degraded materials, or other surface contaminants.

C. Field Patch Tests

A patch test evaluates the encapsulant on a small area of the painted surface prior to the start of work. When more than one surface preparation is being tested, each surface preparation procedure, plus the encapsulant, is a separate patch test. An encapsulant/surface preparation system that fails a patch test is not suitable for use in the large-scale job.

Surface preparation and encapsulation applications and installations can be done by certified contractors or knowledgeable workers. After the encapsulant has cured according to the manufacturer's recommendations, an inspector technician performs the evaluation. In at least one State (Maryland), a public agency inspector technician determines where the patches should be placed, based on the plan submitted by the owner or contractor, and inspects the patch test (Maryland, 1988). Since other States may have similar requirements (e.g., Massachusetts has a formal procedure for approving encapsulants), it is important to contact local or State agencies before starting work.

1. Size of Patch Tests

For liquid-applied systems, the recommended test patch size is about 6 by 6 inches. For narrow surfaces such as doorframes, a differently shaped patch may be needed but should be about the same area. Smaller 3- by 3-inch patches may be used for fiber-reinforced wall coverings, since they may be impossible to remove and can be thick enough to show through a completed system.

2. Location of Patches

At least one test patch should be applied to each type of component in each room or exterior location representing different types of paint where the encapsulant is to be used. For example, if the encapsulant is to be used on walls in both the kitchen and the living room, a patch test should be done on one wall in each room. Although the rooms may appear to have the same surface paint, past painting practices may have been different; therefore, both rooms should be tested. The paint testing protocol contained in Chapter 7 also is based on the idea that paint history and type is unique for each room. If localized areas of a surface or component are suspected of having underlying adhesion problems due to moisture, then the patch test should be done in one of these areas. Outer walls are good areas to test since they may be more likely to experience moisture. Similarly, load-bearing walls are good areas for patch testing because they are subject to stress. For thick, reinforced coatings or wall-covering systems, patches should be placed in an inconspicuous place, if possible. If it is known that one type of component has the same paint history in several rooms, only one patch test is needed for that component type.

3. Surface Preparation for Patch Testing

The area prepared for the patch test should be at least 2 inches larger in each direction than the area to be encapsulated for the test, unless the shape of the component makes this impossible. The surfaces should be inspected following preparation to ensure that the preparation was carried out properly. The inspection results should be documented separately for each patch.

4. Encapsulant Application and Installation

The encapsulant(s) should be applied in accordance with the manufacturer's recommendations. The application method, wet film thickness (if appropriate), and environmental conditions should be documented for each patch, since they should be the same when used on the target surface. For encapsulants that cannot be cut with a knife, consideration should be given to substituting the soundness test described below. After the encapsulant has cured, the patch is examined for adhesion and compatibility with the existing lead-based paint film. Since the cure times of encapsulants range from less than 24 hours to a period of months for a *complete* cure, it may not always be possible to perform patch tests on completely cured patches. Nevertheless, the patch test is still a useful method of assessing the likelihood of success with a given product on a given surface.

5. Patch Preparation for Conducting a Lead-Based Paint Soundness Test

The following procedure has been employed in past projects to prepare a patch test for soundness or integrity of the lead-based paint film/ base substrate system. A 3/8- by 3-inch bead of construction adhesive is applied to the central portion of the face of an 8-inch-square piece of gypsum wallboard. The wallboard square is pressed onto a 6- by 6-inch patch. The curing time recommended by the adhesive manufacturer should be observed. Evaluation of results is discussed below.

6. Visual and Adhesive Evaluation of Field Patch Tests

The encapsulant coating should be visually examined for signs of incompatibility with the paint film. These signs include wrinkling, blistering, cracking, cratering, and bubbling of the encapsulant. Solvent-based encapsulants (e.g., epoxies, polyurethanes) may react with the underlying paint layer and cause bubbling, disbonding, or other lead-based paint film deterioration. Bubbling or disbonding may be detected by scraping the *surface* of the patch, using sufficient pressure to break any visible and nonvisible surface bubbles. Surface imperfections may indicate that the encapsulant is incompatible with the existing coating. Bubbles may also form in liquid-coating encapsulants because of foaming during application, solvent entrapment during cure, and other conditions. If it can be established that the bubbles are associated with chemical reactions between the encapsulant and the underlying paint film, or the extent of bubbling is unacceptable, the patch test is a failure. If deeper probing reveals a weakened layer of paint, the patch test is also a failure. If it has failed a patch test, the encapsulant should not be applied to the target surface.

No standard method has been defined for field testing encapsulant adhesion. The "X"-cut adhesion method, used by the Maryland Department of the Environment for some encapsulants since 1988, is described here as an interim method that appears to be effective. A patch-edge method is also suggested for encapsulants that cannot be cut with a knife. Procedures for evaluating the soundness test are also provided in this section. The ASTM or another group or agency may provide additional technical standards or guidelines in the future. While the ASTM has two standard field methods for measuring adhesion of coatings—a tape test using pressure-sensitive tape (ASTM D 3359) and a portable adhesion tester (ASTM D 4541), they have not been technically defined or used for field patch testing of lead-based paint encapsulants.

"X"-Cut Adhesion Method. For the "X"-cut method, the inspector technician should take a sharp cutting tool (e.g., a knife, razor blade, or scapel) in good condition and a hard metal ruler (as a cutting guide) and inscribe an "X" in the center of the patch after the encapsulant system has cured according to the manufacturer's recommendations. Each cut line should be 1 1/2 to 2 inches long and should be made through the coating, the paint, and the patch all the way down to the substrate. A flashlight may be necessary to determine the depth of the cut. If the cut does not go through the patch to the base substrate, a second "X" cut should be made in a different location. The first cut should not be deepened.

To evaluate the adhesion and integrity of the paint film, the inspector technician should use the point of the cutting tool to attempt to peel or lift the patch from the existing topcoat. The point of the tool should be placed below the encapsulant layer at the intersection of the two cut lines. If the inspector technician can lift, peel, or tear a large (more than1/2inch- or 1/2 inch-square) portion or section of the patch away from the existing topcoat to which it was applied, then the encapsulant fails the patch test. The inspector technician should expect that a small piece of the patch will separate from the base substrate (up to 1/4 to 1/2 inch). This does not indicate failure of the patch test. Figure 13.1 shows one example of patch test failure.

Patch-Edge Method. For the patch-edge method, the inspector technician should make a cut adjacent to the edge of the patch through to the base substrate. If the thickness of the encapsulant does not change abruptly, but gradually decreases at the edge of the patch, the cut should be made through as thick a layer of the encapsulant as possible to the base substrate. The point of the knife should be placed under the encapsulant at the cut, attempting to peel or lift the patch from the lead-based paint topcoat or locate other delaminated layers within the lead-based paint film. If a large portion of the encapsulant can be lifted easily, then the patch test fails.

Soundness Method. For the soundness method, the inspector technician should attempt to pull the wallboard square away from the painted surface. If the paper backing of the wallboard remains on the adhesive of the painted surface of the patch, the test is a success. The patch test fails if the adhesive is removed from the surface of lead-based paint or if the paint film splits. Failure at the adhesive/wallboard interface can perhaps be overcome by the use of a different surface preparation procedure, as discussed below for the encapsulant patch test.

If failure occurs in any of these procedures, it is important to carefully examine the back of the delaminated portion of the patch in order to determine if the failure occurred at the encapsulant/paint film interface or in an underlying layer of paint. As discussed below, encapsulation may still be suitable—with a different system or surface preparation—when the failure is interfacial but not when the failure is within the old paint film. It may be difficult to determine the locus of failure if the paint layers and the encapsulant coating are similar colors.

If a failure occurs, one of the following courses of action must be taken, depending on the cause of failure:

The adhesion between two underlying layers of paint failed, causing delamination. Check for this condition by examining the back of the delaminated portion of the patch for signs of paint. This result indicates a layer of paint that bonded poorly and does not have sufficient adhesion. Poor bonding between underlying layers may be due to inadequate deglossing, poor-

Figure 13.1 Encapsulant Failure.

quality paint, or incompatible coatings. These conditions are usually not correctable. Since multiple patch tests are recommended, complete all patch tests before deciding upon a plan of action. The encapsulant should not be used on a surface or component that has failed patch tests.

The adhesion between the paint and the base substrate failed. Check for this by looking for signs of bare substrate and paint adhering to the back of the delaminated portion of the patch. Failure may be due to a painting history that has included so many layers of paint that the weight of the paint plus the encapsulant has begun to weaken the bond between the paint and the substrate. Moisture can also cause this type of failure. This is usually not correctable, and the encapsulant should not be used.

The adhesion between the encapsulant coating and the top layer failed. Check for this by examining the back of the delaminated portion of the patch for lack of paint. Failure may be due to:

- Application of the encapsulant to a glossy surface without adequate deglossing. It may be possible to degloss the surface using a different technique and apply a second patch test to a different area on the same component. Wet sanding is permitted to degloss but not dry sanding.
- Inadequate curing time or improper curing conditions. Manufacturer's recommendations for curing and application conditions should be consulted.
- Application of the encapsulant to a dirty or greasy surface. The surface must be recleaned, and possibly deglossed before a second patch test is tried.
- Application of material to excessive thickness. This can cause failure due to internal stresses that cause the coating to pull away from the substrate. The applicator should be trained according to the manufacturer's instructions and a wet film or dry film thickness gauge (sometimes referred to as a "mil" gauge) should be used during application.

Evaluation of Adhesively Bonded Flexible Surface Covering Tests. A successful patch is one that cannot be easily removed. If the patch cannot be removed, the covering will have to be installed over the patch. In such a case, a smaller patch in an inconspicuous place will minimize the irregularity in the appearance of the finished product.

7. Documentation of Patch Test Results

Patch testing may involve multiple patches on multiple surfaces. Therefore, documentation is very important to be sure that the correct encapsulant systems (including surface preparation) are applied to the target surfaces. If multiple patch tests are performed in a dwelling, it is recommended that a schematic drawing be used to indicate the locations of the patches. Form 13.1 can be completed for this purpose.

VII. Application and Installation of the Encapsulation Systems

Upon successful completion of a patch test, the encapsulant system can be applied or installed to the targeted surface. The steps for a proper application of an encapsulant system are summarized in Table13.2.

A. Surface Preparation for Job

The surface preparation must be the same one that was used in the successful patch test and should be conducted with the same thoroughness and level of effort. The process of repairing components and preparing surfaces for the application and installation of encapsulants can generate leaded dust and debris, so precautions must be taken. The type of precautions needed will depend upon the methods used. The appropriate Worksite Preparation Level should be selected from Chapter 8.

Repair of defective surfaces or components may also be necessary. The encapsulant manufacturer should be asked to provide recommendations for caulk and other filling compounds that are compatible with the encapsulant. To minimize future crack formation in the encapsulant, these materials should match the expansion characteristics of the encapsulant and be compatible with the existing coatings.

For large jobs, it is advisable to have an encapsulant manufacturer's representative onsite to provide additional information on repair and surface preparation. When the repair work and the surface preparation have been completed, the surface should be inspected prior to application and installation of the encapsulant. Once the encapsulant is applied, it becomes impossible to fix a poor surface preparation or, in the case of a failure, to confirm that surface preparation was done properly.

B. Installation and Application of Encapsulant System

1. Nonreinforced and Reinforced Coatings

The application procedures and requirements depend upon the specific product type. The same application method should be used for the targeted surface that was used in the patch test.

Several safety considerations are important in application: the applicator must have the appropriate MSDS documentation; personal protective equipment may be needed and must be in compliance with NIOSH or OSHA regulations; and areas need to be properly ventilated.

Masking procedures should be carried out, as needed. Surfaces to receive masking tape or other masking materials should be clean and free from dirt, dust, grease, and oil to ensure good contact. Loose edges of masking materials should be secured to avoid "flyaway," if spray application is being used. The time between coating application and masking material removal may depend upon the specific encapsulant being used.

The required environmental conditions for application depend upon the specific encapsulant being used. The manufacturer's specifications should be followed. As noted previously, water-based systems generally should not be applied to substrates when temperatures are below 40 °F or above 95 °F and the relative humidity is above 85 percent. For all encapsulants, application should be done only when the surface is dry and the temperature of the target surface is above the dewpoint.

Additional mixing and/or thinning of liquid encapsulants may be needed and should be done in accordance with the manufacturer's directions. Excessive thinning can cause premature failure. For two-component coatings, it is essential that the proper ratio of materials be mixed according to the manufacturer's directions. Not all two-component products are to be mixed together in the same ratio. Two-component materials will have a limited "pot life." That is, once the two components are mixed, a chemical reaction begins that can be slowed, but not stopped, by cooling. This means that the user has a limited period of time, i.e., pot life, in which to apply the product and to clean tools. Two-component coatings may also have an "induction time" requirement. This is a period required after mixing but before application to allow time for initiation of the reaction between the two components.

Encapsulants should be applied according to the manufacturer's recommended thicknesses. Wet film thickness gauges (sometimes called mil gauges) should be used to ensure proper film thickness. An encapsulant layer that is either too thick or too thin can cause premature failure.

Reinforced liquid encapsulants can require the use of a fabric. The manufacturer's recommendations for application of the fabric and procedures for seaming should be followed.

For liquid coatings, cure times vary from product to product and can depend upon atmospheric conditions. Thick elastomeric coatings may take only a few hours to be dry to the touch, but it may take several weeks for their mechanical properties to reach optimum values. The time for two-component coatings to cure depends upon temperature but is generally about a day.

2. Adhesively Bonded Coverings

Adhesively bonded wall coverings are installed in a manner similar to that used for vinyl wall coverings (NBS, 1973). No special tools are required. The typical three-step procedure is to apply adhesive with a roller; align and trowel the covering over the adhesive; and apply the topcoat, if needed. There are two options for coloring. The adhesive can be tinted the same color as the topcoat, which ensures two coatings with color, or two topcoats with color can be applied over untinted adhesive.

Some product manufacturers do not supply specific adhesive and topcoat products but only provide recommendations for choosing these products. Generally, there are two types of adhesives—"permanent" clay-based adhesives and water-based, heavy-duty, but strippable adhesives. Since the permanent clay-based adhesive is more durable, it is preferred for lead-based paint encapsulation. However, removal of a wall system is difficult, if not impossible, when the permanent adhesive is used. Water-based adhesives are more easily removed than permanent adhesives but may blister and fail when they come in contact with moisture.

Form 13.1
Encapsulant Patch Test Documentation

Name of Person Performing Patch Test ______________________________

License or Certificate Number (If Applicable) ______________________________

Complete Address of Dwelling ______________________________

Date Patch Test Applied ________________ Curing Time ________________

Date of Patch Test Evaluation ________________

Temperature During Application and Curing ________

Humidity During Application and Curing ________

Room	Surface Location	Substrate	Type of Patch Test (X-cut or Adhesive Wallboard)	Surface Preparation	Name and Formulation of Encapsulant	Observations	Pass/ Fail

Adhesively bonded floor tile should be installed according to the manufacturer's directions. If new subflooring is installed, then the tile/subfloor system constitutes an enclosure. If adhesion alone is used, the tiles constitute an encapsulant.

C. Inspection of Encapsulant Systems

Proper application and installation of encapsulant systems requires that the surface preparation and application procedures are carried out according to the manufacturer's recommendations and in accordance with the job specifications, if any. Monitoring of surface preparation and application is essential, in addition to conducting the final clearance examination.

1. Tools

Tools that may be required are a dark cloth to check for chalk removal, copies of referenced surface preparation standards, wet film and dry film thickness gauges, a moisture meter, surface and air thermometers, a relative-humidity meter, pressure gauges, a timepiece, and an illuminated viewing device. A logbook should be used to record all inspection data.

2. Procedures

Surface preparation and application inspection checkpoints and procedures are listed below:

- Prior to start of job—check equipment and encapsulant material.
- After preliminary cleanup and readying of the area prior to surface preparation—check for containment, protection of belongings and property, and completion of surface repairs, such as caulking.
- After surface preparation—ensure that the surface has been prepared in accordance with the specification and in the same manner as used in the patch test.

Table 13.3 Steps for Obtaining Proper Application and Installation of an Encapsulant System

Step	Description
Identify hazard.	Complete patch test and other prejob procedures.
Develop job specification.	Prepare complete job specifications. Describe all work to be done. Include all job requirements (e.g., quality of surface preparation, dry film thickness). Reference standard procedures or equipment to the extent possible to avoid misunderstandings.
Hold prejob conference.	Establish common understanding of amount and quality of work to be done among owner/specifier, contractor, and inspector technician. For example, all parties should agree on the extent of surface preparation. Document any changes in writing to avoid future disputes. The contractor should be prepared to provide work (scheduling) plans, worker safety plans, lists of materials and the amounts to be used, material manufacturer's written technical data sheets, application instructions, MSDS, test reports, and other information required in the job specification.
Conduct inspection.	Inspect coating operations. This is essential in obtaining a durable encapsulant system. All inspection data should be recorded by the inspector technician in a daily logbook. Suggested "inspection checkpoints" are described in Section C.2.
Perform final clearance inspection.	Conduct final clearance testing as described in Chapter 15.

- For liquid encapsulants, just prior to material application—observe mixing and thinning, if any, for compliance with manufacturer's written instructions. Ensure that mixing ratio of two-component coatings is correct.

- During application of encapsulant—check environmental conditions (temperature, relative humidity, etc.). For liquid coatings, check wet film thickness, color of material (different colors should be required for different coats), and cure of previous coat before application of next coat for compliance with manufacturer's written instructions.

- After job completion—check dry film thickness and cure of liquid-applied coatings and appearance for all encapsulants.

VIII. Periodic Monitoring and Reevaluation

Because of the limited experience with the use of encapsulant systems and because of their dependence upon the integrity of a lead-based paint film, the property owner or manager must arrange for regular monitoring and repairs, as needed. Visual monitoring should be performed 1 month and 6 months after application and at the schedule specified in Chapter 6. If signs of wear or deterioration are apparent during any reevaluation examination, the monitoring should be increased to a quarterly basis for the next 6 months, then annually thereafter. In addition, residents should be instructed to notify management of the need for repairs on a timely basis. In some cities and States, regulatory reexaminations may be required, including sampling of settled dust for lead analysis. For example, the Maryland Department of the Environment has the authority to inspect dwellings for a period of 1 year following application of an encapsulant. This is because encapsulants are approved on a case-by-case basis, and the reevaluation provides a means of documenting their performance (Maryland, 1988).

IX. Recordkeeping

The owner and contractor should both maintain documentation of interim control or abatement measures. Since the lead is not removed, appropriate protective measures must be taken if the encapsulant fails or if the building is renovated or demolished. Although it would be possible to label existing lead-based painted surfaces prior to encapsulation, the warning would likely be hidden, since it would be covered by the encapsulant. A chemical reaction between the marking substance and the encapsulant could cause the encapsulant to fail. Therefore, drawings showing locations of lead-based paint should be mounted on a wall of a basement, storage closet, or utility room. Records of both the initial installation and reexaminations should be provided to a new owner at the time of property transfer.

The following information describing the initial application should be included with the drawings kept in the building:

- Type of encapsulant and product name.

- Exact location of encapsulant.

- Product label and/or copy of manufacturer's technical product information.

- MSDS for all products used.

- Contractor name.

- Date of application.

The visual monitoring document should be kept by the owner or local agency. Each document should include the name of the person performing the periodic visual monitoring, the date of the visual monitoring, the condition of coating and signs of wear or deterioration, and results of any leaded dust tests performed. If failure was observed or encapsulant had been repaired, the reasons for failure (if known), corrective actions recommended or taken to repair failures, and any other information pertinent to the maintenance of the encapsulant should be included. Form 13.2 may be used for this purpose.

Form 13.2
Lead-Based Paint Encapsulation Visual Monitoring Form

Name of Person Performing Visual Monitoring ______________________________

License or Certificate Number (If Applicable) ______________________________

Complete Address of Dwelling ____

Date Encapsulant was Applied ________________

Date of Last Evaluation ____________________

Today's Date ______________________________

Room	Surface Location	Substrate	Name and/or Formulation of Encapsulation	Observations	Pass/Fail

Signature ____

CHAPTER 14: CLEANING

Cleaning: How To Do It

1. Include step-by-step procedures for precleaning, cleaning during the job, and daily and final cleanings in project design or specifications.
2. Assign responsibilities to specific workers for cleaning and for maintaining cleaning equipment.
3. Have sufficient cleaning equipment and supplies *before* beginning work.
4. If contamination is extensive, conduct precleaning of the dwelling unit. Move or cover all furniture and other objects.
5. Conduct ongoing cleaning during the job, including regular removal of large and small debris and dust. Decontamination of all tools, equipment, and worker protection gear is required before it leaves containment areas. Electrical equipment should be wiped and high-efficiency particulate air (HEPA) vacuumed, not wetted down, to minimize electrocution hazards.
6. Schedule sufficient time (usually 30 minutes to an hour) for a complete daily cleaning, starting at the same time near the end of each workday after lead hazard control activity has ceased.
7. For final cleaning, wait at least 1 hour after active lead hazard control activity has ceased to let dust particles settle.
8. Use a vacuum cleaner equipped with a HEPA exhaust filter. HEPA vacuum all surfaces in the room (ceilings, walls, trim, and floors). Start with the ceiling and work down, moving toward the entry door. Completely clean each room before moving on.
9. Wash all surfaces with a lead-specific detergent, high-phosphate detergent, or other suitable cleaning agent to dislodge any ground-in contamination, then rinse. Change the cleaning solution after every room is cleaned.
10. Repeat step 8. To meet clearance standards consistently, a HEPA vacuum, wet wash, and HEPA vacuum cycle is recommended. For interim control projects involving dust removal only, the final HEPA vacuuming step is usually not needed (see Chapter 11). Other cleaning methods are acceptable, as long as clearance criteria are met and workers are not overexposed.
11. After final cleaning, perform a visual examination to ensure that all surfaces requiring lead hazard control have been addressed and all visible dust and debris have been removed. Record findings and correct any incomplete work. This visual examination should be performed by the owner or an owner's representative who is independent of the lead hazard control contractor.
12. If other construction work will disturb the lead-based paint surfaces, it should be completed at this point. If those surfaces are disturbed, repeat the final cleaning step after the other construction work has been completed.
13. Paint or otherwise seal treated surfaces and interior floors.
14. Conduct a clearance examination (see Chapter 15).
15. If clearance is not achieved, repeat the final cleaning.

16. Continue clearance testing and repeated cleaning until the dwelling achieves compliance with all clearance standards. As an incentive to conduct ongoing cleaning and a thorough final cleaning, the cost of repeated cleaning after failing to achieve clearance should be borne by the contractor as a matter of the job specification, not the owner.

17. Do not allow residents to enter the work area until cleaning is completed and clearance is established.

18. Cleaning equipment list:

    - HEPA vacuums.
    - Detergent.
    - Waterproof gloves.
    - Rags.
    - Sponges.
    - Mops.
    - Buckets.
    - HEPA vacuum attachments (crevice tools, beater bar for cleaning rugs).
    - 6-mil plastic bags.
    - Debris containers.
    - Waste water containers.
    - Shovels.
    - Rakes.
    - Water-misting sprayers.
    - 6-mil polyethylene sheeting (or equivalent).

Chapter 14: Cleaning

I. Introduction

This chapter describes cleaning procedures to be employed following abatement and interim control work. Dust removal as an interim control measure is covered in Chapter 11.

All lead hazard control activities can produce dangerous quantities of leaded dust. Unless this dust is properly removed, a dwelling unit will be more hazardous after the work is completed than it was originally. Once deposited, leaded dust is difficult to clean effectively. Whenever possible, ongoing and daily cleaning of leaded dust during lead hazard control projects is recommended. Ongoing and daily cleaning is also necessary to minimize worker exposures.

Cleaning is the process of removing visible debris *and* dust particles too small to be seen by the naked eye. Removal of lead-based paint hazards in a dwelling unit will not make the unit safe unless excessive levels of leaded dust are also removed. This is true regardless of whether the dust was present before or generated by the lead hazard control process itself. Improper cleaning can increase the cost of a project considerably because additional cleaning and clearance sampling will be necessary. However, cleaning and clearance can be achieved routinely if care and diligence are exercised.

A. Performance Standard

Although the cleaning methods described in this chapter are feasible and have been shown to be effective in meeting clearance standards, other methods may also be used if they are safe and effective. This performance-oriented approach should stimulate innovation, reduce cost, and ensure safe conditions for both residents and workers.

B. Small Dust Particles

Dust particles that are invisible to the naked eye remain on surfaces after ordinary cleaning procedures. A visibly clean surface may contain high and unacceptable levels of dust particles and require special cleaning procedures.

C. Difficulties in Cleaning

While cleaning is an integral and essential component of any lead hazard control activity, it is also the most likely part of the activity to fail.

Several common reasons for this failure include low clearance standards, worker inexperience, high dust-producing methods, and deadlines.

1. Low Clearance Standards

Because very small particles of leaded dust are easily absorbed by the body when ingested or inhaled, a small amount can create a health hazard for young children. Therefore, "clearance standards" are extremely low for acceptable levels of leaded dust particles on surfaces after hazard control activities, and careful cleaning procedures are required. Although it is not possible to remove *all* leaded dust from a dwelling, it is possible to reduce it to a safe level.

Clearance standards are described more fully in Chapter 15. The permissible amount of leaded dust remaining on each of the following surfaces following lead hazard work is as follows:

- 100 $\mu g/ft^2$ on floors.
- 500 $\mu g/ft^2$ on interior window sills (stools).
- 800 $\mu g/ft^2$ on window troughs (the area where the sash sits when closed).
- 800 $\mu g/ft^2$ on exterior concrete.

These levels are based on wipe sampling. Clearance testing determines whether the premises or area are clean enough to be reoccupied after the completion of a lead paint hazard control project. A cleaned area may not be reoccupied until compliance with clearance standards has been established. To prevent delays, final testing and final cleaning activities should be coordinated.

2. Worker Inexperience

To understand the level of cleanliness required to meet the established clearance standards for hazard control cleanup, new hazard control personnel often require a significant reorientation to cleaning. Many construction workers are used to cleaning up only dust that they can see, not the invisible dust particles that are also important to remove.

3. High Dust-Producing Methods and/or Inadequate Containment

High dust-generating methods, inadequate containment during hazard control work, and poor work practices can all make achievement of clearance particularly difficult. Work practices necessary to prevent spreading of dust throughout a dwelling (e.g., by tracking dust out of work areas) are essential but sometimes tedious. Essential work practices are sometimes mistakenly considered to be "flexible guidelines" rather than necessary standards that are designed to ensure that the job is completed, not only safely, but also on time and within budget.

4. Deadlines

Daily and final cleanings have sometimes been compromised due to project deadlines, since cleaning comes at the end of the job. Hurried efforts often result in clearance failure. Delayed and over-budget hazard control projects are often the result of repeated, unplanned recleanings that are necessitated by inadequate containment and sloppy work practices.

II. Coordination of Cleaning Activities

A. Checklist

The owner or contractor may use the following cleaning checklist before any lead hazard control activity:

- ✔ Is the critical importance of cleaning in a hazard control project understood?
- ✔ Have all workers been trained and certified for hazard control work?
- ✔ Have the precleaning, daily, and final cleanings been scheduled properly and coordinated with the other participants in the hazard control process?
- ✔ Have cleaning equipment and materials been obtained?
- ✔ Do the workers know how to operate and maintain special cleaning equipment, and do they have directions for the proper use of all cleaning materials?
- ✔ Have all workers carefully studied the step-by-step procedures for precleaning (if needed), in-progress cleaning, and daily and final cleanings?
- ✔ Are all workers properly protected during the cleaning processes (see Chapter9)?
- ✔ Have provisions been made to properly contain and store potentially hazardous debris (see Chapter 10)?
- ✔ Have dust-clearance testing and related visual inspections been arranged (see Chapter 15)?
- ✔ Are the clearance criteria to be met fully understood?
- ✔ Have all appropriate surfaces been properly painted or otherwise sealed?
- ✔ Have appropriate records been maintained that document participants' roles in the hazard control project?

B. Equipment Needed for Cleaning

The following equipment is needed to conduct cleaning: high-efficiency particulate air (HEPA) vacuums and attachments (crevice tools, beater bar for cleaning rugs), detergent, waterproof gloves, rags, sponges, mops, buckets, 6-mil plastic bags, debris containers, waste water containers, shovels, rakes, water-misting sprayers, and 6-mil polyethylene plastic sheeting (or equivalent).

C. Waste Disposal

Regulations governing hazardous and nonhazardous waste storage, transportation, and disposal affect both the daily and final cleaning procedures. The hazard control contractor and the disposal contractor should work together to establish formal written procedures, specifying selected containers, storage areas, and debris pickups, to ensure that all relevant regulations are met.

III. Cleaning Methods and Procedures

Many of the special cleaning methods and procedures detailed in this chapter are not standard operating procedure for general home improvement contractors. Therefore, project designers, responsible agencies, or owners must ensure that contractors follow the methods and procedures recommended herein or specially designed alternative procedures, even though some may appear to be redundant and unnecessary. These methods have been shown to be feasible and effective in many situations and skipping steps in the cleaning procedures can be counterproductive.

A. Containment

Because of the difficulty involved in the removal of fine dust, dust generated by hazard control work should be contained to the extent possible to the inside of work areas. Inadequately constructed or maintained containment or poor work practices will result in additional cleaning efforts, due to dust that has leaked out or been tracked out of the work area (see Chapter 8).

B. Basic Cleaning Methods: Wet Wash and Vacuum Cleaning Techniques

Because leaded dust adheres tenaciously, especially to such rough or porous materials as weathered or worn wood surfaces and masonry surfaces (particularly concrete), workers should be trained in cleaning methods. As a motivator, some contractors have awarded bonuses to workers who pass clearance the first time.

Two basic cleaning methods have proven effective, when used concurrently, in lead-based paint hazard control projects: a special vacuum cleaner equipped with a HEPA exhaust filter, followed by wet washing with special cleaning agents and rinsing, followed by a final pass with the HEPA vacuum.

Although HEPA filtered vacuums and trisodium phosphate (TSP) cleaners have been considered the standard cleaning tools for lead hazard control projects, new research, discussed under the "Alternatives Methods" section in this chapter, suggests that other tools and products may also be effective in efficiently cleaning dust while providing adequate worker protection from airborne exposure risks. Some of these innovations may even be superior.

1. HEPA Vacuuming

HEPA vacuums differ from conventional vacuums in that they contain high-efficiency filters that are capable of trapping extremely small, micron-sized particles. These filters can remove particles of 0.3 microns or greater from air at 99.97 percent efficiency or greater. (A micron is 1 millionth of a meter, or about 0.00004 inches.) Some vacuums are equipped with an ultra-low penetration air (ULPA) filter that is capable of filtering out particles of 0.13 microns or greater at 99.9995 percent efficiency. However, these ULPA filters are slightly more expensive, and may be less available than HEPA filters.

Vacuuming with conventional vacuum machines is unlikely to be effective, because much of the fine dust will be exhausted back into the environment where it can settle on surfaces. A recent Canadian study revealed that fine-dust air levels were exceedingly high when a standard portable vacuum with a new bag was used, although partially filled bags were found to be more efficient (CMHC, 1992). Considerations for the proper use of a HEPA vacuum are listed below.

Operating Instructions

There are a numerous manufacturers of HEPA vacuums. Although all HEPA vacuums operate on the same general principle, they may vary considerably with respect to specific procedures, such as how to change the filters. To ensure the proper use of equipment, the manufacturer's operating instructions should be carefully followed and if possible, training sessions arranged with the manufacturer's representative.

Although HEPA vacuums have the same "suction" capacity as ordinary vacuums that are comparably sized, their filters are more efficient. Improper cleaning or changing of HEPA filters may reduce the vacuum's suction capability.

Special Attachments

Because the HEPA vacuum will be used to vacuum surfaces other than floors, operators should buy attachments and appropriate tool kits for use on different surfaces—such as brushes of various sizes, crevice tools, and angular tools.

Selecting Appropriate Size(s)

HEPA vacuums are available in numerous sizes, ranging from a small lunchbucket-sized unit to track-mounted systems. Two criteria for size selection are the size of the job and the type of electrical power available. Manufacturer recommendations should be followed.

Wet-Dry HEPA Vacuums

Some hazard control contractors have found the wet-dry HEPA vacuums to be particularly effective in meeting clearance standards. These vacuums are equipped with a special shut-off float switch to protect the electrical motor from water contact.

Prefilters

HEPA filters are usually used in conjunction with a prefilter or series of prefilters that trap the bulk of the dust in the exhaust airstream, particularly the larger particles. The HEPA filter traps most of the remaining small particles that have passed through the prefilter(s). All filters must be maintained and replaced or cleaned as specified in the manufacturer's instructions. Failure to do so may cause a reduction in suction power (thus reducing the vacuum's efficiency and effectiveness). Failure to change prefilters may damage the vacuum motor and will also shorten the service life of the HEPA filter, which is far more expensive than the prefilters.

HEPA Vacuuming Procedures

Surfaces frequently vacuumed include ceilings, walls, floors, windows, interior and exterior sills, doors, heating, ventilation, and air conditioning (HVAC) equipment (heating diffusers, radiators, pipes, vents), fixtures of any kind (light, bathroom, kitchen), built-in cabinets, and appliances.

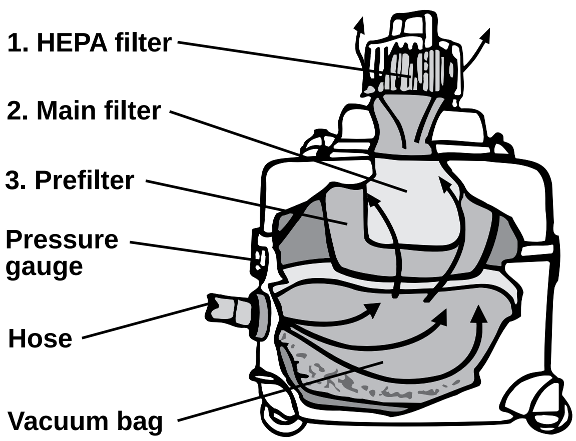
To aid in dislodging and collecting deep dust and lead from carpets, the HEPA vacuum must be equipped with a beater bar (agitator head) that is fixed to the cleaning head. This bar should be used on all passes on the carpet face during dry vacuuming (see Chapter 11 for details on carpet and furniture cleaning).

All rooms and surfaces should be included in the HEPA vacuum process, except for those that (1) were found not to have lead-paint hazards *and* were properly separated from work areas before the process began (see Chapter 8), or (2) were never entered during the process. Porches, sidewalks, driveways, and other exterior surfaces should be vacuumed if exterior hazard control work was conducted, or if debris was stored or dropped outside. Vacuuming should begin on the ceilings and end on the floors, sequenced to avoid passing through rooms already cleaned, with the dwellings' entryway cleaned last.

Emptying the HEPA Vacuum

Used filters and vacuumed debris are potentially hazardous waste and should be treated accordingly (see Chapter10). Therefore, operators should use extreme caution when opening the HEPA vacuum for filter replacement or debris removal to avoid accidental release of accumulated dust into the environment. This may occur, for example, if the vacuum's seal has been broken and the vacuum's bag is disturbed.

Figure 14.1a Vacuum With a HEPA Filter.



Parts of a HEPA-vacuum

Most HEPA-vacuums have three filters: HEPA filter, main filter, and pre-filter. Debris gets sucked in through the hose into the vacuum bag. The air and dust get filtered through the pre-filter, the main filter, and the HEPA filter. The HEPA filter captures the lead dust before the air is released into the work area again.

Operators should also wear a full set of protective clothing and equipment, including appropriate respirators, when performing this maintenance function, which should be done in the containment area or offsite.

2. Wet Detergent Wash

Several types of detergents have been used to remove leaded dust. Those with a high-phosphate content (containing at least 5 percent trisodium phosphate, also known as TSP) have been found to be effective when used as part of the final cleaning process (Milar, 1982). TSP detergents are thought to work by coating the surface of dusts with phosphate or polyphosphate groups which reduces electrostatic interactions with other surfaces and thereby permits easier removal. Because of environmental concerns some States have restricted the use of TSP, and some manufacturers have eliminated phosphates from their household detergents. However, high-TSP detergents can usually be found in hardware stores and may be permitted for limited use, such as lead hazard control.

Other non-TSP cleaning agents developed specifically for removing leaded dust have also been found to be effective (possibly more effective than TSP) in limited trials by several

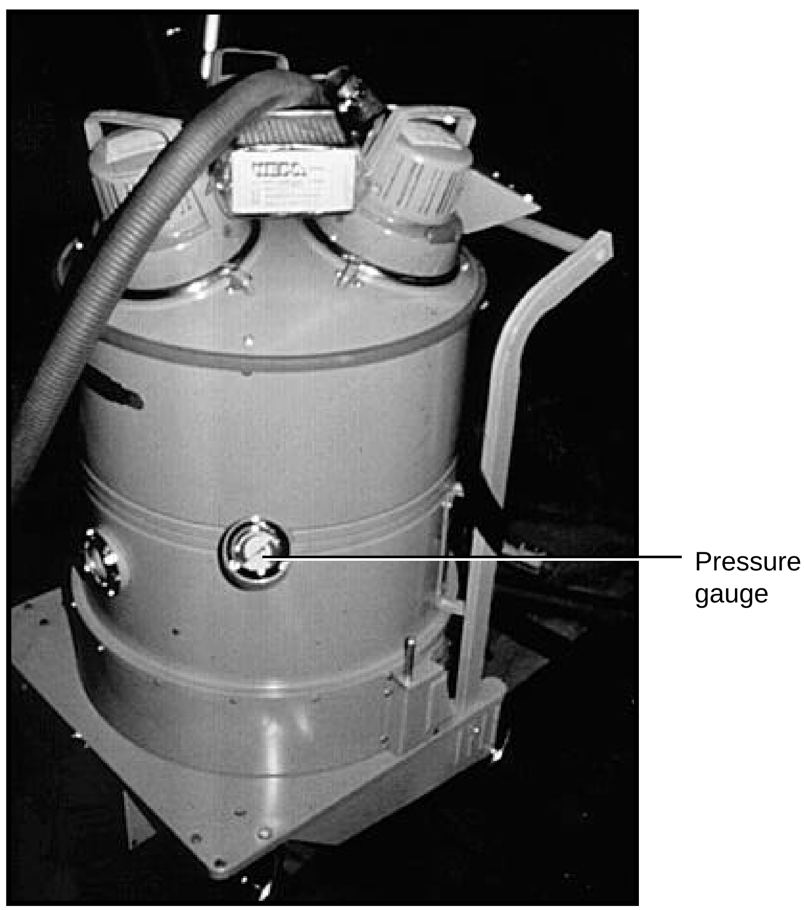
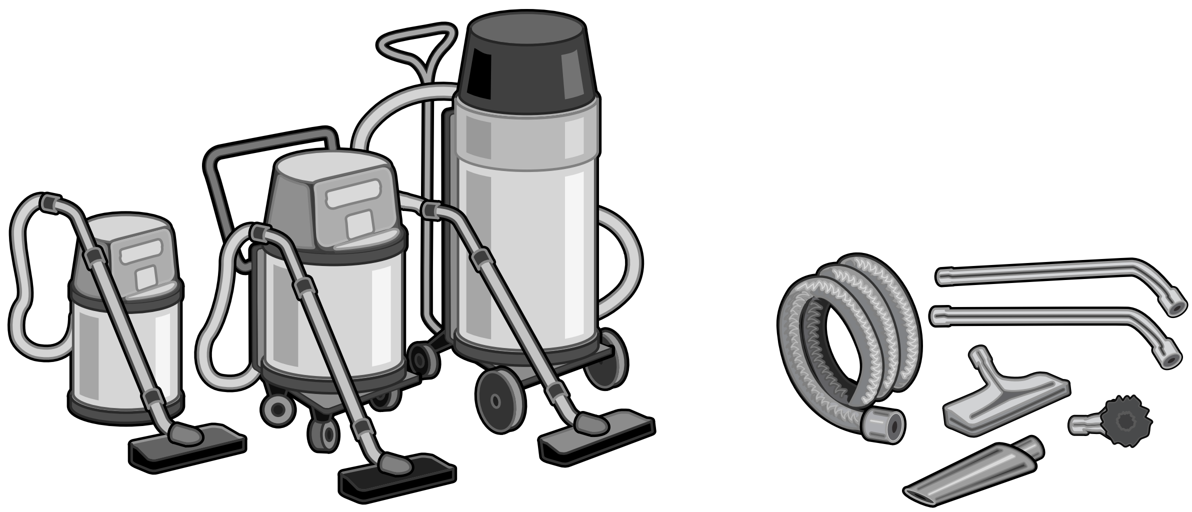


Figure 14.1b Pressure Gauge Indicator Shows When Filters Require Changing.

Figure 14.2 HEPA Vacuum Sizes and Tools.



investigators (Grawe, 1993; Wilson, 1993) and may also be safer, since TSP is a skin and eye irritant. See section VII for more information on non-TSP detergents. Proper procedures for using high-phosphate detergents also apply to most other types of detergents and include the following steps:

Manufacturer's Dilution Instructions

Users of cleaning agents for leaded dust removal should follow manufacturer's instructions for the proper use of a product, especially the recommended dilution ratio. Even diluted, trisodium phosphate is a skin irritant and users should wear waterproof gloves. Eye protection should also be worn, and portable eyewash facilities should be located in or very near the work area. Consult manufacturer's directions for the use of other detergents.

Appropriate Cleaning Equipment

Because a detergent may be used to clean leaded dust from a variety of surfaces, several types of application equipment are needed, including cleaning solution spray bottles, wringer buckets, mops, variously sized hand sponges, brushes, and rags. Using the proper equipment on each surface is essential to the quality of the wet-wash process.

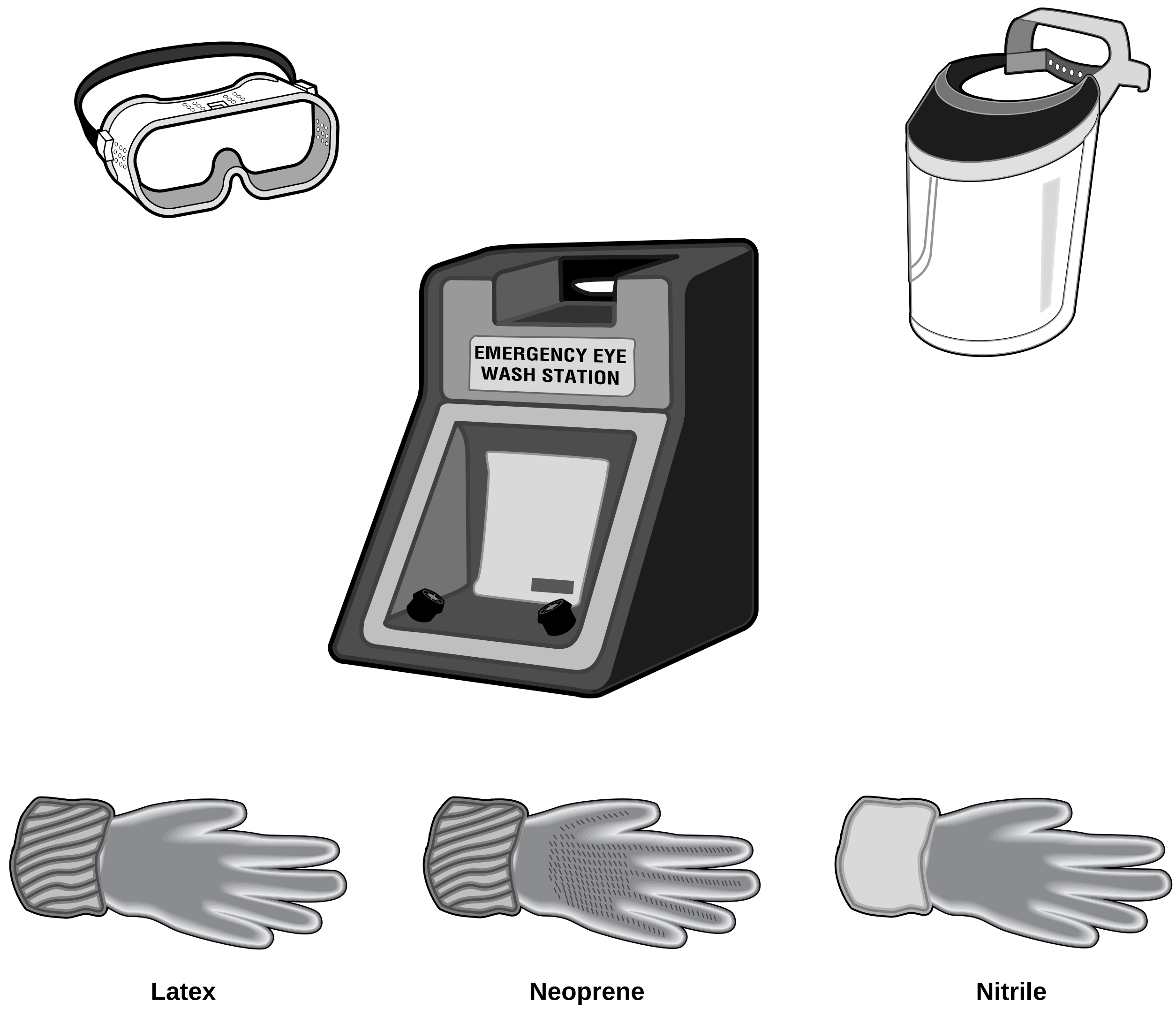
Proper Wet-Cleaning Procedures

At the conclusion of the active lead hazard control process and the initial HEPA vacuuming, all vacuumed surfaces should be thoroughly and completely washed with a high-phosphate solution or other lead-specific cleaning agent (or equivalent) and rinsed. Select a detergent that does not damage existing surface finishes (TSP may damage some finishes). Work should proceed from ceilings to floors and sequenced to avoid passing through rooms already cleaned.

Changing Cleaning Mixture

Many manufacturers of cleaners will indicate the surface area that their cleaning mixture will cover. To avoid recontaminating an area by cleaning it with dirty water, users should follow manufacturer-specified surface-area limits. However, regardless of manufacturers' recommendations, the cleaning mixture should be changed after its use for each room. As a rule of thumb, 5 gallons should be used to clean no

Figure 14.3 Goggles, Face Shields, Gloves, and Eye Wash Facilities Should Be Available When Used With Chemicals Such as TSP.



more than 1,000 square feet. Used cleaning mixture is potentially hazardous waste (see Chapter 10); consult with your local water and sewage utility for directions on its proper disposal. Wash water should never be poured onto the ground. The wash water is usually filtered and then poured down a toilet (if the local water authority approves).

3. The HEPA/Wet Wash/HEPA Cycle

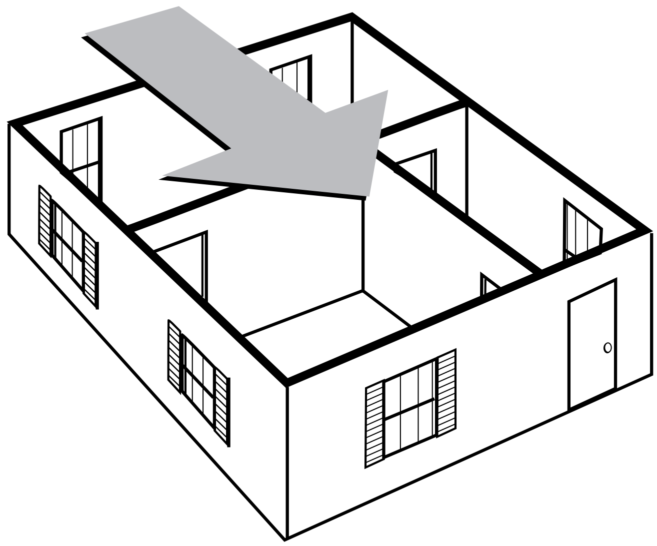
Typical Procedures

The usual cleaning cycle that follows lead hazard control activities is called the HEPA vacuum/wet wash/HEPA cycle and is applied to an entire affected area as follows:

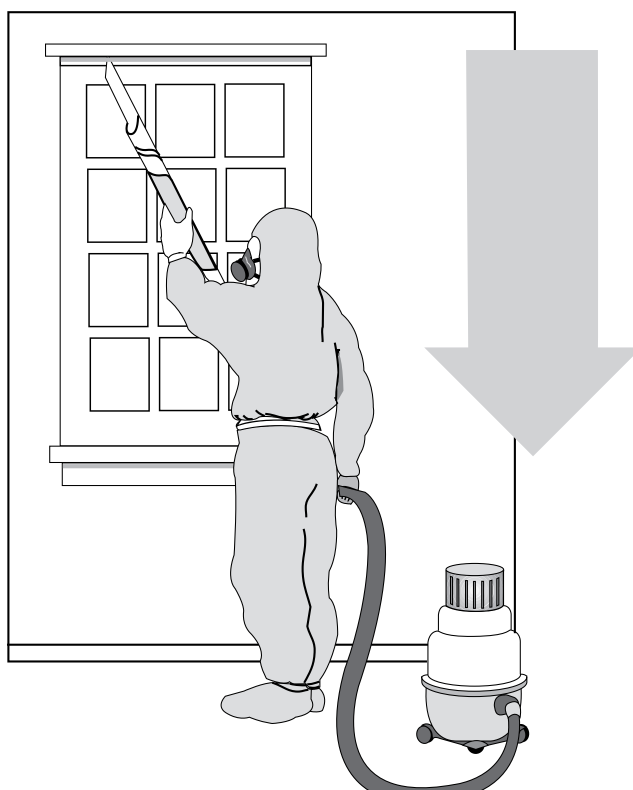
- First, the area is HEPA vacuumed.

Figure 14.4a The HEPA Vacuum, Wet Wash, HEPA Vacuum Cycle Helps in Meeting Clearance Standards.

HEPA vacuum all surfaces
Start at the end farthest from the main entrance/exit. As you vacuum, move towards the main exit and finish there.



Begin at the top of each room and work down. For example, start with the top shelves, the top of the woodwork, and so on, and work down to the floor. Do every inch of the windows, especially the window troughs.



Courtesy: Alice Hamilton Occupational Health Center

- Next, the area is washed down.
- After drying, the area is again HEPA vacuumed.

The rationale for this three-pass system is as follows:

- The first HEPA vacuum removes as much dust and remaining debris as possible.
- The wet wash further dislodges dust from surfaces.
- The final HEPA cycle removes any remaining particles dislodged but not removed by the wet wash.

Single-Pass Wet Wash/HEPA Vacuum

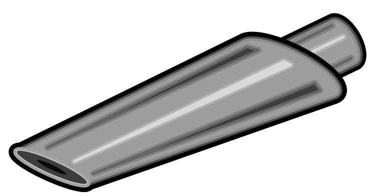
Some lead hazard control contractors have found HEPA spray cleaner vacuums to be a cost-effective alternative to the three-pass system. Similar to home carpet-cleaning machines, these vacuums simultaneously deliver a solution to the surface and recover the dirty solution. Theoretically, this process combines two of the steps in the HEPA vacuum/wet wash/HEPA cycle into one step. While anecdotal evidence indicates that the spray cleaner wet wash/HEPA is effective for some uses, limitations have been noted in its use for ceilings, vertical surfaces, and hard to reach areas. This device may be used as long as clearance standards are met.

Figure 14.4b (continued)

Use special attachments
Use the rubber cone where the floor meets the baseboard and along all the cracks in the floor boards. Use the brush tool for walls and woodwork.

Use the wheeled floor nozzle for bare floors and the carpet beater for rugs.

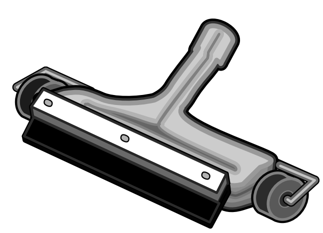
Move slowly
Vacuum slowly so the HEPA vacuum can pick up all the lead dust.



Rubber Cone

Dust Brush

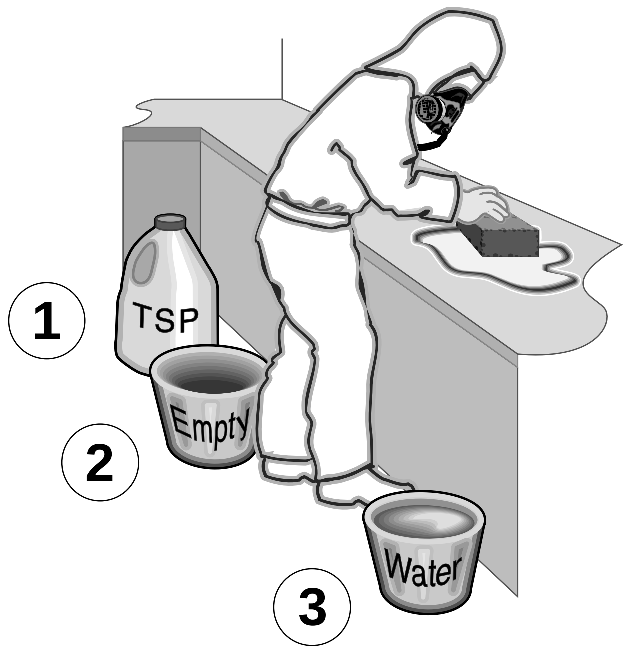
Powered Carpet Beater



Wheeled Floor Nozzle

Figure 14.4c (continued)

Wash all surfaces with suitable detergents
Wash *all surfaces* in the work area with suitable detergents, including areas that had been covered with plastic. Some wallpaper should only be HEPA vacuumed, since it may be damaged by the detergent.



Wipe All Surfaces

Wet Mop Floor

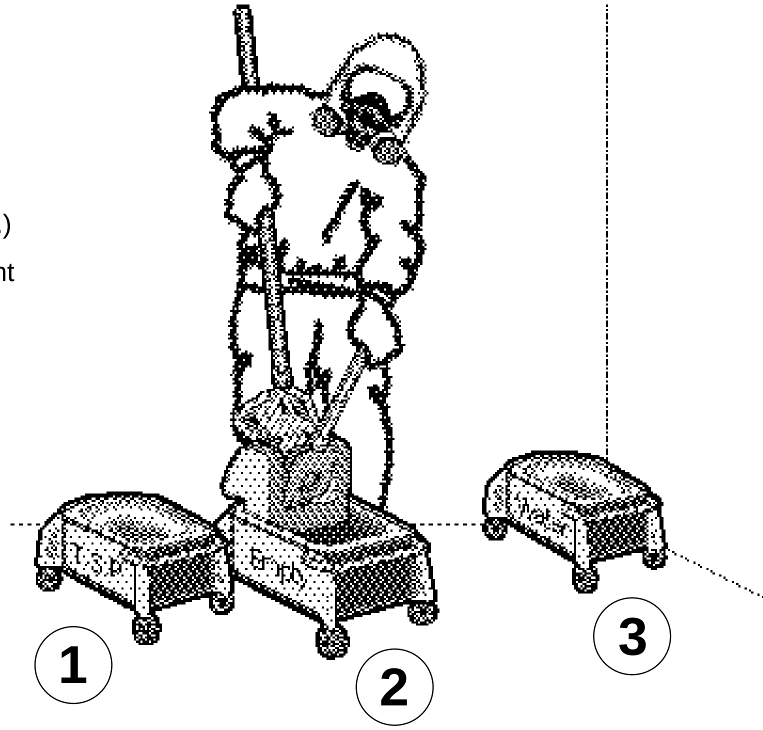
Don’t Dry Sweep

Figure 14.4c (continued)

Use the 3-Bucket System.

To wash: Use string mops and mop buckets with wringers. (Some experts say NEVER use a sponge mop on the floor. Sponge mops may only push the lead around on the floor, not remove it.)

Dip the string mophead in the detergent wash in bucket #1. Mop the floor.



Squeeze out the mophead in empty bucket #2. Return to bucket #1 for more detergent solution and continue mopping. Repeat.

Use the third bucket for rinsing the floor.

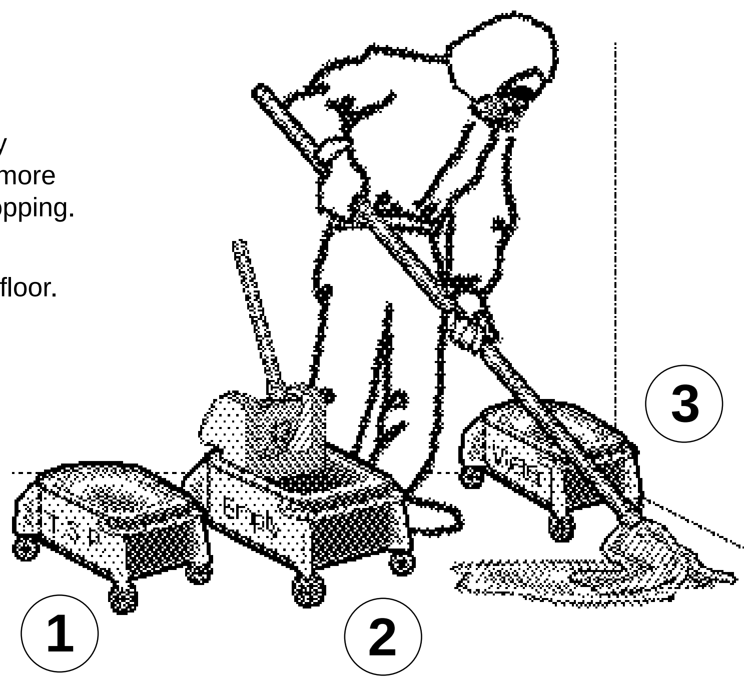
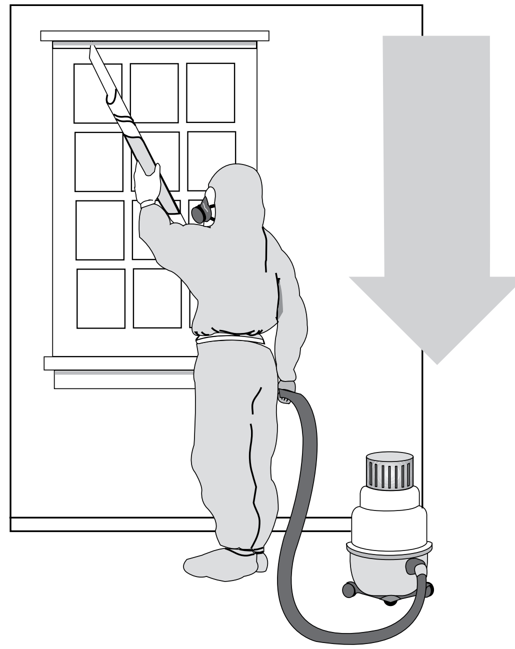


Figure 14.4d (continued)

HEPA vacuum all surfaces a final time
HEPA vacuum *all surfaces* in the work area, including areas that had been covered with plastic.

Starting at the far end, work towards the decontamination area. Begin with ceilings or the top of the walls and work down, cleaning the floors last. Do every inch of the windows, especially the troughs. Use the corner tool to clean where the floor meets the baseboard and all the cracks in the floor boards. Use the brush tool for the walls. Move slowly and carefully to get all the dust.



4. Sealing Floors

Before clearance, all floors without an intact, nonporous coating should be coated. Sealed surfaces are easier for residents to clean and maintain over time than those that are not sealed. Wooden floors should be sealed with a clear polyurethane or painted with deck enamel or durable paint. Vinyl tile, linoleum, and other similar floors should be sealed with an appropriate wax. Concrete floors should be sealed with a concrete sealer or other type of concrete deck enamel. However, if these floors are already covered by an effective coat of sealant, it may be possible to skip this step.

As an alternative to sealing, floors may be covered with new vinyl tile, sheet vinyl, linoleum flooring, or the equivalent to create a more permanent cleanable surface. New surfaces should be cleaned with a cleaning solution that is appropriate for that type of surface.

IV. Order of Cleaning Procedures During Lead Hazard Control

The special cleaning procedures to be followed during a lead-based paint hazard control project are discussed in chronological order below. Skipping steps in the process may result in failure to meet post-lead hazard control clearance standards.

A. Precleaning Procedures

Precleaning (i.e., cleaning conducted before lead hazard control is begun) is necessary only in dwelling units that are heavily contaminated with paint chips. Precleaning involves the removal of large debris and paint chips, followed by HEPA vacuuming. These steps may be followed by removal of occupant personal possessions, furniture, or carpeting, depending on the

Figure 14.5 Single-Pass HEPA Vacuum/Wet Wash Technology.

Worksite Preparation Level selected (see Chapter 8). If the furniture will not be cleaned, it should be removed from the area or covered with plastic prior to beginning the precleaning procedure. Carpeting should always be misted before its removal to control the generation of hazardous dust.

It is usually the resident's responsibility to remove most of his or her personal possessions. However, if necessary, owners or project management should be prepared to complete this activity before lead hazard control work begins. As a last resort, the contractor may pack any remaining belongings and carefully seal and move the boxes, supplying all necessary boxes, packing materials, and staff to complete the task. Following cleaning and clearance, the contractor should return all packed items to their appropriate places. Leaving these tasks to the contractor may be expensive and inefficient, since the contractor will need to be insured for this function if the occupant's

Figure 14.6 Precleaning Is Needed in Areas Where Contamination and Deterioration Are High.

belongings are damaged. Additionally, moving furniture, rugs, drapes, and other items owned by the occupant could increase leaded dust levels. Clearance should be conducted after cleaning but before resident items are moved back in.

B. Ongoing Cleaning During the Job

Periodic HEPA vacuuming during the lead hazard control work may be necessary to minimize tracking of dust and paint chips from one area to another (e.g., when a large amount of paint chips or dust is being generated).

C. Daily Cleaning Procedures

Cleaning activity should be scheduled at the end of each workday when all active lead hazard control throughout the dwelling has ceased. Sufficient time must be allowed for a thorough and complete cleaning (usually about 30 minutes to an hour). Daily cleaning helps achieve clearance dust levels by minimizing problems that may otherwise occur during final cleaning and limiting worker exposures. While daily cleaning can be skipped in vacant dwelling units, it is required when occupants will return in the evening. Under no circumstances should debris or plastic be left outside overnight in an unsecured area, even if the dwelling is vacant. Daily cleaning should consist of:

- Removing large debris.
- Removing small debris.
- HEPA vacuuming, wet clean, HEPA vacuuming (horizontal surfaces only).
- Cleaning exterior.
- Patching and repairing plastic sheeting.
- Securing debris/plastic.

Figure 14.7 Plastic Sheeting Should Be Repaired as Part of Daily Cleanup.

1. Large Debris

Large demolition-type debris (e.g., doors, windows, trim) should be wrapped in 6-mil plastic, sealed with tape, and moved to a secure area on the property designated for waste storage. All sharp corners, edges, and nails should be hammered down to prevent injury and minimize the tearing of plastic. It is not necessary to wrap each individual piece of debris in plastic if the entire load can be wrapped. A secure area either outside or inside the property must be designated as a temporary waste-storage area. Covered, secured, and labeled dumpsters placed on or near the property may be used. Proper segregation of waste should be enforced at this time (see Chapter 10).

2. Small Debris

After being misted with water, small debris should be swept up, collected, and disposed of properly. The swept debris should be placed in double 4-mil or single 6-mil polyethylene (or equivalent) plastic bags, properly sealed, and moved to the designated trash storage area. Trash bags should not be overloaded; overloaded bags may rupture or puncture during handling and transport.

3. Exterior Cleaning

Areas potentially affected by exterior lead hazard control should be protected via a containment system (see Chapter 8). Because weather can adversely affect the efficacy of exterior containment, the surface plastic of the containment system should be removed at the end of each workday. On a daily basis, as well as during final cleaning, the immediate area should be examined visually to ensure that no debris has escaped containment. Any such debris should be raked or vacuumed and placed in single 6-mil or double 4-mil plastic bags, which should then be sealed and stored along with other contaminated debris. HEPA vacuuming is appropriate for hard exterior surfaces, not soil.

4. Worker Protection Measures

General worker protection measures are discussed in Chapter 9. Studies indicate that during daily cleaning activities, especially while wet sweeping, workers may be exposed to high levels of airborne dust. Therefore, workers should wear protective clothing and equipment, especially appropriate respirators.

5. Maintaining Containment

The integrity of the plastic sheeting used in a lead hazard control project must be maintained. During their daily cleaning activities, workers should monitor the sheeting and immediately repair any holes or rips with 6-mil plastic and duct tape.

V. Order of Final Cleaning Procedures After Lead Hazard Control

Before treated surfaces can be painted or sealed, final cleaning procedures must be completed. Because airborne dust requires time to settle, the final cleaning process should start no sooner than 1 hour after active lead hazard control has ceased in the room. See Appendix 11 for details regarding dust settling.

A. Final Cleaning

As the first stage in the final cleaning, floor plastic should be misted and swept as detailed earlier in this chapter. Upper-level plastic, such as that on cabinets and counters, should be removed first, after it has been misted with water *and cleaned*. All plastic should be folded carefully from the corners/ends to the middle to trap any remaining dust. Next, remove both layers of plastic from the floor.

Plastic sheets used to isolate contaminated rooms from noncontaminated rooms should remain in place until after the cleaning and removal of other plastic sheeting; these sheets may then be misted, cleaned, and removed last.

Removed plastic should be placed into double 4-mil or single 6-mil plastic bags, or plastic bags with equivalent (or better) performance characteristics, which are sealed and removed from the premises. As with daily cleanings, this plastic-removal process usually requires workers to use protective clothing and respirators.

After the plastic has been removed from the contaminated area, the entire area should be cleaned using the HEPA/wet wash/HEPA cycle, starting with the ceiling and working down to the floor. After surfaces are repainted or sealed, a final HEPA/wet wash/HEPA cycle may be necessary if accumulated dust caused by other work is visible.

1. Decontamination of Workers, Supplies, and Equipment

Decontamination is necessary to ensure that worker's families, other workers, and subsequent properties do not become contaminated. Specific procedures for proper decontamination of equipment, tools, and materials prior to their removal from lead hazard control containment areas should be implemented, as described below and in Chapters 9 and 10.

Work clothing, work shoes, and tools should not be placed in a worker's automobile unless they have been laundered or placed in sealed bags. All vacuums and tools that were used should be wiped down using sponges or rags with detergent solutions.

Consumable/disposable supplies, such as mop heads, sponges, and rags, should be replaced, after each dwelling is completed. Soiled items should be treated as contaminated debris (see Chapter 10).

Figure 14.8a Pick Up Corners of Plastic Sheeting.

Figure 14.8b Fold Plastic Inward.

Durable equipment, such as power and hand tools, generators, and vehicles, should be cleaned prior to their removal from the site; the cleaning should consist of a thorough HEPA vacuuming followed by washing.

B. Preliminary Visual Examination

After the preliminary final cleaning effort is completed, the certified supervisor should visually evaluate the entire work area to ensure that all work has been completed and all visible dust and debris have been removed. While the preliminary examination may be performed by the lead hazard control supervisor, contractor, or owner as a preparatory step before the final clearance examination, it does not replace the independent visual assessment conducted during clearance.

If the visual examination results are unsatisfactory, affected surfaces must be retreated and/or recleaned. Therefore, it is more cost effective to have the supervisor rather than the clearance examiner perform this initial examination.

C. Surface Painting or Sealing of Nonfloor Surfaces

The next step of the cleaning process is painting or otherwise sealing all treated surfaces except floors.

Surfaces, including walls, ceilings, and woodwork, should be coated with an appropriate primer and repainted. Surfaces enclosed with vinyl, aluminum coil stock, and other materials traditionally not repainted are exempt from the painting provision.

D. Final Inspection

The final clearance evaluation should take place at least 1 hour after the final cleaning. Clearance has three purposes: 1) to ensure that the lead hazard control work is complete, 2) to detect the presence of leaded dust, and 3) to make sure that all treated surfaces have been repainted or otherwise sealed. Clearance is usually performed after the sealant is applied to the floor. See Chapter 15 for information on clearance examination procedures.

E. Recleaning After Clearance Failure

If after passing the final visual examination, the dwelling unit fails the clearance wipe dust tests, the HEPA/wet wash/HEPA cleaning cycle should be carefully and methodically repeated. Failure is an indication that the cleaning has not been successful. Recleaning should be conducted under the direct supervision of a certified supervisor. Care should be exercised during the recleaning of "failed" surfaces or components to avoid recontaminating "cleared" surfaces or components.

VI. Cleaning Cost Considerations

An important consideration in determining lead hazard control strategies and methods is the cost and difficulty of required daily and final cleanup operations and the ease with which one can meet dust-clearance standards. A general rule of thumb is that lead hazard control strategies that generate the most dust will have higher cleanup costs and higher initial clearance test-failure rates.

A. Initial Clearance Test Failure Rates

The likelihood of passing final dust-clearance tests is highly correlated with the chosen intervention strategy, methods, and care exercised by the contractor. For example, in one study (HUD, 1991) initial wipe-test failure rates were 14 percent for interior window sills, 19 percent for floors, and 33 percent for window troughs. The pass/fail rates for each surface were strongly associated with the dwelling unit abatement strategy employed. Chemical removal and hand-scraping strategies experi-enced higher failure rates than replacement and encapsulation/enclosure strategies (see Table 14.1).

However, results of the HUD demonstration project indicated that clearance failure is not solely related to abatement method. The report stated that "the diligence and effectiveness of an abatement contractor's cleaning process ... had a major impact on ... the likelihood of the dwelling unit to pass the final wipe test clearance" (HUD, 1991).

Figure 14.8c Dispose of Plastic Sheeting in a Plastic Trash Bag.

B. Key Factors In Effective Cleaning

Effective cleaning will be aided by adequate sealing of surfaces with polyethylene sheeting prior to lead hazard control, proper daily cleaning practices, good worker training, and attention to detail. Where poor worksite preparation is employed, additional cleaning may be required to meet clearance.

C. Special Problems

Surfaces such as porous concrete, old porous hardwood floors, and areas such as corners of rooms and window troughs pose especially difficult cleaning challenges. Porous concrete and corners of rooms normally require additional vacuuming to achieve an acceptable level of cleanliness.

The lead hazard control strategy of enclosure is frequently chosen for window troughs and for old porous hardwood floors due to the difficulty of adequately cleaning these surfaces. This option provides not only a clean surface but a more permanently cleanable surface for dwelling occupants to maintain.

VII. Alternative Methods

Alternatives to the recommended cleaning tools and practices discussed in this chapter are available, some having significant potential for increasing effectiveness and lowering costs.

A recent Canadian study (CMHC, 1992) evaluated the effectiveness of contaminated dust cleanup activities using tools that would generally be available to construction contractors and homeowners. Vinyl flooring and carpeting were cleaned using several wet/dry vacuuming systems, sweeping, and wet mopping. The study found that regular vacuums with empty bags send a steady stream of fine particles into the air, while vacuums with partially filled bags were more efficient. This finding suggests the necessity for HEPA vacuums. Other vacuums may be used if workers do not experience increased exposures, if compliance with clearance standards is achieved, and if a variance from OSHA regulation (29 CFR 1926.62 (h)(4)) is obtained by the contractor or employer (if required).

Agitator heads on vacuums were demonstrated to significantly enhance vacuum effectiveness on carpets in cleaning up fine dust without increasing airborne dust levels. Table 14.2 suggests that a central vacuum with an agitator head is most efficient at removing dust and minimizing recontamination, probably because the vacuum exhaust is blown away from living areas. Because many houses do not have central vacuuming systems, a portable HEPA vacuum is the next best choice (see Table 14.2). Vacuums without agitator heads appeared to perform relatively poorly on carpets.

A. Vacuums

Regular (non-HEPA) dry vacuums potentially produce hazardous levels of airborne dust and therefore should be avoided. Externally exhausted vacuum units with adequate dust-retaining capability may be used. The OSHA lead standard requires the use of HEPA vacuum equipment (see 29 CFR 1926.62 (h)(4), which states, “where vacuuming methods are selected, the vacuums shall be equipped with HEPA filters”).

B. Trisodium Phosphate and Other Detergents

TSP detergents have been used successfully for a number of years in lead hazard control work. However, in recent years, other new cleaning agents have been developed specifically for leaded dust removal. The need for alternatives has been fueled by the fact that TSP is an eye

Table 14.1 Initial Cleaning Wipe-Test Failure Rates for Various Abatement Strategies

Dust Test Location	Hand Scrape w/Heat Gun	Chemical Removal	Enclosure	Encapsulation	Replacement	All Methods
Floors	28.8%	22.7%	20.0%	13.8%	12.5%	19%
Sills	24.4%	24.1%	8.2%	4.8%	17.4%	14%
Wells	44.5%	45.7%	23.7%	25.7%	21.0%	33%

Source: U.S. Department of Housing and Urban Development (August 1991) The HUD Lead-Based Paint Abatement Demonstration (FHA) and skin irritant and is increasingly restricted from household use and unavailable in many local jurisdictions. TSP also damages some finishes. Recently reported trials of two new products suggest that alternative lead-specific cleaning agents may be more effective and safer than TSP (Grawe, 1993; Wilson, 1993).

These *Guidelines* do not prohibit the use of non-TSP cleaning agents. HUD encourages further evaluation of alternative cleaning methods. Use of any cleaning agent that results in compliance with clearance criteria is encouraged.

Table 14.2 Mass Removal Efficiency for Extended Vacuuming Cycles

Cycle Number	Mass Removal Efficiency Percentages			
	Cleaning Method			
	Central Vacuum—Plain Tool	Central Vacuum—Agitator Head	HEPA Vacuum	Portable Vacuum—Plain Tool
1	34.7	71.0	55.4	17.5
2	47.0	80.2	61.2	23.0
3	51.9	85.9	66.3	26.6
4	56.0	87.8	67.0	29.4
5	59.3	88.9	72.1	32.5
6	61.6	91.2	74.4	34.9
7	63.8	93.1	76.4	36.5
8	67.5	95.4	77.5	38.1
9	67.5	97.7	78.7	40.1
10	67.2	100.0	80.2	41.7
11		102.3	80.2	41.7
12		104.6	84.1	44.8
13		104.6	84.5	46.8
14		103.8	84.5	48.4
15				49.6
16				50.8
17				52.4
18				53.6
19				54.4
20				55.2

Source: Canada Mortgage and Housing Corporation: Saskatchewan Research Council (December 1992) *Effectiveness of Clean-up Techniques for Leaded Paint Dust*

Chapter 15: Clearance

Clearance: How To Do It

1. Decide who will conduct clearance. Clearance on all abatement projects and federally funded interim control work must be done by a certified risk assessor or inspector technician. The U.S. Department of Housing and Urban Development (HUD) strongly recommends the use of a certified risk assessor or inspector technician who is completely independent of the lead hazard control contractor to eliminate conflicts of interest. Some local jurisdictions may require a license to conduct clearance.

2. Finish the lead hazard control and cleanup effort. Seal floors before clearance testing (if necessary).

3. Wait 1 hour to allow any airborne dust to settle. Do not enter the work area during that hour.

4. Conduct visual examination.

   a. Determine if *all* required work has been completed and *all* lead-based paint hazards have been controlled.

   b. Determine if there is visible settled dust, paint chips, or debris in the interior or around the exterior.

5. Complete the Visual Clearance Form contained in this chapter; if all specified work was not completed, inform the owner and order completion of work and repeated cleanup, if necessary.

6. Conduct clearance dust sampling of floors, interior window sills, and window troughs using the protocol in this chapter.

7. Conduct clearance soil sampling if bare soil is present that was not sampled previously, or if exterior paint work was completed as part of the lead hazard control effort. Whenever exterior work has been done, it may be necessary to take samples from soil that is not bare to determine if contamination has occurred. If results are above 2,000 µg/g (or 400 µg/g in high contact play areas), compare the results to baseline soil sampling results to determine what additional measures are needed.

8. Complete the Dust and Soil Sampling Clearance Form contained in this chapter.

9. Submit samples to a U.S. Environmental Protection Agency (EPA) recognized laboratory participating in the National Lead Laboratory Accreditation Program (NLLAP) for analysis.

10. Interpret results by comparing them to the HUD Interim Clearance Standards contained in this chapter (until EPA issues its health-based leaded dust standards).

11. If clearance is achieved, go to step 15.

12. Order repeated cleaning or soil treatments if results are above applicable standards. Clean all surfaces the sample represents.

13. Continue sampling and repeated cleaning until the dwelling achieves compliance with all clearance standards.

14. Complete any related construction work that does not disturb a surface with lead-based paint (all work that does disturb painted surfaces or that could generate leaded dust should be completed as part of the lead hazard control effort).
15. Issue any necessary statements of lead-based paint compliance or releases and maintain appropriate records.
16. Permit residents into the cleared work area.

Chapter 15: Clearance

I. Introduction

A. Purpose of Clearance

Clearance refers to the various environmental evaluation procedures used to determine if:

- ✥ The lead hazard control work was actually completed as specified.
- ✥ The area is safe for unprotected workers to enter.
- ✥ The area is a safe place for residents and young children to live.

Since most lead hazard control work generates a considerable amount of leaded dust, and since previous studies have indicated that cleaning can be accomplished only with great care and skill (HUD, 1991), it is necessary to determine if the cleaning was successful. Some type of clearance is required for all forms of lead hazard control. Certified risk assessors or certified inspector technicians (clearance examiners) can best recommend the exact type of clearance testing to be employed on a specific project. The process outlined in this chapter provides a means of determining if lead hazards have been controlled.

B. Clearance as the Endpoint

If clearance criteria are met, the contractor who performed the work can conclude that the job is complete. However, if the clearance criteria are not met, the contractor must complete the work and/or repeat the cleaning process until the area is clean enough to meet clearance criteria. For example, if the job included the removal and replacement of all windows, but the clearance examiner determines that one window has been overlooked, the contractor must remove and replace it as originally specified (in addition to carrying out any necessary additional cleaning in that area). Similarly, if excessive leaded dust levels remain, the contractor's job cannot be considered complete until leaded dust levels are below clearance standards. Normally, the final payment to the contractor is withheld until compliance with clearance standards is achieved.

The clearance examination described in this chapter is similar to the punchlist that follows a typical construction or repair job. The major difference is that the normal visual check is almost always augmented with environmental testing since leaded dust and soil hazards are not visible to the naked eye.

The clearance examination protects *all* parties involved—the job contractor, the owner, and the resident. The process provides the contractor with an objective determination that the job was completed safely. The owner will have assurance that the abatement job was successful in correcting hazards and that the amount of leaded dust left after the work was completed is at a safe level. The resident can be certain that dangerous shortcuts were not taken during the work process and that resident children will be safe.

C. Conflicts of Interest

The owner should retain the services of a certified risk assessor or a certified inspector technician to determine compliance with clearance criteria. The clearance examiner must not be paid or employed, or otherwise compensated by the lead hazard control contractor and should have no vested interest in seeing that the job is completed on schedule. The clearance examiner's *only* concern should be that compliance with clearance standards has been achieved.

This does not mean that job supervisors should not perform their own visual assessments of the quality of the cleanup job performed by their workers. Such assessments will help ensure that clearance criteria are met the first time around.

Some owners of multiple dwelling units may wish to have lead hazard control work performed by their own trained crews, rather than contract for such services. In this case it is essential that clearance testing be performed by an independent third party whose payment is not dependent on completion of the job within any particular time period.

The clearance procedures contained in this chapter should always be included in the job specifications so that performance responsibilities are clear.

II. Time Between Completion of Cleanup and Clearance

Clearance dust sampling should be performed no sooner than 1 hour after completion of the final cleanup to permit airborne leaded dust to settle. Clearance dust sampling is for *settled* leaded dust, not airborne leaded dust, since the main source of lead exposure for children is through contact with contaminated surfaces followed by ingestion. Most children in the United States. are *not* lead poisoned by inhalation (ATSDR, 1988). Airborne leaded dust sampling is not recommended for clearance purposes in lead hazard control work.

While often performed for asbestos abatement projects, air sampling does not appear to be a useful tool for determining if clearance has been achieved in lead hazard control work. Because asbestos fibers are known to have low settling velocities (that is, they take a long time to settle out of the air), air sampling can be used to determine the effectiveness of the cleanup effort in asbestos abatement jobs. But because dust particles typically generated during lead abatement jobs are larger, denser, more spherical, and heavier, settling time is much faster.

The U.S. Department of Housing and Urban Development's (HUD's) *Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing* recommended 24 hours as the minimum waiting period to allow airborne lead-contaminated particles to settle, although no justification for the 24-hour waiting period was provided (HUD, 1990a). The reduction in the waiting period before sampling from 24 hours to 1 hour marks an important change in the new recommendations. The current *Guidelines* recommend 1 hour because the additional amount of leaded dust that would settle onto floors after 1 hour is negligible. The analysis supporting this finding is summarized below. (A full description of the analysis can be found in Appendix 11.)

Analysis of the settling velocity of airborne leaded particulate has demonstrated that nearly all particulate greater than 5 µm in diameter will have settled out of the air within an hour. It is estimated that any remaining airborne particulate less than 5 µm would contribute no more than an additional 5 $\mu g/ft^2$ of lead to surface dust, even if all of it were to settle out of the air. This is well below the HUD Interim Clearance Standard for floors (100 $\mu g/ft^2$) and also well below the routine limit of quantitation for wipe sampling (25 $\mu g/ft^2$). Therefore, a reduction in the waiting period to 1 hour is justified. This change will contribute to significant cost savings by cutting 1 day off the length of the abatement job (reducing relocation costs and job delays). Entry into the area should be prohibited during the 1-hour waiting period to keep turbulence and re-entrainment of particulate matter to a minimum.

III. Visual Examination Procedures

Clearance occurs in two main phases: visual examination and environmental sampling (dust and, if exterior work was conducted, soil sampling). A standard Visual Clearance Form can be found at the end of this chapter (see Form 15.1).

A. Determination of Completed Work

A visual examination determines whether the work on all interior and exterior surfaces to be treated was in fact completed and to ensure that no visible settled leaded dust or debris are present. Visual clearance is a relatively straightforward process requiring an understanding of the scope of the job and a keen eye for detail. It is essential that clearance examiners have full knowledge of the extent of the work and specifically which surfaces did *not* require treatment. The clearance examiner should have access to any risk assessment or paint inspection report as well as the job scope of work or specifications and a report from the owner or contractor that the work has been completed.

The visual examination of completed work should be done on a room-by-room basis to ensure that all areas are examined (this includes the exterior and common areas). In most cases the visual examination will be conducted by a clearance examiner when the environmental samples are collected.

When paint removal and repainting or soil removal and covering is planned, verification of the removal of the lead hazards will be necessary prior to the completion of work. In these instances the owner or a representative of the owner (which may be the hazard control contractor) may take responsibility for confirming that the hazard is removed prior to repainting or covering. This allows the owner to avoid the expense of having the clearance examiner travel to the job site twice—once to verify the hazard removal and again to collect environmental samples. On the other hand, owners may choose to have the clearance examiner confirm that the work was actually completed. Regardless of who verifies the hazard removal, verification should be documented on Form 15.1.

In multifamily housing of similar construction, it is not necessary to perform a visual examination of every single unit. Instead, a random sample of abated units can be visually examined before the paint is applied. The abatement contractor should not know ahead of time which units will be visually inspected prior to repainting. The random sample size can be determined by using the table for lead-based paint inspections (Table 7.3). Random sampling of single-family dwellings is not possible due to the large variability in construction and work. Therefore, each single-family dwelling should be cleared individually.

In the case of a child with an elevated blood lead level, local authorities may require that the treatment of all indicated surfaces be verified by a government employee or certified third party, especially in cases where the abatement has been ordered by local authorities. Clearance examiners should determine if the property they are investigating has been abated as a result of a legal or regulatory proceeding. If so, the enforcement agency should be contacted to coordinate clearance procedures, prevent duplication of effort and, most importantly, ensure that the private clearance process is not inadvertently overstepping the bounds of the normal practices of the local health department or childhood lead-poisoning prevention program.

1. Paint Removal and Repainting

All surfaces where paint has been removed should be visually examined *prior to repainting*. If clearance is conducted after new paint is applied, it is often impossible to determine if the old paint was actually removed. Areas commonly overlooked during paint removal projects include the underside of interior window sills and handrails, backside of radiator ribs, bottom edge of doors, top of doorframes, and the back edge of shelving.

For both onsite and offsite removal, the clearance examiner or the owner should examine the bare surfaces to ensure that there is no visible residue. If residue remains, the component should be cleaned prior to repainting or refinishing.

Wipe sampling and x-ray fluorescence (XRF) testing are not appropriate tools for determining the effectiveness of paint removal from a particular surface. Wipe sampling cannot dislodge any leaded dust that may have been absorbed into the substrate during the removal process, nor can it remove paint that is still bonded to the substrate. Wipe sampling *is* appropriate for measurement of settled leaded dust on floors, interior window sills, and window troughs. It is not appropriate to apply the settled leaded dust clearance standard to these components since the bare surface will be sealed with new paint, thus rendering the dust inaccessible. Appendix 1 describes how much lead-contaminated dust can remain on a surface (at least 35,000 µg/ft^2) before it would cause the newly applied paint to become lead-based paint (at 0.5 percent).

2. Building Component Removal and Replacement

If building components coated with lead-based paint were removed as a lead hazard control measure, the clearance examiner should have detailed knowledge of the scope of the replacement activities so that actual removal can be verified. Each building component specified for replacement should also be examined to determine if it was overlooked during the lead hazard control work.

3. Enclosures

Complete installation of enclosure systems, such as new drywall, paneling, or siding, can be best evaluated by direct visual observation. The clearance examiner should determine that the mechanical fastening system used to hold the enclosure to the substrate is adequate. This is especially important for ceilings. All seams and edges in the enclosure should be sealed to provide a "dust-tight," but not necessarily airtight, system.

4. Soil Treatments

Soil treatments, which typically consist of some form of covering or removal and/or replacement, can be assessed by direct visual observation to determine if the covering is present. For example, if sod or asphalt has been used as a soil covering, the clearance examiner should determine if all bare areas have been covered by the sod or asphalt, as specified.

No visible lead-based paint chips should be observed in soil following lead hazard control work. It is not necessary to turn over or rake soil to look for paint chips. A visual examination of the surface is adequate.

If exterior work on lead-based paint has been performed, baseline soil samples should have been collected but not necessarily analyzed until clearance soil samples have been collected, analyzed, and compared to clearance standards. It may be necessary to collect samples from soil that is not bare to determine if contamination has occurred. If post-hazard control soil levels are below applicable limits, the preabatement samples need not be analyzed. The clearance level for most soil is 2,000 µg/g (400 µg/g for small, high-contact play areas). If post-hazard control soil levels are greater than or equal to the applicable limits, the baseline samples should be analyzed to determine where additional work is needed. If paint chips originating from the work are identified in the soil, they should be picked up with a high-efficiency particulate air (HEPA) vacuum.

5. Encapsulants

Another category of lead hazard control that can best be assessed visually is the application of encapsulants. Assuming that the encapsulant was properly selected for the surface undergoing treatment and that patch tests were conducted as recommended in Chapter 13, the clearance examiner can determine if the encapsulant is in fact present.

6. Interim Controls

Visual examination of the wide variety of interim control measures consists of a confirmation that all lead-based paint (either suspected or identified through testing) is stabilized and that any friction, impact, and other surfaces marked for treatment in the risk assessment report or project specifications have all been properly treated. No known or suspected lead-based paint should be in a deteriorated condition in a cleared dwelling.

B. Visual Examination for Settled Dust and Debris

There should be no evidence of settled dust following a cleanup effort. If dust is observed, the contractor must be required to repeat the cleaning effort *before* clearance dust samples are collected to avoid conducting dust sampling twice. Any settled dust present following abatement or interim control work provides sufficient evidence that cleanup was not adequate (see Figure 15.1).

Figure 15.1 Visible Dust Indicates Cleaning Should Be Repeated.

Lead Tracking

Lead dust can be transported from one area to another on shoes.

Tracking lead dust from one area to another is a big problem on lead hazard control jobs. Lead dust can be tracked on shoes from the work area to the outside. Sometimes lead dust from the outside soil is tracked into the work area. Lead dust from a porch or nonwork area can get tracked into a cleaned area. When this happens, the whole area must be cleaned.

There are conflicting reports regarding the use of the so-called "white glove test" as part of the visual examination. Some housing agencies have indicated that they find this to be a useful preliminary examination tool, while others indicate that this test almost always shows some discoloration, even if surfaces have been cleaned well. Until it has been demonstrated to effectively predict leaded dust levels, use of the "white glove test" is left to the discretion of the examiner and is not recommended by HUD. The "white glove test" is *not* a substitute for laboratory analysis of dust samples.

Finally, the grounds around the dwelling should also be examined visually to make certain that all waste and debris have been removed and that leaded dust or paint chips were not transferred outside the dwelling. For example, waste should not be left at the curbside for trash pickup; all waste should be removed from the site. The examiner should be particularly conscientious about looking for paint chips when exterior components have been disturbed.

IV. Clearance Dust Sampling

A visual examination alone is not adequate for determining if a residence is safe for occupancy, since small dust particles are not visible to the naked eye. A person with normal eyesight cannot detect individual dust particles smaller than 50 μm in diameter (Olishifski, 1983). Data indicate that a significant percentage of the dust generated during abatement is smaller than 50 μm (Mamane, 1994; NIOSH, 1993b). Since these smaller dust particles are associated with an increased risk of lead poisoning, clearance dust testing is required to determine if a leaded dust hazard remains following lead hazard control work.

Unless U.S. Environmental Protection Agency (EPA) regulations establish different clearance levels, the following HUD clearance standards should be used, based on wipe sampling:

- 100 µg/ft^2 for floors.
- 500 µg/ft^2 for interior window sills.
- 800 µg/ft^2 for window troughs and exterior concrete or other rough surfaces.

There is no standard for vacuum sampling at this time.

Portable XRF analyzers have not yet demonstrated a capacity to detect dust lead levels in the range of interest. Wet chemical field test kits are also not sufficiently reliable for routine analysis of leaded dust at this time and do not yield quantitative data that can be compared to clearance standards.

Dust samples must be analyzed by laboratory methods such as atomic absorption spectroscopy, inductively coupled plasma-emission spectroscopy, laboratory XRF using standard methods, or other equivalent analytical methods (see Appendix 14). Only laboratories that participate in a national proficiency testing program and are recognized by EPA should be used.

If the dust sample from any surface indicates a leaded dust level above the clearance standard, all similar surfaces in the dwelling that sample represents (e.g., all interior window sills or floors) should be recleaned and retested. Only the similar components need to be recleaned, not necessarily the entire dwelling. If any such surface fails twice, the property owner should consider additional hazard control measures and/or further sealing of the surface. See sections D and VII for further disussion interpreting dust sampling results.

A. Multifamily Housing (20 or More Units)

It is possible to conduct clearance dust sampling in a number of randomly selected dwelling units in multifamily housing where similar dwelling units have undergone comparable types of lead hazard control activity. The random sampling can be performed for a portion of the housing development or for all of it. In either case the randomly selected units represent a specified group of housing units. The contractor must not know in advance which units will be sampled since this would bias the results. In addition, it is necessary to choose an adequate number of randomly selected units (Table 7.3). Significant cost savings could be realized with such a sampling plan.

However, the implications of random clearance sampling should be understood fully before it is used. First, if the random sampling shows that levels of leaded dust are too high, it will be necessary to reclean not only the affected component in the selected dwelling unit, but also the affected component in *all* the other units that the randomly selected unit was meant to represent. Alternatively, all the units represented by the randomly selected unit could be sampled individually to determine which ones need recleaning. The costs of repeated sampling should be compared with the costs of repeated cleaning. Regardless of whether all the represented units are sampled or recleaned, a further delay in permitting residents back into the area is possible when using random clearance sampling.

Second, insurance carriers covering lead hazard control work may demand a high degree of assurance that the work was performed properly in each and every dwelling. The extra cost of dust sampling in all units is likely to be minor compared to the liability of a child with an elevated blood lead level in an abated unit that was not sampled but was later found to contain high leaded dust levels.

Third, there has been a significant failure rate in attaining compliance with clearance dust standards in both the ongoing public housing program and the HUD Demonstration Project

(HUD, 1991). In the latter study, failure rates on the initial wipe tests were 19 percent for floors at 200 µg/ft^2, 14 percent for window sills, and 33 percent for window troughs. In one large abatement job for a public housing authority, 15 percent of the housing units failed the clearance tests and required recleaning (Jacobs, 1993a). While this failure rate can be partially attributed to abatement strategy, variable contractor performance, and perhaps the inexperience of the abatement industry, the high rate of failure argues for more extensive unit-by-unit testing.

In spite of all these caveats, there is one special situation that may lend itself well to random clearance sampling. A large *vacant* apartment building or housing development that will not be immediately reoccupied following abatement could conceivably be randomly sampled at the end of the project and, if necessary, completely recleaned. Alternatively, all units could be sampled to determine which ones require recleaning.

Whether random clearance sampling or unit-by-unit clearance sampling is performed, repeated sampling should *always* be performed in all units that required recleaning. In short, most cases of lead hazard control will require that clearance dust sampling be conducted in every unit treated. With additional research and innovative abatement and cleaning techniques that improve compliance rates with clearance dust standards, it may be possible to sample only a fraction of the units treated.

B. Single-Family Housing and Multifamily Housing (Fewer Than 20 Units)

Clearance dust sampling should be conducted in every single-family dwelling unit and in all multifamily housing with fewer than 20 units. Because treatment and housing conditions vary so greatly in these housing units, random sampling is inappropriate.

C. Clearance Dust Sampling and Floor Sealant Application

Wipe samples should be collected after application of a floor sealant, not before. In lead hazard control programs, coating floors with a sealant is often one of the final measures completed. The purpose of sealing floors is not to trap leaded dust underneath the sealant, but to provide a surface that can be cleaned effectively by the resident. The type of flooring determines the type of sealant. Wooden floors should either be painted with a deck enamel or coated with polyurethane, concrete floors should be sealed with a concrete sealant, and tile floors should be sealed with appropriate wax.

The maintenance and monitoring system should check the integrity of the floor sealant at least yearly.

D. Location and Number of Clearance Dust Samples

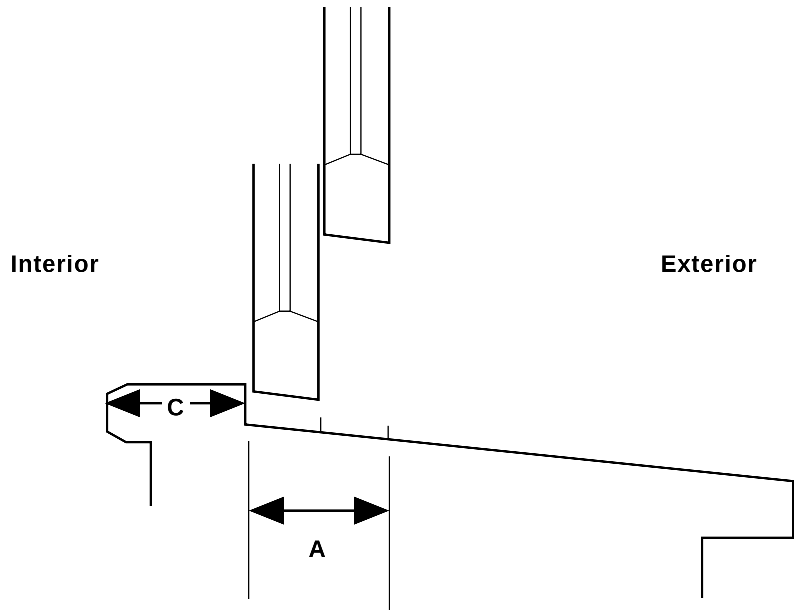
Clearance dust samples should be taken either from specific locations near the area where the lead hazard control treatment was done, from nearby high-traffic areas (around doorways, for example), or from other areas. The clearance examiner may determine which specific site is best based on the type of treatment, visual observation, and professional judgment. The abatement contractor must not know exactly where the clearance samples will be collected.

The number of clearance samples depends on whether composite or single-surface samples are collected.

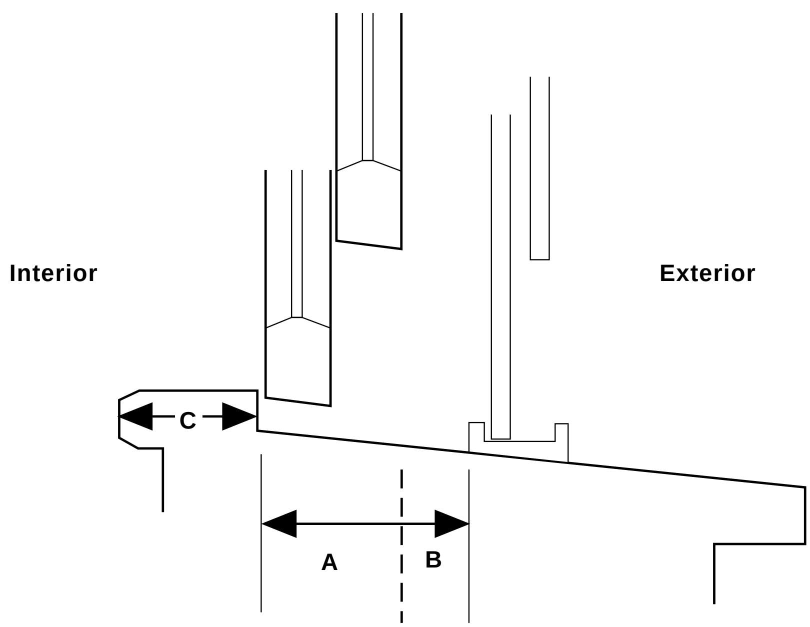
1. Single-Surface Sampling

Single-surface sampling can be conducted using essentially the same methodology as that described in Chapter 5 and Appendix 13. However, the number and location of clearance samples is based on the type of containment used and the number of rooms treated, not on the use pattern of the room (as is the case for risk assessment purposes). The three building components that should be tested are floors, interior window sills, and window troughs. A window trough is the part of the window in which both sashes sit when lowered. An interior window sill (sometimes called the stool) is the part of the window ledge facing the interior of the room (see Figure 15.2 for an illustration of areas to be sampled).

Figure 15.2 Window Locations for Dust Sampling.



1. Sectional view of window (with no storm window) showing window trough area, A, to be tested. Trough is the surface where both window sashes can touch the sill when lowered. The interior window sill (stool) is shown as area C. Interior window sills and window troughs should be sampled separately.



2. Sectional view of window (including storm window) showing window trough area, A and B, to be tested. Trough extends out to storm window frame. The interior window sill (stool) is shown as area C. Interior window sills and window troughs should be sampled separately.

Courtesy: Warren Friedman

The field sampling and analytical methods for collecting and analyzing wipe dust samples are in Appendixes 13 and 14, respectively. Until the EPA standards and protocols are established, wipe sampling should be performed on all surfaces. While vacuum samples can be collected, neither HUD nor EPA can provide standards to interpret vacuum sampling results at this time. Until vacuum sampling standards have been established, wipe sampling is the preferred method.

Readers should note that these *Guidelines* recommend the following precautions when conducting dust sampling (see Appendix 13.1):

- A standard sampling motion should be used.
- Only certain brands of wipes can be used (unless equivalence is demonstrated through side-by-side field sampling).
- Whatman™ filters and thick diaper wipes should not be used (Whatman™ filters are not sufficiently durable and some thick diaper wipes are too difficult for the laboratory to digest).
- Field-spiked wipe samples will need to be included in the sample stream in a blind fashion (i.e., the lab should not know the amount of lead spiked onto the wipe) to ascertain the efficiency of the laboratory digestion procedure.
- Hard-shelled containers (not plastic bags) must be used to contain wipe samples, since the container must be rinsed thoroughly and quantitatively. A nonsterilized 50-ml polypropylene centrifuge tube works well.

The minimum number of clearance samples recommended in each room is shown in Table 15.1. Field sampling data can be recorded on Form 15.2.

Further information on wipe sampling technique can be obtained from ASTM Standard ES–30–94.

2. Composite Clearance Dust Sampling

When lead hazard control treatments are similar in multiple rooms of the same dwelling, composite samples may be collected. For composite sampling each room treated must be included. The total number of required samples will depend on the number of rooms treated and whether those treatments are similar (see Table 15.1). Wipe samples are composited in the field, not in the laboratory, by inserting up to four wipes from four surfaces into the same tube. The laboratory analyzes all four wipes as one sample using a modified analytical procedure (see Appendix 13).

An example of a composite sampling scheme can be found in the example below. Field sampling data can be recorded on Form 15.2a.

The rules for combining subsamples into a sin-gle composite sample described in Chapter 5 for risk assessment also apply to clearance sampling. Those rules are as follows:

- Separate composite samples are required from carpeted and hard surfaces (e.g., a single composite sample should not be collected from both carpeted and bare floors).
- Separate composite samples are required from each different component sampled (e.g., a composite sample should not be collected from both floors and interior window sills).
- Separate composite samples are required for each dwelling.
- Floor surface areas sampled in each room should be approximately the same size (approximately 1 ft^2). Interior window sill and window trough sampling sizes are dependent on window characteristics, but should also be similar from room to room, if possible (e.g., the surface sampling area should not be skewed so that one room is oversampled).
- For composite wipe samples, a separate wipe must be used for each spot sampled (each subsample).

Table 15.1 Recommended Minimum Number and Location of Single-Surface Dust Samples

Clearance Category	Category Description	Number and Location of Single-Surface Wipe Samples in Each Area[1]	Number and Location of Composite Wipe Samples
1	Interior treatments No containment within dwelling	Two dust samples from at least four rooms in dwelling (whether treated or untreated): ✥ One interior window sill or window trough, alternating between rooms. ✥ One floor. AND ✥ For common areas, one for every 2,000 ft^2 of a common area room floor (if present).	Three composite samples for every batch of four rooms (whether treated or untreated): ✥ One floor composite. ✥ One interior window sill composite. ✥ One window trough composite. AND ✥ For common areas, one floor subsample for every 2,000 ft^2 (if present); up to 8,000 ft^2 can be sampled for each composite.
2	Interior treatments With containment (plastic sheeting as airlock on doors between treated and untreated areas)	Same as Category 1 but only in every *treated* room (up to four rooms) AND One floor sample outside the containment area but within 10 feet of the airlock to determine the effectiveness of the containment system. This extra single-surface sample is recommended in 20 percent of the treated dwellings in multifamily housing and *all* single-family homes. ✥ For common areas, one floor sample for every 2,000 ft^2 and one floor sample outside containment.	Same as Category 1 but only in every *treated* room AND One floor sample outside the containment area but within 10 feet of the airlock to determine the effectiveness of the containment system. This extra single-surface sample is recommended in 20 percent of the treated dwellings in multifamily housing and *all* single-family homes. ✥ For common areas, one floor subsample for every 2,000 ft^2 (up to 8,000 ft^2 for each composite) and one floor sample outside containment.
3	Exterior treatments	Two dust samples as follows: ✥ At least one dust sample on a horizontal surface in part of the outdoor living area (e.g., a porch floor or entryway). ✥ One window trough sample on each floor where exterior work was performed. An additional trough sample should be collected from a few lower floors to determine if troughs below the area were contaminated by the work above.	Two dust samples as follows: ✥ One composite on a horizontal surface in part of the outdoor living area (e.g., a porch floor or entryway). ✥ One window trough composite for every four floors where exterior work was performed, including lower floors where exterior work was not done, if present.
4	Routine maintenance work	At least 1 floor dust sample for every 20 high-hazard jobs near the work area (see Chapter 17 for definition of "high hazard").	Same as single-surface sampling.
5	Soil treatment	One dust sample from the entryway.	One dust sample from the entryway.

[1] A room includes a hallway or a stairway. If no window is present, collect just one floor sample. When a closet is treated, the room to which it is attached should be tested. A closet is not considered to be a separate room. If all rooms received similar treatments and cleaning, only four rooms need to be sampled for clearance purposes. More rooms may need to be sampled in larger dwellings. The room to be sampled should be selected based on where most of the dust-generating work was done or in the judgment of the clearance examiner.

- The same wipe should not be used to sample two different spots. All subsamples should be inserted into the same tube. No more than four different wipes should be inserted into a single container for a composite sample. Acceptable recovery rates have been found when no more than four wipes are analyzed as a single sample (Jacobs, 1993b).

Because composite sampling requires fewer samples than single-surface sampling, sampling costs may be reduced. Also, more surfaces are often sampled than would be possible for single-surface sampling. The drawback to composite sampling, however, is that if only one of the composite samples fails, all similar components in each room will have to be recleaned or each room will need to be sampled individually. In contrast, if one of the single-surface samples fails, only one room will have to be recleaned.

Composite samples should not be taken from rooms that have dramatically different conditions. For example, if the clearance examiner has some reason to believe that cleanup was not performed adequately in a room, a single-surface sample should be collected there. In some cases both single-surface samples and composite samples may be needed.

V. Clearance Soil Sampling

If no exterior lead hazard control work was performed, it is not necessary to conduct any soil sampling. Clearance soil sampling should be conducted following any abatement or interim control treatment on the exterior of a house or soil treatment. The purpose of such testing is to ensure that the treatment did not contaminate soil surrounding the dwelling.

Clearance soil sampling is typically conducted around the foundation of the house, although it is also important to collect samples in play areas that could have been contaminated as a result of the work. All soil samples should be composite samples. If the exterior work involved covering bare soil areas only, clearance soil samples are not needed; a visual examination is adequate. A detailed protocol for soil sampling is provided in Appendix 13 and ASTM ES–29–94. Sampling data can be recorded on Form 15.3.

There is evidence that soil lead levels can increase following abatement if proper precautions are not taken. For example, in one study, 6 percent of the dwellings had statistically significant increases in soil lead levels when compared to pre-abatement soil lead levels (NIOSH, 1990).

There should be no visible paint chips on the surface of the soil near the foundation. However, soil sampling near the foundations of dwellings is often complicated by the presence of paint chips embedded in or under the soil surface from previous repainting efforts. The hazard associated with these paint chips in the soil is difficult to assess since it is often not practical to sample all the different paint chips that may be present. Therefore, these paint chips should be considered a part of the soil. They should not be sampled preferentially or excluded when collecting or analyzing the soil. Laboratories should be instructed to disaggregate (force) paint chips through the soil sieve as part of the analytical process.

If the paint chips were generated by hazard control work, they should be picked up with a HEPA vacuum. A visual examination is usually adequate. If the clearance soil samples are above 2,000 µg/g in the yard (or 400 µg/g in bare, high-contact play areas), the baseline soil samples should be analyzed to determine if soil lead levels were already high before the work began. Soil samples collected during risk assessments (if one was performed) can be used for this purpose.

A. Multifamily Housing (20 or More Units)

If a large complex of multifamily housing has undergone similar lead hazard control work, random sampling of the soil around the buildings can be conducted using the sampling scheme for lead-based paint inspection. The drawbacks of conducting random clearance sampling are the same for soil as for dust (see the section on clearance dust sampling earlier in this chapter).

Example of Clearance Composite Sampling Scheme

A house has undergone an abatement job involving extensive interior paint removal (clearance category 1) and has passed a visual examination. The owner and the clearance examiner have agreed to use composite clearance dust sampling to minimize expenses. The house has eight rooms that were treated, four of which are carpeted, and all of which have windows.

At a minimum, the clearance examiner should collect the following samples:

No.	Description
1	Composite carpeted floor sample (one subsample from each of the four carpeted rooms).
1	Composite hard floor sample (one subsample from each of the four uncarpeted rooms).
1	Composite interior window sill sample, with a subsample collected from a location in four selected rooms.
1	Composite window trough sample, using the same procedure as for interior window sills.

This results in a total of four composite samples for analysis. If single-surface sampling had been completed under the recommendations in Table 15.1, it would have been necessary to collect eight samples (four rooms x two samples/room = eight samples/dwelling).

B. Single-Family Housing

If exterior lead hazard control work was done, composite soil samples should be collected near the building foundation close to the work area and in nearby play areas that could have been contaminated by the work. All single-family housing units should be cleared.

C. Number and Location of Clearance Soil Samples at Each Building

One composite soil sample should be collected around the perimeter of the building. If only selected faces of the building were treated, the samples should come from those faces.

A second composite soil sample should be collected from any nearby play areas.

In both cases bare soil should be sampled preferentially. If there is no bare soil, the soil covering should be sampled to determine if it has been contaminated by the lead hazard control work.

VI. Clearance Paint Testing

XRF testing of surfaces that have been stripped and repainted is not recommended. If the paint has been removed, removal should be assessed visually prior to repainting. If for some reason it is not possible to visually determine that the paint has been removed, then XRF readings can be taken. The protocols described in Chapter 7 apply.

Some forms of interim control involve paint film stabilization (repainting). In this case the clearance examiner must visually inspect all painted surfaces to determine if they are all sealed, intact, smooth, and cleanable.

VII. Interpretation of Clearance Testing Results

A. Visual Examination Results

Interpreting the results of the visual examination is a straightforward process. If there is visual evidence that work on building components or soil is incomplete, the clearance examiner should inform the owner and contractor and ensure that the work is completed *before collecting any dust or soil samples*. In situations where job specifications are used, they should clearly state that failure to pass the clearance visual examination means failure to comply with clearance standards.

Table 15.2 Interim HUD Clearance Dust Standards (Wipe Sampling Only)[1]

Surface	Leaded Dust Loading (µg/ft^2)	Leaded Dust Loading (mg/m^2)[2]
Bare and carpeted floors	100	1.08
Interior window sills	500	5.38
Window troughs	800	8.61
Exterior concrete or other rough surfaces	800	8.61

[1] No clearance standards are currently available for vacuum sampling.

[2] To convert from µg/ft^2 to mg/m^2, multiply by 0.01076.

B. Dust Results

Interim HUD clearance dust standards are shown in Table 15.2. These may be revised subject to EPA's issuance of regulations.

No standard method has been developed to correlate the wide variety of vacuum methods available with the wipe sampling standards. Until and unless EPA regulations state otherwise, all hard surfaces should be tested with wet wipe samples. While vacuum sampling is acceptable, there is no HUD Interim Clearance Standard for vacuum sampling at this time, making interpretation of vacuum sampling results against recognized standards impossible.

The results of dust samples collected using a vacuum method may be reported in lead concentration (µg/g) and loading (µg/ft^2); wipe sampling results are reported in loading only. For clearance purposes, however, the lead concentration cannot be used to determine the effectiveness of the cleanup. It is possible to remove nearly all leaded dust from a surface, but not change its concentration significantly, since most cleaning methods do not preferentially remove lead from the dust. However, adding lead-free soil or dust to the area *will* reduce the concentration, even in the absence of cleaning. In short, leaded dust loading (not leaded dust concentration) should be used to determine if an adequate cleanup job has been completed. If leaded dust levels exceed those given in Table 15.2, the contractor must repeat the cleaning until compliance is achieved.

The recleaning should be focused on those surfaces where the sampling results indicate that the first round of cleaning was inadequate. For example, if floor leaded dust levels are above the standard, but interior window sills and window troughs are below the standard, only the floors need to be recleaned. Similarly, if single-surface samples fail in one room, then only that room and any rooms not sampled need to be recleaned. If composite samples fail, then *all* the surfaces the composite represents need to be recleaned (or resampled individually to determine which ones require recleaning). For example, consider the two examples shown in Tables 15.3 and 15.4.

In Table 15.3, only the floors in Rooms 1 and 2 require recleaning (assuming a four-room unit). In Table 15.4 the window troughs should be recleaned in all four rooms and any rooms not sampled. While the window troughs could conceivably be sampled individually to determine which ones require recleaning, it is likely to be far more cost-effective to simply reclean all of them. When cleaning troughs, the sills should also be cleared, even if they were not originally contaminated. In both examples, repeated sampling of the recleaned surfaces should be completed to ensure that the recleaning was sufficiently effective.

For composite sampling the HUD Interim Clearance Standard should *not* be reduced by dividing the standard by the number of subsamples in the composite. The purpose of the

Table 15.3 Hypothetical Example of Single-Surface Clearance Dust Sampling Data

Room	Floors (µg/ft^2)	Interior Sills (µg/ft^2)	Window Troughs (µg/ft^2)
1	475	40	60
2	878	65	90
3	30	70	75
4	50	40	80

Table 15.4 Hypothetical Example of Composite Clearance Dust Sampling Data

Surface	Rooms Included in Composite	Leaded Dust (µg/ft^2)
Floors	1, 2, 3, 4	30
Interior window sills	1, 2, 3, 4	129
Window troughs	1, 2, 3, 4	3,695

composite sample is to average the lead loading in all rooms sampled to determine if *all* the rooms require additional cleaning. Composite sampling is used to determine the average lead loading in a group of rooms, not individual rooms. Since composite sampling is done in units with the same hazard control technique and since the method of correction is always the same (i.e., recleaning), it is not necessary to determine the leaded dust level in each room. Even a single-surface sample only represents a small area on a larger surface, in much the same way as a composite represents many surfaces over a larger area, e.g., all floors within a unit. For paint chip sampling, however, it *is* necessary to know the concentration on each surface sampled, making it necessary to divide the paint standard by the number of subsamples contained in a composite sample (see Chapter 5).

C. Soil Results

If clearance sampling shows that post-abatement soil samples are more than 2,000 µg/g, additional soil treatment should be required. If the area sampled is a high-contact play area, the soil should be no more than 400 µg/g.

VIII. Recordkeeping and Issuance of Statement of Lead-Based Paint Compliance

A. Recordkeeping Responsibilities

Three parties should maintain records of all abatement, interim control, risk assessment, inspection, and clearance results:

- Property owner.
- Contractor.
- Clearance examiner.

Some jurisdictions will also require submission of such records to an enforcement agency or a lead-safe housing registry.

B. Record Content

The records should include all laboratory results, quality control/quality assurance procedures, dates of both visual examination and environmental sampling, completed forms, and appropriate identifiers for the property—the owner, inspector, job contractor, and resident(s).

Depending on the jurisdiction and the type of abatement or interim control work undertaken, the owner may be awarded a Statement of Lead-Based Paint Compliance. One State now issues a statement indicating that the property is "Lead-Free" when all lead-based paint is removed and all other lead hazards are corrected. The property is "Lead-Safe" when all lead-based paint *hazards* have been rectified (Rhode Island, 1993).

C. Length of Time

Statements of lead-based paint compliance and records of all clearance testing should be kept for the duration of the life of the building, since it is to the benefit of the owners to retain this information.

IX. Clearance and Reevaluation Procedures

The clearance process evaluates the effectiveness of the lead hazard control efforts immediately following cleanup. Reevaluation determines the continued effectiveness of all lead hazard control treatments (except complete removal of all lead-based paint). Reevaluation also determines whether any new lead-based paint hazards have appeared. Because most forms of lead hazard control have limited lifespans, they will require ongoing monitoring by the owner and a reevaluation by a certified risk assessor based on the reevaluation schedule for the specific property. The method and frequency of reevaluation is detailed in Chapter 6.

In those cases where the owner did not have a risk assessment or inspection before hazard control, the clearance examiner should conduct a risk assessment at the time of clearance to ensure that all lead-based paint hazards were, in fact, addressed.

Form 15.1
Lead Hazard Control Visual Clearance Form

Date ____

Name of clearance examiner ______________________________

License no. (if applicable) ______________________________

Name of property owner ________________________________

Property address __________________________ Apt. no.________

Date cleanup completed ________________________________

Time cleanup completed ________________________________

Abatement/interim control contractor name ______________________

Address ______________________

Telephone no. ___________________

Check if repeat clearance examination ________

Room identifier	List all building components required to be treated in each room	Work on each component completed? (yes or no)	Visible paint chips seen? (yes or no)	Visible settled dust seen? (yes or no)	Additional work required?

Exterior soil ______Treated ______Not treated

If treated, is bare soil present? ______Yes ______No

Was contaminated soil removed? ______Yes ______No

Is additional soil treatment required? ______Yes ______No

NOTES:

Signature ______________________________

Form 15.2
Lead Hazard Control Clearance Dust Sampling Form (Single-Surface Sampling)

Date ____

Name of clearance examiner __________________________

License no. (if applicable) ____________________________

Name of property owner ____________________________

Property address _____________________ Apt. no. ________

Clearance categories:

1. Interior treatments without containment.
2. Interior teatments with containment.
3. Exterior work on painted surfaces.
4. Routine maintenance.
5. Soil work.

Sample number	Room number or identifier	Surface type (floor, interior window sill, window trough)	Clearance category number	Dimensions of sample area (inches)	Area (ft^2) (can be completed by lab)	Result of lab analysis ($\mu g/ft^2$) (can be completed by lab)	Pass or Fail

Total number of samples on this page________

Page _________ of _________

Date of sample collection ____/____/____ Date shipped to lab ____/____/____

Shipped by ______________________________ Received by ______________________________
(Signature) (Signature)

Form 15.2a
Lead Hazard Control Clearance Dust Sampling Form (Composite Sampling)

Date ____

Name of clearance examiner __________________________

License no. (if applicable) ____________________________

Name of property owner ______________________________

Property address ___________________ Apt. no.__________

Clearance categories:

1. Interior treatments without containment.
2. Interior treatments with containment.
3. Exterior work on painted surfaces.
4. Routine maintenance.
5. Soil work.

Sample number	Name of room or identifiers included in sample	Dimensions of surface sampled in each room (inches x inches)	Total surface area sampled (ft^2)	Type of surface sampled (smooth floors, carpeted floors, interior window sills, window troughs)	Clearance category number	Lab result (µg/ft^2)	Pass or fail
	________ ________ ________ ________	______ X ______ ______ X ______ ______ X ______ ______ X ______					
	________ ________ ________ ________	______ X ______ ______ X ______ ______ X ______ ______ X ______					
	________ ________ ________ ________	______ X ______ ______ X ______ ______ X ______ ______ X ______					
	________ ________ ________ ________	______ X ______ ______ X ______ ______ X ______ ______ X ______					

Total number of samples on this page ________

Page _________ of _________

Date of sample collection ____/____/____ Date shipped to lab ____/____/____

Shipped by ________________________________ Received by ________________________________
(Signature) (Signature)

Form 15.3
Lead Hazard Control Clearance Soil Sampling Form (Composite Sampling Only)

Date ____

Name of clearance examiner ________________________

License no. (if applicable) ___________________________

Name of property owner____________________________

Property address ____________________ Apt. no._______

Sample number	Location	Bare or covered	Lab result (µg/g)
	building perimeter		
	building perimeter		

Sketch soil sampling plot plan. Collect only the top 1/2” of soil.

Total number of samples on this page ________

Page _________ of _________

Date of sample collection ____/____/____ Date shipped to lab ____/____/____

Shipped by _________________________________ Received by _________________________________
(Signature) (Signature)

Chapter 16: Investigation and Treatment of Dwellings Housing Children With Elevated Blood Lead Levels

Investigation and Treatment of Dwellings Housing Children With Elevated Blood Lead Levels: How To Do It

1. Identify children with elevated blood lead (EBL) levels. Children with blood lead levels greater than or equal to 20 µg/dL (or a *persistent* 15 µg/dL) are considered EBL children. Blood lead levels can be determined through local health departments, local childhood lead-poisoning prevention programs, or other health care providers. Ensure that further medical treatment or case management is undertaken by the responsible authority (if appropriate).

2. Coordinate with the child's parents and the appropriate public health, environmental, and housing agencies to avoid duplication of efforts and to determine how the investigation should best be conducted.

3. Review the findings of any risk assessment (Chapter 5), reevaluation (Chapter 6), or lead-based paint inspection (Chapter 7) that has already been completed for the property. The protocols in Chapters 5 and 7 are not adequate for use in dwellings with a lead-poisoned child, since additional environmental testing and interviewing are often required.

4. Conduct a comprehensive interview using the questionnaire in this chapter or an equivalent questionnaire. If a clear lead hazard is identified, correct the hazard within the applicable regulatory timeframe. If necessary, conduct environmental sampling to confirm the presence of the hazard.

5. If no clear lead hazard source can be identified from the interview, conduct targeted environmental testing using the protocol contained in this chapter. Even if a source becomes apparent during environmental testing, it may not be the true or only source of exposure. Environmental testing in the case of a dwelling housing an EBL child may include:

   - Paint testing of all surfaces with defective paint (including painted furniture and play structures).
   - Paint testing of all chewable surfaces.
   - Paint testing of all friction surfaces.
   - Dust testing.
   - Soil testing.
   - Water testing.
   - Testing of glazed pottery or dinnerware that may contain lead glazes.
   - Testing other site-specific, lead hazard sources.

6. Where lead hazard control measures are indicated, relocate the child until the work is completed. If time elapses prior to environmental intervention, temporary lead hazard control measures should be immediately taken to protect the child living in the dwelling unit.

7. Conduct clearance examination.

8. Permit reoccupancy if results of clearance testing are acceptable.

Chapter 16: Investigation and Treatment of Dwellings Housing Children With Elevated Blood Lead Levels

I. Introduction

This chapter provides a method for investigating the possible causes of lead poisoning in an individual child. Although lead-based paint and lead-contaminated dust and soil are the causes of most lead exposure in American children, another lead source may be the principal cause for a specific instance of lead poisoning or contribute to the blood lead elevation (secondary source). The methods and descriptions contained in this chapter are consistent with those used by the Centers for Disease Control and Prevention (CDC) and by local lead-poisoning prevention programs across the Nation.

The protocol in this chapter is fundamentally different from the risk assessment protocol in Chapter 5 and the lead-based paint inspection protocol in Chapter 7 of these *Guidelines*. Both of those protocols are meant for use in dwellings regardless of a resident child's blood lead level ("primary prevention"). The protocol in this chapter is intended for use as part of "secondary prevention," which involves medical and environmental followup services for individual lead-poisoned children (i.e., children whose blood lead levels are greater than or equal to 20 µg/dL) (CDC, 1991b). However, many of the basic procedures and sampling methods are similar.

The investigations of dwellings housing lead-poisoned children differ from normal risk assessments in the following siximportant ways:

(1) The purpose of the investigation is to identify a cause or causes for the lead poisoning of a child. A normal risk assessment attempts to uncover lead-based paint hazards in a dwelling, regardless of whether a child is poisoned.

(2) The investigator is obligated to conduct a comprehensive investigation of all sources of lead in the child's environment, not just those lead exposures directly related to the child's residence. This investigation includes studying relatively uncommon sources of lead, such as glazed pottery and traditional medicines or remedies, and other dwellings or areas frequented by the child. Some of these sources may be discovered by the results of the questionnaire.

(3) The property owner is not the sole decisionmaker regarding the appropriate hazard control options and the development of a plan. Parents and local regulatory and other agencies are also included in the decisionmaking.

(4) The investigator tests deteriorated paint on furniture identified as a potential lead hazard to the lead-poisoned child, regardless of who owns the furniture.

(5) The range of dust sampling in a dwelling depends on the areas frequented by the child.

(6) Bare soil areas frequented by the child should be identified and sampled individually so that the hazards in a particular play area can be quantified.

Many activities described in this chapter are generally performed by local health departments and childhood lead-poisoning prevention programs, which bear the principal responsibility for responding to individual cases in some jurisdictions. However, situations may occur when private risk assessors or investigators are hired by State or local public health authorities or parents to investigate the dwelling of a child with an elevated blood lead level. Any child with a blood lead level greater than or equal to 20 µg/dL (or a *persistent* 15 µg/dL) is considered an EBL child. Some of these local agencies can only respond to the children with the highest blood lead levels, leaving less serious cases for others to investigate. In addition, many jurisdictions may not have programs available to investigate EBL children. Medicaid and other third-party payers may reimburse expenses for investigations performed by certified, private-sector investigators.

Investigators who gather the information needed to characterize possible hazards in dwellings that house EBL children should possess good interviewing techniques as well as proficiency in risk assessment and environmental sampling techniques.

Private individuals who respond to lead-poisoned children should always coordinate their activities with local authorities, such as health care providers, physicians, public health nurses, public health environmental investigators, and housing agencies to prevent unnecessary duplication of effort and to acquire information on sources of lead poisoning that may be significant in a specific locale or culture. In some instances risk assessments or lead-based paint inspections may have already been completed. Before eliminating paint or dust as the cause of the poisoning, the investigator should carefully review any previous reports to assess the quality of the previous investigations.

A. Information for Parents on the Meaning of Blood Lead Levels

Investigators are sometimes asked to explain the meaning of a particular blood lead level. For a specific child, this interpretation is best left to the child's pediatric health care provider. States and local health departments may also provide the basic information to parents. (See Table 16.1 for information about blood lead levels.)

II. Management of Lead Hazards in the Environment of Individual Children

The investigation of lead-poisoned children is a complex issue requiring team work. Three governmental entities are most likely involved: public health, environmental, and housing agencies.

A. Public Health Case Management

Public health case management consists of coordinating the child's care and followup, usually managed by a trained public health professional, such as a physician, public health nurse, other health care provider, or public health investigator. This management includes monitoring of medical care, education of the family, and coordination of services. Care for lead-poisoned children often entails repeated blood lead level testing, psychological and mental development testing, and medical treatment that may include iron therapy and chelation treatment. Families should be educated about lead poisoning, including how to recognize warning signs and symptoms, how to reduce risks, and how to help their child get well. In addition, environmental investigation and intervention is required. The public health case manager, if available, should help the family schedule visits, arrange transportation, care for other young children, and monitor the affected child. Some families will need extensive case management and referral to social service providers. The public health case manager is the primary point of contact between the childhood lead-poisoning prevention program and the family.

B. Environmental Investigation and Intervention

Environmental investigation and intervention are usually managed by agencies and programs with legal responsibility for the protection of human health in the dwelling environment; responsibilities may be shared by public health, environmental, and housing agencies. Public health or environmental agencies may have the

Table 16.1 How To Interpret Blood Lead Levels in Children[1]

Venous[2] Confirmed Blood Lead Level (μg/dl)	Interpretation for Children Under Age 6	Action
Below 10	Child is not lead poisoned.	Another blood lead test may be needed next year. Inform a doctor if the child lives in a dwelling built before 1978 or in an older house that is being renovated or repainted. Control any known lead hazards.
10–14	Child has *some* exposure to lead.	Another blood lead test will be needed. Talk to a doctor. Check the dwelling unit for *possible* lead hazards and seek more information. Control any known lead hazards.
15–19	Child is considered an EBL child if blood lead is persistent at this level.	Another blood lead test is needed. Talk to a doctor. If the repeated test is still in this range, have the dwelling checked for *possible* lead hazards using the methods described in this chapter. Control any known hazards.
20–44	Child is considered lead-poisoned.	A full medical checkup, including more blood lead tests and medical care needed until the blood lead level is normal. The child needs to move to a lead-safe dwelling. Get professional help from the health department or from a private risk assessor or investigator to find the lead hazards.
Above 45	Child is severely lead-poisoned. *A blood lead level over 70 μg/dL is a medical emergency.*	A full medical checkup and medical treatment (*chelation*) is needed **NOW!** Hospital stay may be required. The child *must* be removed from lead hazards. Get professional help from the health department or from a private risk assessor or investigator to find the lead hazards. The child needs to reside in a lead-safe dwelling to get well.

[1] Adapted from the *Maryland Childhood Lead Poisoning Prevention Program* brochure.

[2] Blood lead levels are best measured using venous sampling, rather than capillary (finger-stick) methods, which are more susceptible to contamination.

responsibility, technical equipment, and expertise for the investigation, but housing agencies may have to enforce the codes or laws.

For EBL children, a public health nurse or case manager can assess the dwelling for obvious lead hazards, educate the family about how to reduce those hazards, and monitor the child's blood lead levels. If the assessment identifies serious environmental lead hazards or if the child's blood lead level continues to increase, a thorough environmental investigation should be performed.

For lead-poisoned children, a thorough environmental investigation of all possible sources of lead exposure for the individual child and possible intervention are needed to protect the child from further exposure and harm. Lead-based paint or the lead-contaminated dust and soil it generates may or may not be the main source of the child's exposure to lead. A visit with the public health authorities may improve the communication with the family, the collection of accurate information about the child's exposure, and the success of any needed intervention.

The environmental investigation should be performed during a visit to the child's current dwelling unit. The parents or guardians should be questioned regarding all possible lead sources and risk factors. (Use the questionnaire in Table16.2.) If the child has recently moved, the child's blood lead level may reflect exposure to lead hazards at the previous residence. Where primary and secondary locations are identified (such as present and previous dwelling unit and/or day care center/dwelling unit), all of the locations should be investigated. Testing a previous residence will also identify lead hazards that could harm other young children currently living in that dwelling. Where the questionnaire results indicate that the child may have been exposed to other sources of lead, including drinking water, soil, toys, traditional or "home" remedies, parental occupation, and hobbies, additional environmental testing may be required. The environmental investigator will conduct sampling to identify whether lead hazards are present. If assessment of additional dwelling units or a day-care center/dwelling is required, the investigator should make the necessary arrangements for assessment and possible testing at these locations.

Once the assessment of all possible sources of lead exposure has been completed, the most probable source(s) of the child's poisoning can be identified and remedial actions to eliminate further lead exposure of the child can be recommended. The investigator should always recommend temporary measures to immediately reduce the child's exposure to lead hazards. Where probable sources of poisoning are not related to a building (for example, use of ceramics or traditional remedies), followup should be referred to the public health team.

The results of the investigation should be released only to parents and public health authorities. Confidential information about the child or household should not be revealed to any other individual or agency. Information concerning building and site hazards and options for correction of those hazards should be reported to both the owner and/or occupant.

If legal action is necessary, public health authorities should determine (based on State and local law) the nature and extent of requirements for the property. In some cases the appropriate response may be to help the family move the poisoned child into a lead-safe dwelling unit.

In some situations the investigator and public health case manager will be unable to identify sources of lead exposure. The source may be obscure or the parent or guardian may be concealing information about a babysitter or family member whose interests they want to protect. This situation can best be handled by establishing a good rapport with the family and convincing them that the intent is not to find the family or any individual at fault but rather to help the child get well.

During the investigation and remediation, the investigator and public health team should discuss their concerns with the family in a clear and direct manner for the well-being of the child. If exposures continue, the child will be unable to get well. The best approach is to provide clear information and to maintain contact and open communication with the family. The public health case manager may continue to follow the child's medical followup and treatments.

C. State/Local Housing Intervention

Public-sector health and housing agencies should take joint responsibility for coordination of the housing effort for lead-poisoned children. This effort may involve working closely with the environmental investigator to require control of lead hazards. Housing officials can also use their access to State and locally managed properties and programs to ensure that lead-safe, temporary housing is available for families with lead-poisoned children.

III. Lead Hazard Identification

Lead hazards are identified through the administration and evaluation of a questionnaire (see Table 16.2) and through environmental sampling. Sampling procedures are addressed in

Chapters 5 and 7 and Appendixes 13 and 14.1. The questionnaire should always be completed prior to sampling. In some cases, a clear lead source will emerge from the answers to the questionnaire. If this occurs, the investigation of exposure sources should still be thorough and complete. Environmental testing should be linked to the child's history and may include a prior residence or other areas frequented by the child.

If the child's home is identified as a probable source of lead exposure, appropriate environmental sampling should be conducted. This should include the following samples:

- X-ray fluorescence (XRF) or laboratory paint-chip analysis of all defective paint on the dwelling, furniture, play structures, or on nearby buildings frequented by the child.
- XRF or laboratory paint-chip analysis of all chewable, impact, and friction surfaces.
- Dust samples from areas frequented by the child, including play areas, porches, kitchens, bedrooms, and living and dining rooms. Dust samples may also be collected from automobiles, work shoes, and laundry rooms (to assess the leaded dust on work clothes brought into the dwelling) if occupational lead exposure is a possibility.
- Soil samples from play areas, areas near the foundation of the house, and areas from the yard. If the child spends significant time at a park or other public play area, samples should also be collected from these areas, unless the area has already been sampled.
- First-drawn and flushed water samples from the tap most commonly used for drinking water, infant formula, or food preparation.
- Glazed dinnerware or ceramic cookware containing lead.

The source of lead exposure should be controlled if the results of this sampling indicate that lead levels are equal to or greater than the limits listed below. Investigators should become familiar with their State and local jurisdiction standards, which may require action at a lower level.

Paint

1.0 mg/cm^2 or 5,000 µg/g (0.5 percent).

Dust (by wipe sampling)

The U.S. Environmental Protection Agency (EPA) will promulgate a health-based standard for leaded dust.

Clearance Standards:

100 µg/ft^2—floors.

500 µg/ft^2—interior window sills.

800 µg/ft^2—window troughs into which the sash fits and exterior surfaces.

800 µg/ft^2—exterior surfaces (porches, sidewalks).

Bare Residential Soil

400 µg/g

Water

15 ppb

Ceramic or Pottery Glazes

See the U.S. Food and Drug Administration (FDA) *Compliance Policy Guidelines on Lead in Ceramic Foodware* for further information on testing ceramic or pottery glazes for lead. The leachate for ceramic foodware is analyzed using method 973.32 of the Association of Official Analytical Chemists (AOAC). The following leachate standards have been developed (FDA,1992):

- 3 µg/g—Plates, saucers, and other flatware.
- 2 µg/g—Small hollowware (cereal bowls).
- 1 µg/g—Large hollowware.
- 0.5 µ/g—Cups, mugs, and pitchers.

IV. Lead Hazard Correction

A. Time Limits

After reviewing the results of the questionnaire and the environmental sampling, steps should be taken to remove and/or control the lead source from the dwelling unit or to relocate the child.

For public housing, other federally supported housing programs, and certain publicly funded housing programs, regulations may require that all testing be completed within 5 days after an EBL child is identified. As a result, the child may be relocated to a dwelling free of lead-based paint hazards. If the child is not relocated, full correction of all lead hazards must be completed within 14 days for most housing programs.

Local jurisdictions may have different time requirements.

B. Modifications to Normal Lead-Based Paint Hazard Controls

Dwellings where extensive lead hazard control activities are occurring, particularly those that increase leaded dust levels, should achieve leaded dust clearance standards before the lead-poisoned child and family reoccupy the dwelling. EBL children should not be permitted to reenter the dwelling at the end of the workday as indicated under Interior Worksite Preparation Levels 1 and 2 and Exterior Worksite Preparation Levels 1 and 2 in Chapter 8. All EBL children should leave the dwelling until *all* the lead hazard control work has been completed and clearance established, regardless of the size of the area to be treated.

In some cases it may make sense for the family to move permanently to a lead-safe house. The owner may be required to facilitate such a move, or local government may assume some or all of the responsibility. In some cities public housing authorities may be one source of providing lead-safe housing on an emergency basis. All local governments should implement a system of prioritization to ensure that EBL children are moved to a lead-safe dwelling as soon as possible.

C. Elimination or Control of Other Lead Hazards

All lead hazards identified in the course of the investigation should be eliminated or controlled. If lead hazards not containing paint are identified, the appropriate agency should be contacted. Drinking water is usually regulated by the local public works agency or water and sewage authority; State or local environmental regulatory agencies should also be notified. If probable occupational lead hazards are identified or contaminated work clothing is being taken into the dwelling, the worker should be cautioned regarding the possibility of take-home exposures and informed of the steps necessary to protect family members. In addition, the Federal or State Occupational Safety and Health Administration (OSHA) should be informed. When appropriate, adult household members may be referred for blood lead testing.

In some cases no probable source of lead may emerge. In these cases public health authorities should reassess possible sources of exposure, with increased emphasis on traditional remedies and other culturally related exposures. Surveillance of the child's blood lead levels should continue until the source is identified.

Table 16.2 Resident Questionnaire for Investigation of Children With Elevated Blood Lead Levels

The results of this questionnaire will be used for two purposes:

- To determine where environmental samples should be collected.
- To develop corrective measures related to use patterns and living characteristics (e.g., flushing the water line if water lead levels are high, moving the pet's sleeping area if it appears the pet is tracking in leaded dust, and so forth).

The investigator should always recommend temporary measures to immediately reduce the child's exposure to lead hazards.

General Information

1. Where do you think the child is exposed to the lead hazard? ___________________________
2. Do you rent or own your home?   rent   own   (circle)

   If rented, are there any rent subsidies?   yes   no   (circle)

   If yes, what type: (check)

   ___ Public housing authority

   ___ Section 8

   ___ Federal rent subsidy

   ___ Other (specify): ___________________________

   Landlord Information (or rent collector agent)

   Name: ____

   Address: ____

   Phone: ________________________________

3. When did you/your family move into this home?

   Complete the following for all addresses where the child has lived during the past 12 months:

Dates of residency	**Address (include city and State)**	**Approximate age of dwelling**	**General condition of dwelling: Any remodeling or renovation? Any deteriorated paint?**

4. Is the child cared for away from the home? (This would include preschool, day-care center, day-care home, or care provided by a relative or friend.)

   If YES, complete the following:

Type of care	Location of care (name of contact, address, and phone number)	Approximate number of hours per week at this location	General condition of structure. Any deteriorated paint? Any recent remodeling or renovation?

Lead-Based Paint and Lead-Contaminated Dust Hazards

1. Has this dwelling been tested for lead-based paint or lead-contaminated dust? yes no (circle)

   If yes, when? Where can this information be obtained? ______________________________

2. Approximately what year was this dwelling built? _________ If unknown, was the dwelling built before 1950? ______________________________________

3. Has there been any recent repainting, remodeling, renovation, window replacement, sanding, or scraping of painted surfaces inside or outside this dwelling unit? If yes, describe activities and duration of work in more detail. ____

4. Has any lead abatement work been conducted at this dwelling recently? yes no (circle)

5. Where does the child like to play or frequent? (Include rooms, closets, porches, outbuildings.)

6. Where does the child like to hide? (Include rooms, closets, porches, outbuildings.)

   Complete the following table:

Areas where child likes to play or hide	Paint condition (intact, fair, poor, or not present)*	Location of painted component with visible bite marks

* Paint condition: Note location and extent of any visible chips and/or dust in window wells, on window sills, or on the floor directly beneath windows. Do you see peeling, chipping, chalking, flaking, or deteriorated paint? If yes, note locations and extent of deterioration.

Assessment: (check)

_____ Probable lead-based paint hazard.

_____ Probable leaded dust hazard.

Action: (check)

_____ Obtain records of previous environmental testing noted above.

_____ XRF Inspection of dwelling (circle one): limited complete.

_____ Paint Testing—deteriorated paint: add any additional areas to Form 5.3.

_____ Leaded dust sampling of home: add any additional areas to the list of rooms to be sampled, using Form 5.4.

_____ Other sampling (specify): ____

Water Lead Hazards

1. What is the source of drinking water for the family? (circle) municipal water private well

   Other (specify): _________________________

   (This information will be used to help determine responsibility and methods of controlling lead exposures from water.)

   If tap water is used for drinking, please answer the following:

2. From which faucets do you obtain drinking water? (Sample from the main drinking water faucet.)

3. Do you use the water immediately or do you let the water run for awhile first? (If water lead levels are elevated in the first flush, but low in the flushed sample, recommend flushing the water after each period the water has remained standing in the pipe for more than 6 hours.)

   ____

4. Is tap water used to prepare infant formula, powdered milk, or juices for the children?

   If yes, do you use hot or cold tap water?

   If no, from what source do you obtain water for the children?

5. Has new plumbing been installed within the last 5 years? yes no (circle)

   If yes, identify location(s).

   Did you do any of this work yourself? yes no (circle)

   If yes, specify. _______________________

6. Has the water ever been tested for lead? yes no (circle)

   If yes, where can test results be obtained?

Determine whether the dwelling is located in a jurisdiction known to have lead in drinking water in either public municipal or well water. Consult with State/local public health authorities for details. (check) _____ at risk _____ not at risk

Assessment: (check)

_____ At risk for water lead hazards.

Actions: (check)

_____ Test water (first-draw and flush samples).

_____ Other testing (specify): ____

_____ Counsel family (specify): ____

Lead in Soil Hazards

(Use the following information to determine where soil samples should be collected.)

1. Where outside does the child like to play?
2. Where outside does the child like to hide?
3. Is this dwelling located near a lead-producing industry (such as a battery plant, smelter, radiator repair shop, or electronics/soldering industry?) yes no (circle)
4. Is the dwelling located within two blocks of a major roadway, freeway, elevated highway, or other transportation structures?
5. Are nearby buildings or structures being renovated, repainted, or demolished?
6. Is there deteriorated paint on outside fences, garages, play structures, railings, building siding, windows, trims, or mailboxes?
7. Were gasoline or other solvents ever used to clean parts or disposed of at the property?
8. Are there visible paint chips near the perimeter of the house, fences, garages, play structures? If yes, note location.
9. Has soil ever been tested for lead? If yes, where can this information be obtained?
10. Have you burned painted wood in a woodstove or fireplace? If yes, have you emptied ashes onto soil? If yes, where?

Assessment: (check)

_____ Probable soil lead hazard.

Actions: (check)

_____ Test soil. Complete Field Sampling Form for Soil (Form 5.5). Obtain single samples for each bare soil area where the child plays.

_____ Advise family to obtain washable doormats for entrances to the dwelling.

_____ Counsel family to keep child away from bare soil areas thought to be at risk.

(specify): ____

Occupational/Hobby Lead Hazards

Use the information in this section to determine if the child's source of lead exposure could be related to the parents', older siblings' or other adults' work environment. Occupations that may cause lead exposure include the following:

- Paint removal (including sandblasting, scraping, abrasive blasting, sanding, or using a heat gun or torch).
- Chemical strippers.

- Remodeling, repairing, or renovating dwellings or buildings, or tearing down buildings or metal structures (demolition).
- Plumbing.
- Repairing radiators.
- Melting metal for reuse (smelting).
- Welding, burning, cutting, or torch work.
- Pouring molten metal (foundries).
- Auto body repair work.
- Working at a firing range.
- Making batteries.
- Making paint or pigments.
- Painting.
- Salvaging metal or batteries.
- Making or splicing cable or wire.
- Creating explosives or ammunition.
- Making or repairing jewelry.
- Making pottery.
- Building, repairing, or painting ships.
- Working in a chemical plant, a glass factory, an oil refinery, or any other work involving lead.

1. Where do adult family members work? (include mother, father, older siblings, other adult household members)

Name	Place of employment	Occupation or job title	Probable lead exposure (yes/no)

2. Are work clothes separated from other laundry?
3. Has anyone in the household removed paint or varnish while in the dwelling? (includes paint removal from woodwork, furniture, cars, bicycles, boats)
4. Has anyone in the household soldered electric parts while at home?
5. Does anyone in the household apply glaze to ceramic or pottery objects?
6. Does anyone in the household work with stained glass?
7. Does anyone in the household use artist's paints to paint pictures or jewelry?

8. Does anyone in the household reload bullets, target shoot, or hunt?

9. Does anyone in the household melt lead to make bullets or fishing sinkers?

10. Does anyone in the household work in autobody repair at home or in the yard?

11. Is there evidence of take-home work exposures or hobby exposures in the dwelling?

Assessment: (check)

_____ Probable occupational-related lead exposure.

_____ Probable hobby-related lead exposure.

Actions: (check)

_____ Counsel family (specify):

_____ Refer to (specify): ________________________

Child Behavior Risk Factors

1. Does child suck his/her fingers? yes no (circle)
2. Does child put painted objects into the mouth? yes no (circle)

   If yes, specify: ________________________
3. Does child chew on painted surfaces, such as old painted cribs, window sills, furniture edges, railings, door molding, or broom handles?

   If yes, specify: ________________________
4. Does child chew on putty around windows?
5. Does child put soft metal objects in the mouth? These might include lead and pewter toys and toy soldiers, jewelry, gunshot, bullets, beads, fishing sinkers, or any items containing solder (electronics).
6. Does child chew or eat paint chips or pick at painted surfaces? Is the paint intact in the child's play areas?
7. Does the child put foreign, printed material (newspapers, magazines) in the mouth?
8. Does the child put matches in the mouth? (Some matches contain lead acetate.)
9. Does the child play with cosmetics, hair preparations, or talcum powder or put them into the mouth? Are any of these foreign made?
10. Does the child have a favorite cup? A favorite eating utensil? If yes, are they handmade or ceramic?
11. Does the child have a dog, cat, or other pet that could track in contaminated soil or dust from the outside? Where does the pet sleep?
12. Where does the child obtain drinking water?
13. If child is present, note extent of hand-to-mouth behavior observed.

Assessment: (check)

_____ Child is at risk due to hand-to-mouth behavior.

_____ Child is at risk for mouthing probable lead-containing substance (specify): ______________________

_____ Child is at risk for other (specify): ________________________

Actions:

_____ Counsel family to limit access or use of (specify):

_____ Other (specify): ________________________

Other Household Risk Factors

1. Are imported cosmetics such as Kohl, Surma, or Ceruse used in the home?
2. Does the family ever use any home remedies or herbal treatments? (What type?)
3. Are any liquids stored in metal, pewter, or crystal containers?
4. What containers are used to prepare, serve, and store the child's food? Are any of them metal, soldered, or glazed? Does the family cook with a ceramic bean pot?
5. Does the family use imported canned items regularly?
6. Does the child play in, live in, or have access to any areas where the following materials are kept: shellacs, lacquers, driers, coloring pigments, epoxy resins, pipe sealants, putty, dyes, industrial crayons or markers, gasoline, paints, pesticides, fungicides, gasoline, gear oil, detergents, old batteries, battery casings, fishing sinkers, lead pellets, solder, or drapery weights?
7. Does the child take baths in an old bathtub with deteriorated or nonexistent glazing?

Assessment: (check)

_____ Increased risk of lead exposure due to ___________________________

Actions: (check)

_____ Counsel family to limit access or use (specify): ______________________________

_____ Other (specify): ________________________

Assessment for Likely Success of Hazard Control Measures

1. What cleaning equipment does the family have in the dwelling? (circle)

   broom, mop and bucket, vacuum (does it work?), sponges and rags
2. How often does the family:

   Sweep the floors?

   Wet mop the floors?

   Vacuum the floors?

   Wash the window sills?

   Wash the window troughs?
3. Are floor coverings smooth and cleanable?
4. What type of floor coverings are found in the dwelling? (circle *all* that apply)

   vinyl/linoleum carpeting wood other (specify): ______________________
5. Cleanliness of dwelling (circle one):

   Code: 1 = appears clean, 2 = some evidence of housecleaning, 3 = no evidence of housecleaning, 4 = _____________, 5 = ______________, 6 = ______________, 7 = _____________

[Pick the best category based on overall observations of cleanliness in the dwelling.]

1. Appears clean.

2. Some evidence of housecleaning.

3. No evidence of housecleaning.

No visible dust on most surfaces.
Evidence of recent vacuuming of carpet.
No matted or soiled carpeting.
No debris or food particles scattered about.
Few visible cobwebs.
Clean kitchen floor.
Clean doorjambs.
Slight dust buildup in corners.
Slight dust buildup on furniture.
Slightly matted and/or soiled carpeting.
Some debris or food particles scattered about.
Some visible cobwebs.
Slightly soiled kitchen floor.
Slightly soiled doorjambs.
Heavy dust buildup in corners.
Heavy dust buildup on furniture.
Matted and/or soiled carpeting.
Debris or food particles scattered about.
Visible cobwebs.
Heavily soiled kitchen floor.
Heavily soiled doorjambs.

Assessment: (check)

_____ Cleaning equipment inadequate.

_____ Cleaning routine inadequate.

_____ Floor coverings inadequate to maintain clean environment.

Actions: (check)

_____ Counsel family to limit access or use (specify): ______________________________

_____ Provide cleaning equipment.

_____ Instruct family on special cleaning methods.

_____ Flooring treatments needed.

_____ Other (specify): _______________________

Chapter 17: Routine Building Maintenance and Lead-Based Paint

Routine Building Maintenance and Lead-Based Paint: How To Do It

1. Develop a written program assigning responsibilities for controlling lead hazards caused by maintenance work. Train maintenance workers who will be working with lead, covering all the topics listed in this chapter. Change any existing work order forms to include the items in the lead-based paint maintenance work order form contained in this chapter. If no work order is used, develop a system to inform workers when a job may involve a lead hazard or lead-based paint.

2. Determine if lead-based paint is present on the surface where work will be performed. If the surface *has not been tested*, take x-ray fluorescence (XRF) measurements or send a paint chip to a qualified laboratory. If testing cannot be conducted, then it will be assumed that lead-based paint is present on all painted surfaces built before 1978. If some building components are new or were replaced after 1978, it can be assumed that they do not have lead-based paint and maintenance work can proceed normally.

3. Develop a ready-to-use list of those surfaces that are known to contain lead-based paint, if the surface has been tested, using the inventory form in this chapter.

4. Determine whether the individual task is low risk or high risk, using the table in this chapter. High-risk jobs are those that typically produce a significant amount of dust by disturbing more than 2 square feet of a painted surface. Low-risk jobs are those that do not produce much dust by disturbing less than 2 square feet per room.

5. Require the use of disposable 6-mil, polyethylene plastic drop cloths (or equivalent) and thorough cleanup of the immediate work area using wet cleaners. However, *if the job is low risk*, respirators and protective clothing may not be needed.

6. Use respirators; protective clothing; plastic, disposable drop cloths; and work area isolation *if the job is high risk*. High-efficiency particulate air (HEPA) vacuuming should be used in connection with wet cleaning methods.

7. Educate residents on why workers will be taking special precautions before maintenance work begins in the unit. Inform residents that workers need more protection, since they have a higher risk of exposure.

8. Complete work order forms for each job, defining specific protective measures to be used. If no written work order system is used, verbally inform workers of the required protective measures.

   a. For low-risk jobs, put a small sheet of plastic immediately underneath the work area (approximately 5 feet by 5 feet), except for ceiling work. For ceilings, cover the entire floor with plastic. Keep all doors closed and do not let children into the work area.

   b. For high-risk jobs, cover the entire floor with plastic. Remove all furniture or toys from the room or cover them with plastic. Seal the doorway by taping the door closed with light-duty tape or placing a sheet of plastic over the doorway, cutting a slit down the middle, and covering the slit with a second layer of plastic to act as a flap. Relocate children away from the dwelling during the work. Use respirators and protective clothing.

9. Complete maintenance task.

10. Conduct cleaning. For low-risk jobs, wet clean the area twice using a phosphate cleaner or lead-specific cleaner or other equivalent cleaning agent. For high-risk jobs, cleaning should be performed using a HEPA vacuum/wet cleaning/HEPA vacuum cycle.

11. Conduct clearance. Visual assessments are adequate for most low-risk jobs. For high-risk jobs, periodic wipe sampling for every 20th job should be conducted as well. Wipe sampling frequency can be reduced after desirable cleanup practices are established and verified for a particular worker or work crew.

Chapter 17: Routine Building Maintenance and Lead-Based Paint

I. The Relationship Between Building Maintenance Work and Lead Hazard Control Work

This chapter describes how routine maintenance work should be modified to protect workers and residents from lead poisoning and to comply with the Occupational Safety and Health Administration (OSHA) lead standards. Detailed information on worker protection is provided in Chapter 9. Maintenance workers may be covered by either the OSHA Lead Exposure in Construction standard (29 CFR 1926.62) or the OSHA General Industry Lead Standard (29 CFR 1910.1025), depending on the extent and type of job. This chapter describes safe practices for *routine* maintenance, not interim control or abatement work. If traditional, routine building maintenance is performed, surfaces with lead-based paint can be disturbed, turning a potential problem into an immediate problem. However, if maintenance practices are modified to provide sufficient protection to workers and residents, lead hazards associated with maintenance work can be controlled. If the maintenance work does not disturb lead-based paint (or surfaces suspected to contain lead-based paint) or create a dust hazard, then it can proceed in the traditional fashion.

To illustrate the importance of protective measures, even for small-scale jobs, consider how much leaded dust is contained within a 1-square-foot area that is painted with lead-based paint at the U.S. Department of Housing and Urban Development (HUD) minimum regulatory limit (1mg/cm ^{2}):

$$1 \text{ mg/cm}^2 \times (2.54 \text{ cm/inch})^2 \times (12 \text{ inches/ft})^2 \times 1{,}000\ \mu\text{g/mg} = 929{,}000\ \mu\text{g/ft}^2$$

If we assume that more of this dust is cleaned up and that it is distributed evenly over an average room measuring 10 feet x 10 feet, then there would be 9,290 μg/ft^2 on the floor.

This figure can be compared to the HUD clearance standard of 100 μg/ft^2. In short, a significant amount of leaded dust can be released from a small painted area. Even though most maintenance jobs would not turn *all* the lead-based paint into leaded dust (as this calculation assumes), it should be clear that large amounts of lead-contaminated dust can be generated from even low concentrations of lead-based paint. Therefore, protection and thorough cleanup are absolutely essential, even for small-scale jobs.

At the same time, it is not feasible to treat every small-scale maintenance job as if it were an abatement job. The following recommendations balance the need for controlling the hazard with the need to perform "routine" maintenance work in a practical way.

The purpose of maintenance work is different from lead hazard control efforts. Maintenance work is designed to simply keep buildings in good repair. On the other hand, lead hazard control efforts are designed to prevent lead poisoning. While these two goals are different, they are not contradictory. For example, lead hazard control work often results in the creation of smooth, cleanable surfaces that are also easier to maintain. Similarly, good maintenance practices (such as repainting on a regular basis) can help maintain surfaces and thus prevent lead poisoning. Information on lead hazard control work (interim controls and abatement) and worker protection during this type of work are provided in other chapters.

II. Summary of Protective Measures for Low- and High-Risk Maintenance Tasks

To determine the extent of protective measures needed, the task should be classified into low- or high-risk categories. Table 17.1 provides general guidance on classifying jobs based on how much dust each is likely to generate. The classification should be made on a case-by-case basis, since the surface area treated and the existing condition of the paint will be different for each job.

Once the job has been classified, protective measures can be determined. Table 17.2 summarizes protective measures for those tasks that are either low- or high-risk. Adjustments should be made depending on the size of the area to be disturbed. If more than 2 square feet are disturbed in the room, an increased degree of protection is usually needed. If the surface area to be disturbed is smaller, protective measures can be downgraded (but not eliminated entirely). If the paint is deteriorated, more protective measures may be needed.

Tables 17.1 and 17.2 should be used on a case-by-case basis. Each job may present unique

Table 17.1 Summary of Low- and High-Risk Job Designations for Surfaces Known or Suspected To Contain Lead-Based Paint.

Job Description	Low Risk	High Risk*
Repainting (includes surface preparation)		✓
Plastering or wall repair		✓
Window repair		✓
Window pane or glass replacement only	✓	
Water or moisture damage repair (repainting and plumbing)		✓
Door repair	✓	
Building component replacement		✓
Welding on painted surfaces		✓
Door lock repair or replacement	✓	
Electrical fixture repair	✓	
Floor refinishing		✓
Carpet replacement		✓
Groundskeeping	✓	
Radiator leak repair	✓	
Baluster repair (metal)		✓
Demolition		✓

* High-risk jobs typically disturb more than 2 square feet per room. If these jobs disturb less than 2 square feet, then they can be considered low-risk jobs.

Table 17.2 Summary of Protective Measures For Low- and High-Risk Jobs

Protective Measure	Low Risk	High Risk
Worksite preparation with plastic sheeting (6-mil thick)	Plastic sheet no less than 5 feet by 5 feet immediately underneath work area	Whole floor, plus simple airlock at door or tape door shut
Children kept out of work area	Yes	Yes
Resident relocation during work	No	Yes
Respirators	Probably not necessary*	Recommended
Protective clothing Note: Protective shoe coverings are not to be worn on ladders, scaffolds, etc.	Probably not necessary*	Recommended
Personal hygiene (enforced hand washing after job)	Required	Required
Showers	Probably not necessary	Recommended
Work practices	Use wet methods, except near electrical circuits	Use wet methods, except near electrical circuits
Cleaning	Wet cleaning with lead-specific detergent, trisodium phosphate, or other suitable detergent around the work area only (2 linear feet beyond plastic)	HEPA vacuum/wet wash/HEPA vacuum the entire work area
Clearance	Visual examination only	Dust sampling during the pre liminary phase of the maintenance program and periodically thereafter (not required for every job)

* Employers must have objective data showing that worker exposures are less than the OSHA permissible exposure limit of 50µg/m^3 if respirators and protective clothing will not be provided.

situations that should be considered by the maintenance supervisor. For example, even though Table 17.1 suggests that repainting is a high-risk activity, it does not necessarily mean that *all* repainting jobs are considered high risk. If the painting job involves only minor touchup (less than 2 square feet per room) or there is no scraping or sanding involved, that particular painting job may be considered low risk.

More detailed descriptions of each protective measure are provided later in this chapter.

III. Ways in Which Maintenance Work Can Create or Intensify Lead Hazards

There are a variety of ways in which maintenance work can inadvertently create lead hazards where none previously existed or worsen hazards that are already present.

A. Paint Abrasion or Other Disturbance

The most common problem involves maintenance work that disturbs or rubs against a painted surface. Common activities such as sanding, scraping, hammering, cutting, or grinding on surfaces coated with lead-based paint or lead-contaminated dust can create large exposures. Torch cutting or welding on painted metal surfaces is especially dangerous and is prohibited under OSHA regulations (the paint must be removed before torch cutting or welding). Although most individual maintenance jobs do not last very long, it is possible to cause a significant exposure for the worker and the occupant. For example, power sanding on lead-based painted surfaces has been found to cause exposures as high as 11,000 $\mu g/m^3$ in the residential setting (Jacobs, 1991b), which is well above the OSHA permissible exposure limit (PEL) of 50 $\mu g/m^3$. Other typical tasks, such as carpet removal, have also been shown to result in exposures well above the OSHA PEL, depending on how long the exposures last (NIOSH, 1990). While there is not adequate information on exposures during routine maintenance jobs, exposures can be kept well below the limit if the work is carefully conducted (NIOSH, 1990). In other words, paint deterioration should no longer be regarded as a minor cosmetic problem.

B. Water Damage

Water damage can occur from sudden circumstances, such as bursting pipes, overflowing tubs and sinks, broken fixtures, or storm damage. Water damage can also occur from less obvious problems, such as condensation, slow leaks in pipes or fixtures, improper building drainage around the perimeter, or accidental resident neglect (e.g., leaving the windows open during rain). Both conditions can lead to paint failure, either by deterioration of the paint itself, or deterioration of the substrate behind the paint. In traditional maintenance work, it is customary to repair only the source of the water leak, especially in emergency situations. In some cases, the paint deterioration may not be evident until several weeks following the water leak repair and it may be left to the resident to repaint.

If lead-based paint is known or suspected to be present, however, paint deterioration deserves as much attention as the hole in the roof would receive. The paint should be repaired as quickly as possible using controlled work practices.

C. Dust Exposures

Many types of maintenance work can release substantial quantities of dust into the residence. Examples include repainting, floor sanding, window repair (window troughs often contain very high levels of leaded dust), and plastering. Typical maintenance practices employ the use of drop cloths and cardboard or newspapers to protect furniture, eating surfaces, and walkways. If the drop cloths are made of canvas, they may become full of leaded dust, possibly contaminating the next worksite. Poorly controlled dust during maintenance work has accounted for numerous cases of childhood lead poisoning (Farfel, 1990; Amitai, 1991; Rabinowitz, 1985a; Shannon, 1992).

Lead-contaminated dust exposures to both children and adults can be controlled by the following:

- Using wet methods.
- Covering furnishings with disposable, plastic drop cloths.
- Using foot coverings or dedicated footwear to minimize tracking of leaded dust out of the work area.
- Sealing rooms to avoid contamination of adjacent areas.
- Using approved respirators.

D. Groundskeeping

If the soil is contaminated, certain groundskeeping activities can pose a risk to workers and occupants. Excavation to lay new pipes, regrading, or sodding disturbs the soil. Bare soil can be more easily tracked into dwellings where it becomes part of the house dust and where a child can become exposed to it. If the soil is known to contain high concentrations of lead or has yet to be tested, simple protective measures can be introduced to control exposures. Keeping the soil wet is usually effective, as long as proper erosion control measures are established. Disposable shoe coverings or dedicated workshoes will prevent tracking contaminated soil into dwellings, worker's automobiles, and maintenance shops.

IV. Maintenance Program Elements

This section describes how a maintenance program addressing lead-based paint hazards can be developed that clearly assigns the various responsibilities. The following responsibilities need to be assigned to a specific individual:

- Determining whether a specific job will disturb known or suspected lead-based painted surfaces.
- Determining whether a specific job will be low- or high-risk.
- Training workers.
- Purchasing supplies and equipment, including respirators, plastic sheeting, special cleaners, disposable shoe coverings, protective clothing, etc.
- Conducting visual assessments on all jobs to ensure adequate cleanup.
- Conducting wipe tests on some jobs to ensure adequate cleanup.
- Handling communication with residents.

For small staffs, all of these responsibilities may be handled by a single person; for larger staffs, coordination is essential.

A. Identification of Lead-Based Painted Surfaces

Individuals assigning maintenance tasks will need to determine whether work on certain surfaces will result in a lead hazard. The best method for doing this is to list all painted surfaces and then have an inspector technician determine whether lead-based paint is present (using the protocols in Chapter 7).

However, in many instances, such an inspection will not have occurred yet or was deficient (for example, a previous investigation may not have inspected every similar painted surface in each room). Therefore, it may be necessary to make assumptions. *All painted surfaces in dwellings constructed before 1978 should be presumed to contain lead-based paint, until proven otherwise.* While this assumption could result in erroneously requiring controls for working on paint that does not contain lead, it would be dangerous to assume that the paint does not contain lead until an inspection shows that it does. In the latter case, a maintenance supervisor could fail to recommend controls where they are needed, resulting in a poisoned worker or child.

It is important to note, however, that not all painted surfaces in all dwellings constructed before 1978 will contain lead. If it is *known* that certain building components are relatively new or were replaced or added after 1978, it can be assumed that they do not contain lead. For example, if all exterior doors and windows in a building are known to have been replaced in 1981, these surfaces need not be included in the inventory of known or suspected surfaces.

Form 17.1 at the end of this chapter can be used as an inventory form.

An inventory for a single room might look like the example above. Since floors were not painted in this example, floor work is unlikely to produce a lead hazard. Lead-based paint is known to exist on the window troughs because of historical records on exterior paint. Baseboards and doors were replaced after 1978, so it is doubtful that they contain lead-based paint. All other surfaces are listed as "suspect" surfaces, since they have not been tested.

Depending on the size and organization of the maintenance operation, the inventory could be organized by room (appropriate for small owners with only one or a few single-family dwellings) or by unit/apartment building (appropriate for

Figure 17.1 Example of a Lead-Based Paint Inventory.

Dwelling Unit Identifier______________________________

Room Identifier____________________________________

Surface	Known Lead-Based Paint	Suspected Lead-Based Paint	No Lead-Based Paint
Floors			✓
Lower walls		✓	
Upper walls		✓	
Chair rail		✓	
Interior window trim		✓	
Window trough	✓		
Ceiling		✓	
Baseboards			✓
Doors			✓
Door trim		✓	
Crown molding		✓	
Other trim mantels, etc.		✓	
Exterior siding	✓		

larger landlords). For computerized maintenance systems, the lead-based paint inventory system can be added to the database to flag those jobs that could produce lead hazards. If workers or supervisors are unsure about whether or not they are working on a leaded surface, they can quickly consult the inventory.

B. Identification of Low- and High-Risk Jobs

Most maintenance work is unpredictable. Some repair jobs start small but then escalate. Replacement of a ceiling light fixture is an example of a relatively small job that can become a large job if a section of the ceiling falls apart when the fixture is removed.

Maintenance or building supervisors or others who categorize work orders should determine if the job entails a low or high risk of exposure to lead and leaded dust according to the guidance in Table 17.1. Protective measures should also be determined according to the guidance in Table 17.2. Some training is usually necessary to make these judgments.

C. Training

Since most maintenance supervisors and workers are not typically trained to recognize and correct lead hazards in the course of their regular duties, it may be difficult or impossible for maintenance personnel to determine the level of control necessary for a particular job. Presently, no formal U.S. Environmental Protection Agency (EPA) training curriculum specifically targeted at maintenance personnel exists, although a number of such courses have been developed and provided (AFSCME, 1993; Jacobs/

HES, 1992; SOEH, 1993). In addition, the OSHA Hazard Communication Standard (29 CFR 1910.1200) requires training of individuals who are exposed to hazardous substances during their work. Both the OSHA Lead Exposure in Construction standard (29 CFR 1926.62) and the OSHA General Industry Lead Standard (29 CFR 1910.1025) require training. The National Institute of Building Sciences has recently developed an operations and maintenance manual on lead-based paint (call (202) 289–7800).

Maintenance workers and supervisors who deal with lead-based paint hazards should receive a 1- or 2-day training session at their job site that includes hands-on practice in implementing various control measures. The training should include a discussion of how the maintenance program at the facility will be modified to reflect potential lead hazards, and who will make the decisions. The training should emphasize that maintenance workers are not permitted to perform abatement work unless they have completed the State-approved EPA lead-based paint abatement training course(s). Newly hired or trained supervisors or workers should be closely monitored to ensure that appropriate controls are established. Sources of training are provided in Chapter 2.

If outside contractors are employed to conduct maintenance work, they must also be trained and notified if their work will disturb lead-based painted surfaces. Proof of contractor staff training should be verified by the owner before any maintenance work is undertaken.

At a minimum, the training should cover the following topics:

- Definition of lead and lead-based paint hazards.
- Lead health effects.
- Regulations.
- Modifications to existing maintenance operations.
- Listing of known or suspected surfaces containing lead-based paint.
- Methods of identifying lead.
- Distinguishing between low- and high-risk jobs.
- Work practices (use of tools, HEPA vacuums, wet methods, and so forth).
- Prohibited methods of removing lead-based pain include: open-flame burning or torching, machine sanding or grinding, uncontained hydroblasting or high-pressure wash, abrasive blasting or sandblasting, and heat guns above 1100 °F. Methylene chloride strippers and dry scraping are also not recommended.
- Personal hygiene.
- Worksite preparation.
- Respirator program and fitting.
- Medical surveillance.
- Cleanup and post-job visual inspection.
- Clearance procedures.
- Waste handling and storage.
- Resident relations.

An accredited lead training provider should conduct the training. The training can also be conducted by a licensed risk assessor; a certified industrial hygienist, nurse, or physician; or another qualified adult educator. If necessary, maintenance supervisors can provide the training if they have completed the EPA supervisor course.

D. Education of Residents

Maintenance workers may be required to use respirators and protective clothing in occupied units, erect containment systems, and use special equipment; therefore, residents must be informed about the reasons for these measures. It is important that all elements of the lead hazard control plan be fully developed to reassure residents that no hazards will be created as a result of the work. Local health departments and childhood lead-poisoning prevention programs can assist owners in properly educating residents about lead health hazards.

E. Work Order Systems

Work order systems should be modified to reflect whether the job will disturb the lead-based paint, whether the job is low- or high-risk, and which protective measures will be required. Even if an owner does not have a formal work order system developed, the hazard warning information must be transmitted to those conducting the work.

To account for lead hazards, the owner's work order form will need to be modified. Specifically, a check-off box should be added to indicate that the work will disturb known or suspected lead-based paint. If this box is checked, the supervisor or worker should receive a

Figure 17.2 A Typical Work Order Form.

Lead-Based Paint Maintenance Work Order Form

Reference to work order number ______________________

Respirator required? ____ Yes ____ No

Protective clothing required? ____ Yes ____ No

Size of plastic sheeting to be placed under work area __________

Cover whole floor with 6-mil plastic sheeting? ____ Yes ____ No

Cover doorway to room with plastic sheeting and construct airlock? ____ Yes ____ No

Tape door shut? ____ Yes ____ No

Move furniture out of room? ____ Yes ____ No

Shut down HVAC system? ____ Yes ____ No

Wet down item to be repaired? ____ Yes ____ No
(CAUTION: Do not wet down areas near electrical circuits.)

Relocate occupant? ____ Yes ____ No

Cleanup:

HEPA vacuum needed? ____ Yes ____ No

Disposal of waste will be done by ____

Visual inspection of cleanup by supervisor:

____ Sufficient ____ Repeat cleaning

Dust sampling required after task is completed? ____ Yes ____ No

Modifications to work ____

Work assigned by ____

Work completed by ____

Final inspection by ____

Date of completion ____ second form with detailed information on required work practices and control measures required. A standard Lead-Based Paint Maintenance Work Order Form is shown in Figure 17.2, which can be added to the existing maintenance form.

F. Written Program: Assignment of Responsibilities

When the five elements of the maintenance program (described above) have been assembled, a management plan should be put into writing. The plan should authorize specific individuals to perform the following functions:

1. Develop and maintain a list of all suspect and known lead-based painted surfaces.

2. Determine those jobs that pose low and high risks.

3. Train maintenance workers, supervisors, and managers, and implement respiratory protection and medical surveillance programs.

4. Provide notification to residents about lead-based paint maintenance work.

5. Complete work order forms and lead-based paint maintenance work order form.

6. Purchase supplies and equipment, including respirators, plastic sheeting, special cleaners, and protective clothing.

7. Designate those workers permitted to work on lead-based painted surfaces.

8. Conduct wipe tests and visual assessments to determine whether the cleaning in a dwelling has been adequate following the job.

For small staffs, a single person may handle all of these tasks; for larger staffs, coordination is essential. This program should also be included in an interim control plan, if one exists for the property (see Chapter 11). If there is only a single maintenance person and owner/supervisor, a written program is not necessary.

V. Methods To Protect Workers and Residents During Typical Maintenance Jobs

Due to the toxic nature of lead, *all* jobs disturbing lead-based paint require *some* protection.

A. Worksite Containment and Occupant Protection

1. Jobs That Do Not Pose a Lead Hazard

Jobs that do not disturb any lead-based paint or that do not create a lead-contaminated dust hazard can be performed in the traditional fashion.

2. Low-Risk Jobs

For low-risk jobs disturbing a small surface area and not generating much dust, worksite containment consists of a relatively small sheet of plastic (no less than 5 by 5 feet) placed underneath the immediate work area. An exception to this rule is ceiling work where dust contamination is likely to be widespread. For most types of ceiling work, the entire floor and all furnishings should be covered with plastic.

Doors to the work area should be kept closed until cleanup has been completed. The gap at the bottom of the door should be taped shut. Children are not permitted in the work area until the supervisor has visually inspected the cleanup. However, children may be present in adjoining rooms and need not be removed from the entire dwelling (although relocation is preferable). Worksite Preparation Level 1 should be adequate (see Chapter 8).

3. High-Risk Jobs

For those jobs that are high risk and that disturb a large surface area, a more involved worksite containment procedure is required. Typically, the whole floor should be covered with plastic sheeting. Furniture, toys, and other belongings should be either moved out of the room or covered with plastic sheeting. A simple airlock should be constructed at the entryway to the room. (If two entryways exist, one should be completely sealed in plastic.) The airlock consists of two sheets of plastic. One sheet is completely taped along all four edges. The tape must extend all the way around the top, two sides, and the floor. This plastic sheet is then cut down the middle. The second sheet is only taped along the top and acts as a flap covering the slit in the first sheet of plastic. As an alternative, the doorway can be taped on all sides. A weak tape should be used so that workers can quickly break the tape seal in the event of an emergency.

Children should be temporarily relocated from the dwelling while the work is proceeding. If more than 1 day is required to complete the work, a supervisor must have a thorough cleanup conducted, followed by a visual examination, at the end of each workday. Children and residents are permitted to reenter the dwelling at the end of the workday, after the dwelling has been completely cleaned and visually inspected. A high-risk job should be followed by HEPA vacuuming, wet washing with a suitable cleaner, and repeated HEPA vacuuming (see Chapter14).

B. Respirators

1. Low-Risk Jobs

Respirators are not required unless time-weighted average exposures are greater than 50 µg/m^3 as an 8-hour, time-weighted average. Unfortunately, virtually no data exist that characterize maintenance worker exposures. Chapter 9 noted that OSHA requires respirators to be used whenever certain tasks are performed, unless air sampling demonstrates that exposures are low. These tasks include the following:

- Manual demolition.
- Manual scraping.
- Manual sanding.
- Heat gun use.
- Power tools (belt sanders, needle guns, and so forth).
- Spray painting with lead-based paint.

Manual scraping and sanding should be performed only after the surface has been moistened. Power tools should be used with HEPA local exhaust vacuum systems. Since typical maintenance worker exposures may not exceed the permissible limit, half-face air purifying respirators equipped with HEPA cartridges should be used even for small jobs while the surface is being disturbed. The use of respirators for this brief time period is not particularly burdensome and is likely to provide significant protection.

Respirators must be used in conjunction with a respirator program (29 CFR 1910.134) that requires respirators to be fitted to the individual, cleaned and stored properly, and used within their design limits by individuals medically fit to use them (as determined by a physician), among other requirements.

2. High-Risk Jobs

Respirators are required for all high-risk jobs. If an unusually high level of leaded dust is expected to be generated, a full-face powered air-purifying respirator should be used.

C. Protective Clothing

1. Low-Risk Jobs

Protective clothing is not required for low-risk jobs. However, workers must not wear their work clothing home and should ensure that their clothing is laundered separately from their family's clothing.

Protective clothing should be worn if a low-risk job disturbs more than 1 square foot.

Workshoe disposable coverings should be worn to avoid tracking leaded dust throughout the dwelling, unless work will be conducted on ladders. Shoe coverings are not recommended for situations that create a significant risk of workers falling or slipping.

2. High-Risk Jobs

Protective clothing and protective footwear are required for all high-risk jobs.

D. Personal Hygiene and Showers

1. Low-Risk Jobs

Many studies have revealed that poor personal hygiene of workers during lead hazard control jobs can cause lead poisoning. Therefore, thorough washing of the hands and face is required even for low-risk jobs disturbing less than 1 square foot. Eating, smoking, drinking, and applying cosmetics while in the work area should not be permitted. Hand-to-mouth contact should also be minimized. For low-risk jobs, showers are not required.

2. High-Risk Jobs

For high-risk jobs, showers should be taken at the maintenance shop before the worker leaves at the end of the day. Thorough washing of the hands and face should be completed before all breaks (meals, etc.). If showers are not provided, workers should change their clothing and put the contaminated work clothing in a plastic bag for separate cleaning.

E. Work Practices

Protective work practices are the same for both low- and high-risk jobs. Surfaces should be wetted when possible to retard the entrainment of leaded dust into the air. A garden sprayer or pump/squeeze bottle can be used for this purpose. Enough water should be used to just coat the surface; use of excessive water can cause runoff and substrate damage. Work should proceed carefully and deliberately to reduce the amount of dust generated.

Wet methods *must not* be used near electrical circuits due to electrocution hazards.

Children are not permitted in the work area until after completion of all cleanup and final visual inspection.

F. Cleaning

1. Low-Risk Jobs

A HEPA vacuum is not required for low-risk jobs, since all the leaded dust will be caught by the plastic sheeting. However, limited wet cleaning with trisodium phosphate detergent or other lead-specific cleaners or equivalent should be performed twice on all horizontal surfaces at least 2 linear feet beyond the plastic in all directions. Vertical walls or other building components near the work area should also be cleaned. A mild detergent can be used on those surfaces where the finish is likely to be marred by the use of trisodium phosphate. There should be no visible dust in the cleaned area. Brooms should not be used to clean up dust; only wet methods are recommended.

2. High-Risk Jobs

A HEPA vacuum is required for cleanup of high-risk jobs. The entire room should be cleaned following the full HEPA vacuum/wet wash/HEPA vacuum cleanup method described in Chapter 14. Cleaning should proceed from clean to dirty areas and from ceiling to floor. All surfaces in the room that were not covered with plastic should be cleaned. Finally, the floor should be cleaned after the plastic has been removed. The cleaning solution should be changed frequently (at least after each room is cleaned, more frequently, if needed).

G. Clearance

1. Low-Risk Jobs

For low-risk jobs, a visual inspection conducted by a trained supervisor is sufficient. The supervisor should ensure that all required work has been completed and that there is no visible dust in the immediate vicinity of the work area.

2. High-Risk Jobs

For high-risk jobs, clearance dust sampling is recommended for at least every 20th job, in addition to visual examination for every job (see Table 15.1).

H. Waste Disposal

Since maintenance work is part of the routine operations in a dwelling, any waste generated is considered ordinary household refuse and is not regulated under the Resource Conservation and Recovery Act as hazardous waste. Depending on the interpretation of the local regulatory agency, permits may not be required to dispose of waste generated as a result of ordinary maintenance and repair work.

However, the waste can still pose a threat to youngsters who gain access to it. All waste generated as a result of lead-based paint maintenance work should be sealed in a container or plastic bag and stored in a secure, locked area until final disposal. In addition, solid waste should be wrapped in plastic to prevent any release of leaded dust during transport out of the dwelling and to the final disposal site. Lead-contaminated waste should be disposed of in a lined landfill.

Form 17.1
Inventory Form

Dwelling unit address____________________________________
Room or area identifier____________________________________

Surface	Known Lead-Based Paint	Suspected Lead-Based Paint	No Lead-Based Paint
Floors			
Lower walls			
Upper walls			
Chair rail			
Interior window trim			
Window trough trim			
Ceiling			
Baseboards			
Doors			
Door trim			
Crown molding			
Other trim (molding, mantels, etc.)			
Cabinets			
Radiators			
List all other surfaces here:			

Chapter 18: Lead Hazard Control and Historic Preservation

Lead Hazard Control in Historic Buildings: How To Do It

1. If Federal funds are involved in a lead-based paint abatement project, the recipient must determine if the dwelling is listed on the National Register of Historic Places or is eligible for listing and consult with State Historic Preservation Office (SHPO) and local historic preservation officials. Compliance with 36 CFR Part 800 that outlines the Section 106 review process of the Advisory Council on Historic Preservation (ACHP) may be required. Refer to HUD's *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* for technical information on lead-based paint hazard control measures. For agencies or organizations expecting to undertake lead hazard control activities in a large number of homes, a programmatic agreement with the SHPO and the ACHP should be developed. The agreement should define different levels of treatment for houses depending on their level of historic significance.

2. Identify the historic preservation issues that may be faced when conducting lead-based paint hazard control work with the intent of retaining historic building materials and their historic appearance to the greatest extent possible. With the assistance of trained historic preservation architects, architectural historians, or the SHPO, determine which architectural elements of the building can be preserved.

3. Establish priorities for intervention. Determine if the scope of the project will involve full abatement of all paint, abatement of lead-based paint hazards, or interim controls. Part of the scope of work may be determined by the type of housing assistance (e.g., HUD-funded public housing may require full abatement of all lead-based paint; HOME or CDBG-funded projects may require lead-based paint *hazard* control, as defined in the Glossary).

4. Have a combination risk assessment and paint inspection performed by a certified risk assessor. Keep a record to guide future rehabilitation and maintenance work. If properties are of noted historical significance, label and store samples of historic paint for future preservation work.

5. Assess the danger of lead exposure for each significant architectural item to determine how extensive an intervention is necessary, its cost, and its feasibility in order to make the overall project lead safe. The most serious lead hazards may require full abatement or replacement, while the less serious lead hazards may only require repair and paint film stabilization.

6. Negotiate the hazard control strategy with the SHPO and give special consideration to those methods that do not destroy significant architectural features and finishes. Refer to the Secretary of the Interior's "Standards for the Treatment of Historic Properties" (1992). Avoid removal of significant historic materials, avoid the use of harsh abrasive cleaners or chemicals that are too strong on historic materials, and avoid covering over historic siding, whenever possible and financially feasible.

7. If paint is to be removed, the preferred treatments include wet sanding of deteriorated peeling paint; finish sanding with special mechanical sanders with a high-efficiency particulate air (HEPA) vacuum local exhaust ventilation, low-heat paint stripping; chemical strippers (except methylene chloride); and offsite stripping with heat or chemicals. Do not use open flame or high heat removal of lead, or dry sanding or abrasive removal. Comply with worker safety requirements.

8. If the preservation option is economically prohibitive, or if significant features are removed, or if abatement activity will otherwise adversely affect historic properties, the programmatic agreement, if one has been negotiated, should prescribe the procedures to be followed or the methods to be used. In the absence of a programmatic agreement, a Memorandum of Agreement should be negotiated for treatment of the property.

9. Submit the Memorandum of Agreement to the Advisory Council on Historic Preservation.

10. Upon completion of the project, provide educational materials to the residents describing the health hazards of lead-based paint and provide information on appropriate housekeeping methods to keep the property in a lead-safe condition once lead hazard control work is completed. Disclosure of testing and hazard control results may be required.

Chapter 18: Lead Hazard Control and Historic Preservation

I. Introduction

Some of the recommended treatments for lead-based paint hazard control can cause irreversible damage to historic properties. Such actions, when federally assisted, are subject to special review procedures to protect historic properties. Section 106 of the National Historic Preservation Act of 1966, as amended, requires Federal agencies to take into account the effects of their undertakings on historic properties and to afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on such undertakings. This statutory requirement is implemented by the ACHP regulation 36 CFR Part 800. Every State and unit of general local government receiving HUD Community Development Block Grants (CDBG) or HOME program assistance should be familiar with the ACHP regulations, since they must comply with Section 106 as part of the environmental review for program activities. If the agency responsible for lead-based paint abatement or hazard control (and the environmental review) is not familiar with the Section 106 process, they should contact their State Historic Preservation Officer (SHPO) or the State or local agency administering the CDBG or HOME programs for assistance.

Implementing the guidance in this chapter does not substitute for compliance with the ACHP regulations. Many States and local government agencies have entered into CDBG programmatic agreements with the ACHP and the SHPO to facilitate compliance with the historic preservation regulations for rehabilitating historic properties. Expanding the provisions of the programmatic agreements to accommodate lead-based paint abatement activities is recommended. If an agency or organization is planning to undertake lead hazard control in a large number of homes, a programmatic agreement could significantly reduce the time needed to consult with the SHPO for lead interventions.

II. Standards for the Treatment of Historic Properties

The Secretary of the Interior is responsible for establishing standards for the preservation and protection of all cultural resources listed on or eligible for the National Register of Historic Places. The Secretary of the Interior's "Standards for the Treatment of Historic Properties" were initially developed in 1975 and were most recently revised in 1992. These Standards guide owners (including Federal agencies) of historic buildings who are undertaking rehabilitation, restoration, preservation, and reconstruction of historic properties. In addition, the Standards are used by the ACHP and the SHPO to evaluate the impact of physical treatments on historic resources.

When dealing with historic properties, significant spaces, finishes, and features must be identified and priorities for preservation must be set. This applies to both exteriors and period interiors that might include decorative frescoes, polychromed woodwork, or historic painted finishes encased under modern paints.

For homes determined to be on the National Register or eligible for listing, which are historically significant buildings or to exhibit a high degree of craftsmanship, there may be conflicts between certain proposed abatement treatments and the Standards for the Treatment of Historic Properties. These conflicts include:

- Removal of historically significant architectural features and finishes that have been previously painted with lead-based paint may result in loss of significant historic materials.

- Abrasive or chemical paint removal methods may disfigure or destroy evidence of significant craftsmanship.
- Complete removal of paint from substrates can result in the total loss of paint chronology or important evidence of previous decorative paint finishes and colors for properties of great historic significance.
- Replacement or enclosure of historic wooden siding with modern vinyl or aluminum siding may damage historic materials and diminish the architectural integrity of the historic resource.

III. Historic Preservation Issues and Lead-Based Paint

Since lead-based paint was commonly used until the 1950s and was not banned from residential use until 1978, it is almost always present in historic buildings. Lead-based paints are generally found on wooden trim and all surfaces that normally received gloss enamel or oil paints (e.g., metal grills and radiators often were painted with lead-rich enamels). Early calcimine and milk paints that were primarily waterborne were often thought to be lead-free, but many of the color pigments contained lead. Significant decorative techniques, such as faux graining, marbling, stencilling, frescoes, murals, and painted friezes frequently involved the use of lead-based paints.

In homes of great historic significance, it may be important to document evidence of initial construction and subsequent alterations that can be found in paint layering on historic substrates. Unless paint analysis is performed prior to paint removal, this evidence will be lost. By comparing paint layers from one portion of the housing unit or room to another, a list of dates and known changes can be recorded. The relocation of significant elements, such as mantels, from one room to another can often be detected by comparing paint layers. The original colors of these elements can also be determined by evaluating samples of paint under a microscope with correcting light filters.

IV. Property Evaluation

A. Evaluating the Significance of a Property

It is the responsibility of a Federal agency or its recipient to identify the architectural significance of a dwelling prior to undertaking work that might affect the historic resource. The responsible entity may need to enlist an architectural specialist to assist in this effort. (Qualified historical architects and preservation specialists can be found through the State Historic Preservation Office.) The National (or State) Register of Historic Places Nomination Form is often a tool to use to identify significant features.

The quality of a building's architecture and craftsmanship must be considered when evaluating the significance of a property. Buildings that exhibit distinctive characteristics of an architectural design, represent work by skilled craftsmen, or have high artistic value may require a greater sensitivity on the part of a responsible entity when undertaking alterations or modifications to that structure. Worker housing in an industrial mill town was often constructed with heavy timber post and beam construction or balloon frame wooden systems, but may have very simple decorative or trim work on the interior. The significance of these properties is more closely tied to social movements within our cultural history than to architectural design. A property designed by a prominent architect using master craftsmen and artistic painters will be noted for its architectural appearance and design.

To define the elements within a dwelling that are of the highest priority for preservation, the responsible entity should identify physical features that convey the original design intent of the property, both on the exterior and the interior. The exterior may contain significant unique materials such as painted siding, shutters, decorative cornice brackets, porches, and dormers. While the exterior may contain a building's most prominent features, the interior may be even more important in conveying the building's history. Architectural features that indicate the building's history and character

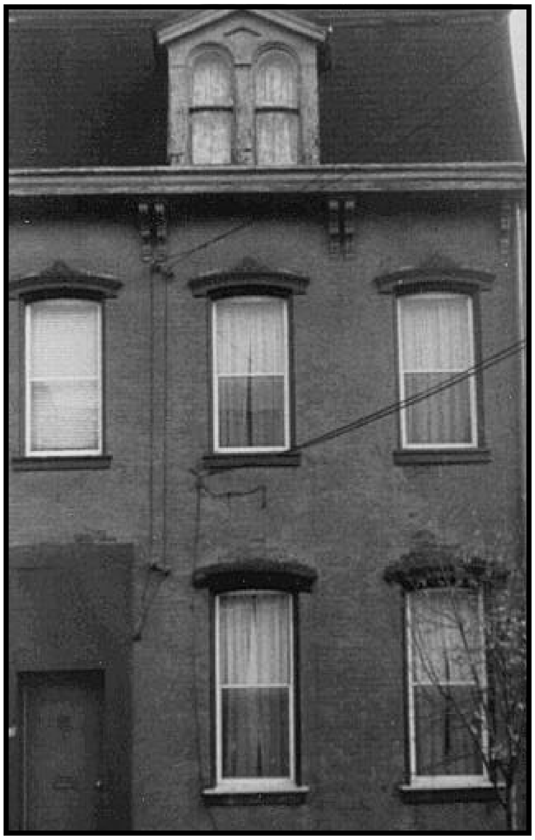


Figure 18.1 Historic Property Before Lead-Based Paint Was Chemically Removed From Exterior Masonry.

Figure 18.2 Historic Property After Lead-Based Paint Was Chemically Removed.

include marble or wood wainscoting in corridors, fireplace mantels, built-in book cases and cabinets, picture and chair rails, crown molding, baseboards, mantels, ceiling medallions and coffers, window and door trim, and staircases. Architectural finishes of note may include grained woodwork, marbled columns, and plastered walls.

Distinctive elements for painted surfaces are generally found in three categories:

- Materials: wood, plaster, stone, cast iron, brick, brass, "compo" (a simulated wood/ plaster), roofing metal.
- Features: mantels, balusters, moldings, window and door trims, cast metal stair assemblies, paneled surfaces, milled siding, turned columns.
- Finishes: grained doors, stencilled borders, painted wallpapers, bronzed or gilded finishes.

For each historic property, some elements will be of lesser significance than others. As part of a survey of each historic property, the responsible entity should identify the elements that could be altered or removed without harming the integrity of the historic resource (e.g., plain plaster surfaces, simple board trim with no distinctive features, and nonhistoric intrusions, such as painted floors or replacement windows). Generally, the front facades of buildings will be more significant than the less visible side and rear elevations. Public spaces on the first floor, such as the entrance and staircase, will be more significant than private spaces, such as the bedroom, kitchen, and bath. This information will be important when decisions are made about where to perform interim controls and where abatement or encapsulation is appropriate.

B. Risk Assessment/Paint Inspection

As with all lead-based paint evaluations, the responsible entity is also responsible for hiring a certified professional to evaluate lead hazards in the dwelling. Because of the need for special care around historic components, the advice of a risk assessor is very helpful when developing a lead hazard control plan. At the same time, any surfaces of historic significance that have been painted should be tested for the presence of lead as part of the evaluation of the dwelling. Ideally, a combination risk assessment/paint inspection should be conducted in historic buildings. At a minimum the risk assessor should perform x-ray fluorescence (XRF) tests on significant features so that the integrity of the elements is not damaged. When laboratory tests are required as a follow up to XRF testing, paint chips should be collected from inconspicuous locations. For properties of great historical significance, significant surfaces found to contain lead-based paint may benefit from additional laboratory analysis to determine the history of each colored layer (chromochronology). The purpose is to provide information on original colors should the property ever be restored. See Chapter 5 for more detail on risk assessments.

V. Establishing Priorities for Intervention

Significant elements should be treated with great care when physical intervention is considered as part of a lead hazard control plan. If the element is extremely significant (e.g., a carved mantel) and is in good condition, it should be disturbed as little as possible while still ensuring that lead hazards will be controlled. In this case interim controls are generally preferred (see Chapter 11). If the element is not particularly significant (e.g., a simple baseboard) and is in poor condition, then it may be acceptable to remove the entire feature and replace it with a duplicate or similar baseboard where possible. If the element is significant, but in deteriorated condition, then preservation measures should ensure that in the process of rebuilding or repairing the element, it is not further damaged. Careful paint removal and thorough cleaning of substrates is very time consuming, but may be appropriate for highly significant elements.

Good preservation practice calls for the removal of only deteriorated paint and the retention of paint layers well-bonded to the substrate, thus preserving the color chronology of the earlier historic paint layers. It is recommended that during interim control work, only the deteriorated topcoats of paint be removed and the remaining well-bonded paint be stabilized. The area can then be washed, reprimed, and covered with one or two topcoats of paint. For highly significant properties (e.g., those listed individually in the National Register of Historic Places) where significant paint layering is to be removed, paint samples should be collected, labeled, and stored by a historic preservation foundation or other organization.

VI. Selecting From the Various Methods of Paint Removal

When historic buildings are involved, the historic preservation goal is to retain as much of the original historic fabric as possible and to preserve the historic character of the resource. There is no simple method for determining which lead hazard treatment may be more or less damaging. It is possible, however, to describe how each treatment may or may not affect the historic character.

Suggested paint removal techniques for historic materials are as follows:

- Wet sanding of loose paint to bonded paint.
- Finish sanding using mechanical sanders with HEPA vacuum.
- Low-heat stripping with heat guns or heat plates (less than 450 °F, round-edge scraper).

- Solvent-based noncaustic stripper in place (not methylene chloride).
- Offsite stripping with heat, chemicals, or cold-tank dipping (be careful of glued joints).

Paint removal techniques that are not recommended:

- Torch or open-flame burning that can vaporize lead and burn substrates.
- Wet grit blasting (except for limited cast iron or concrete under containment).
- Caustic strippers that can raise wood grain (unless supervised by a trained specialist).
- Power sanding that can abrade wood surfaces.
- Hot-tank dipping that often disintegrates glued joints.

Interim controls that allow intact historic paint to remain in place (with topcoats of lead-free paint) are the least damaging to an element. These surfaces will have to be maintained. Records should be kept documenting the presence of lead underneath so that workers will use the proper protective methods during renovations or repair. Residents should be instructed to notify the owner or property manager whenever deterioration is detected.

The removal of lead-based paint down to the operable substrate, if carefully done, is the second least invasive treatment. Chemical, wet sanding, or low-heat removal of paint allows the substrate to stay intact and remain in place. However, these methods are time-consuming, and haphazard wet scraping or sanding may abrade delicate substrate finishes. If paint layering was determined to be significant, then it should be recorded with a preserved sample prior to paint removal.

One of the most invasive and potentially damaging paint removal treatments involves the removal of items for offsite stripping. If the items are easily removed (e.g., doors, shutters, or windows), they can potentially be reinstalled once treated. However, trim, mantels, banisters, newel posts, or other carved elements constructed in sections are often damaged when removed. Gouging, splitting, nail holes, and crowbar marks take their toll on the materials. The creation of leaded dust generally accompanies the removal of attached trim work. If care is taken during removal and stripping (using heat, chemicals, or wet sanding), damage can be reduced. It should be noted that in the process of dipping, glue joints can come apart. Only companies experienced in treating historic building parts should be used to conduct paint stripping. Too often, particularly for wooden elements, surfaces are gouged or grain is raised in an overly aggressive approach to paint removal. If elements deteriorate during the paint removal process, repairs or replacement of significant components should match the originals in size, material, and configuration. Less significant features should match the visual appearance as closely as possible.

Figure 18.3 Historic Property Where the Interior Woodwork and Staircase Were Wet Sanded and Recoated With Three Layers of Encapsulant To Preserve the Carved Profiles.

VII. Selecting Methods Other Than Paint Removal

If elements are too deteriorated to withstand paint removal or if they contain friction surfaces, it may be possible to replace these elements with new elements without threatening their historic integrity. This is particularly applicable to historic, double-hung wooden window sashes. If the windows have been identified as significant elements of the building, new window units that match as closely as possible the size, configuration, sash, mullion and muntin profile, and pane configuration should be installed. Replacement of too many significant features of a building, however, may jeopardize the historic integrity of the resource. For this reason only seriously deteriorated or unsalvageable materials should be replaced.

Encapsulating coatings, rigid encapsulant claddings, and wall enclosures affect historic resources in different ways. Depending on the overall visual effect of the resource, the long-term objectives of a preservation project, and the environmental climate of the resource, there will be differing degrees of success. For example, the use of an approved wall lining and skimcoating encapsulating system over deteriorated plaster with a finish coat of paint may be appropriate in a simple interior. However, encapsulating paint coatings over decorative woodwork would not be appropriate due to the viscous nature of the coating and the loss of the decorative wood detailing. The use of encapsulant coatings on exteriors of historic wooden buildings in moist or humid areas can have damaging long-term effects. Because the exterior coatings range from 10 to 14 mil, substrates may deteriorate because of moisture trapped behind the coating.

Figure 18.4 Deteriorated Window Sashes Were Replaced in This Historic Property While the Frames and Trim Were Wet Sanded and Repainted (vinyl liners were also installed as a friction reduction treatment).

Enclosing a decorative feature, such as a projecting mantel, might be possible if the fireplace is not to be used in the interim, and the decorative finishes are to be enclosed behind drywall finishes. While this is a serious loss of historic character, if it is a temporary solution and no harm is done to the feature, it might be an appropriate treatment. The use of artificial siding over painted historic exteriors often results in a removal of all projecting elements, such as roof brackets, and conceals the historic trim. The use of these artificial sidings is not recommended.

Complete removal of painted features and the failure to replace or replicate them is extremely damaging to the historic resource.

Proper maintenance is especially important in historic properties containing lead-based paint to avoid the creation of new hazards. For example, if bathroom leaks or other moisture sources deteriorate painted surfaces, paint chips or lead-contaminated dust could become a significant hazard. Residents should be advised to clean their dwellings and notify their building managers if deterioration occurs.

VIII. Conclusions

There are different levels of historic treatments appropriate to different levels of building significance and condition. Controlling lead hazards in historic buildings is a balancing act between several important objectives: childhood health, economic feasibility, and historic preservation. For instance, abatement methods that permanently reduce lead hazards can have a more negative effect on the character of a historically significant home than interim controls. For homes of great historic significance, removing historic paint layers and their substrate can result in an irretrievable loss of materials and craftsmanship. Interim controls are more suitable as a long-term solution as long as the historic property is maintained in good condition. As deteriorated elements are repaired or replaced, much of the lead-based paint can be removed with appropriate methods. Retention of the maximum amount of historic material as possible is the goal of historic preservation; however, it need not be an obstacle to providing a lead-safe housing unit.

Historic Preservation Project Case Study

Case Study Project: 1890s row house, which is part of a National Register Historic District noted for its Victorian architecture. This was one of a group of rehabilitated low-to-moderate income rental units using a variety of Federal and State funding sources, including HUD grants to the local Housing and Community Development Agency (CDBG Block Grants). The buildings in the group are mostly brick, 3-story with side hall plans. Lead-based paint hazard control was part of the overall rehabilitation.

There is a Memorandum of Agreement (MOA) among the city, the State Historic Preservation Office (SHPO), and the Advisory Council on Historic Preservation (ACHP) that the rehabilitation of these buildings would conform to the Secretary of the Interior's Standards for the Treatment of Historic Properties (1992).

1. Historic Significance: The significance of each building in the project was established with the assistance of the State Historic Preservation Officer. In the case study example, both the exterior front facade with its distinctive mansard roof, as well as the interior with its traditional plan and period woodwork were significant. Individual features identified for preservation on the interior included an ornate staircase and banister, period woodwork, and trim around windows and doorways, and decorative ceiling medallions. The windows were wooden double-hung units with a curved top with simple large panes of glass in a one over one configuration; the exterior frames had a distinctive bullnose molding. Roof leaks made many upper floor ceilings structurally unsound. Less architecturally detailed areas were the bathrooms, the kitchen, and a rear addition.
2. Risk Assessment/Paint Inspection: The local Housing and Community Development Agency contracted with a certified risk inspector to test the property for the presence of lead-based paint and to identify the lead-based paint hazards, including dust and bare soil sampling. The paint inspection indicated that there was lead-based paint on the painted exterior brick, exterior windows, and all wooden trim and features inside and on glossy painted wall surfaces inside, such as the kitchen and bathrooms. The overall condition of the paint was deteriorated, and many plaster surfaces were water damaged, but the wooden trim underneath the paint was sound. The windows were in poor condition.

Historic Preservation Project Case Study (continued)

3. Lead Hazard Control: In consultation with the organization that was rehabilitating the property, the Housing and Community Development Agency established a lead hazard control plan as part of the building rehabilitation effort. The basic building plan configuration was retained with an upgrade of mechanical and electrical services. All deteriorating paint was removed by wet scraping, except for a few locations where encapsulants were used. New surfaces were installed to cover deteriorating paint.

   Exterior: The exterior was wet scraped to remove flaking paint and was repainted with a primer and an exterior oil/alkyd paint.

   Wall surfaces: Each room received new ceilings of drywall to replace water damaged and deteriorated plaster ceilings. Ceiling medallions were reinstalled. Most plaster walls were repaired and repainted, but the kitchen and bathroom walls and ceilings, which contained high levels of lead-based paint, were replaced with new drywall. The historic trimwork remained in place.

   Interior trim: All historic wooden trim remained in place and was repainted with special encapsulant coatings after wet sanding to remove loose lead-based paint. The ornate banister and handrail that had potentially chewable surfaces, were painted with three light coats of encapsulant to protect the decorative details and to avoid loss of detail due to the thickness of the paint.

   Windows: The window sashes were replaced with new sash matching the visual configuration of the historic sash which included an arched upper portion. The historic frames remained in place and received vinyl jamb liners to eliminate friction surfaces. The project was scheduled to have the window frames on the exterior boxed out and clad in white aluminum, but this treatment was eliminated after consultation with the State Historic Preservation Office because it would have altered a significant architectural feature on the primary facade. To preserve the distinctive bullnose moldings of these exterior frames, it was determined that the wood could either be wet sanded or chemically stripped to remove paint and repainted with oil/alkyd paint, or repainted with encapsulant paint coatings after stabilizing existing lead-based paint. Repainting with oil/alkyd after a mild chemical cleaning was selected for the exterior frames.

4. The scope of the work outlined by the Housing and Community Development Agency adhered to the Secretary of the Interior's Standards because it preserved the significant features of the building and provided for replacement in-kind or with compatible materials which replicated the historic appearance of the deteriorated originals. Had any of the above treatments called for removal or substantial alteration of significant features, the rehabilitation would have resulted in an adverse effect, requiring the city to obtain the Advisory Council's comments.

5. Upon completion of the projects, information was provided to the new occupants that outlined the damaging effects of lead-based paint and summarized the results of the hazard evaluation and control activities completed in the property. Included were several public health safety alert bulletins as well as instruction on how to maintain a lead safe house. These instructions stressed the importance of keeping housing units free of dust and dirt that might contain lead. Residents were encouraged to contact their local public health office, the Housing and Community Development Agency, or the managing office for the rental units should they suspect, in the future, that deteriorated paint surfaces might contain lead-based paint.

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Glossary

AALA: American Association for Laboratory Accreditation. Also known as A2LA.

Abatement: A measure or set of measures designed to permanently eliminate lead-based paint hazards or lead-based paint. Abatement strategies include the removal of lead-based paint, enclosure, encapsulation, replacement of building components coated with lead-based paint, removal of lead-contaminated dust, and removal of lead-contaminated soil or overlaying of soil with a durable covering such as asphalt (grass and sod are considered interim control measures). All of these strategies require preparation; cleanup; waste disposal; postabatement clearance testing; recordkeeping; and, if applicable, monitoring. See also **Complete abatement** and **Interim controls**.

Abrasion resistance: Resistance of the paint to wear by rubbing or friction; related to both toughness and gloss.

Accessible surface: Any protruding interior or exterior surface, such as an interior window sill, that a young child can mouth or chew.

Accreditation: A formal recognition that an organization, such as a laboratory, is competent to carry out specific tasks or types of tests.

Accredited laboratory: A laboratory that has been evaluated and approved by the National Lead Laboratory Accreditation Program (NLLAP), to perform lead measurement or analysis, usually over a specified period of time.

Accredited training provider: A training provider who meets the standards established by EPA for the training of risk assessors, inspectors, lead-based paint hazard control contractors, and workers.

Accuracy: The degree of agreement between an observed value and an accepted reference value (a "true" value); a data quality indicator. Accuracy includes a combination of random errors (precision) and systematic errors (bias) due to sampling and analysis.

Acrylic: A synthetic resin used in high-performance waterborne coatings; a coating whose binder contains acrylic resins.

Adhesion: The ability of dry paint or other coating to attach to a surface and remain fixed on it without blistering, flaking, cracking, or being susceptible to removal by tape.

Administrative removal: The temporary removal of workers from the job to prevent the concentration of lead in their blood from reaching levels requiring medical removal.

AIHA: American Industrial Hygiene Association.

ALC: See **Apparent Lead Concentration**.

Aliquot: See **Subsample**.

Alkali: A chemical, such as lye, soda, lime, etc., that will neutralize an acid. Oil paint films can be destroyed by alkalies. Some paint removal products contain alkaline substances.

Alkyd: Synthetic resin modified with oil; coating that contains alkyd resins in the binder.

Apparent Lead Concentration (ALC): The x-ray fluorescence (XRF) reading or average of more than one reading on a *painted* surface. See also **XRF analyzer**, **Substrate Equivalent Lead (SEL)**, and **Corrected Lead Concentration (CLC)**.

Bare soil: Soil not covered with grass, sod, some other similar vegetation, or paving, including the sand in sandboxes.

Bias: A systematic error in the measurement process. For XRF readings, one source of bias is the substrate effect. See also **Substrate effect** and **XRF analyzer**.

Biennial report (for hazardous waste): A report (EPA Form 8700–13A) submitted by generators of hazardous waste to the EPA Regional Administrator. The report is due on March 1 of even-numbered years. The report includes information on the generator's activities during the previous calendar year. The owners and operators of treatment, storage, and disposal facilities must also prepare and submit biennial reports using EPA Form 8700–1313.

Binder: Solid ingredients in a coating that hold the pigment particles in suspension and bind them to the substrate. Binders used in paints and coatings include oil, alkyd, acrylic, latex, and epoxy. The nature and amount of binder determines many of the coating's performance properties—washability, toughness, adhesion, gloss, etc. See also **Pigment**.

Biological monitoring: The analysis of blood, urine, or both to determine the level of lead contamination in the body. Blood lead levels are expressed in micrograms of lead per deciliter (one-tenth of a liter) of blood, or µg/dL. They are also expressed in micromoles per liter (µmol/L).

Blank: A nonexposed sample of the medium being used for testing (i.e., wipe or filter) that is analyzed to determine if the medium has been contaminated with lead (e.g., at the factory or during transport).

Blind sample: A subsample submitted for analysis with a composition and identity known to the submitter but not to the analyst; used to test the analyst's or laboratory's proficiency in conducting measurements. See also **Spiked sample**.

Blood lead threshold: Any blood lead level greater than or equal to 10 µg/dL as defined by the Centers for Disease Control and Prevention. See also **Elevated Blood Lead level (EBL) child**.

Building component: Any element of a building that may be painted or have dust on its surface, e.g. walls, stair treads, floors, railings, doors, window sills, etc.

Building component replacement: See **Replacement**.

Cementitious material: A material that is mixed with water, either with or without aggregate, to provide the plasticity, cohesion, and adhesion necessary for the placement and formation of a rigid mass (ASTM Standard C 11).

Centimeter: See cm.

Certification: The process of testing and evaluating against certain specifications the competence of a person, organization, or other entity in performing a function or service, usually for a specified period of time.

Certified: The designation for contractors who have completed training and other requirements to allow them to safely undertake risk assessments, inspections, or abatement work. Risk assessors, inspectors, and abatement contractors should be certified by the appropriate local, State or Federal agency.

Certified Industrial Hygienist (CIH): A person who has passed the 2-day certification exam of the American Board of Industrial Hygiene, and who has at least 4 years of experience in industrial hygiene and a graduate degree or a total of 5 years of experience. See also **Industrial hygienist**.

Certified reference material (CRM): Reference material that has at least one of its property values established by a technically valid procedure and is accompanied by or traceable to a certificate or other documentation issued by a certifying body. See also **Standard reference material**.

CFR: See **Code of Federal Regulations**.

Chalking: The photo-oxidation of paint binders—usually due to weathering—that causes a powder to form on the film surface.

Characteristics (of hazardous waste): EPA has identified four characteristics of hazardous waste: ignitability, corrosivity, reactivity, and toxicity (as determined by the TCLP test). Any solid waste that exhibits at least one of these characteristics may be classified as hazardous under the Resource Conservation and Recovery Act (RCRA), depending on how the waste is produced and what quantities are generated. See also Toxicity Characteristic Leaching Procedure (TCLP).

Chewable surface: See Chewed surface and Accessible surface.

Chewed surface: Any painted surface that shows evidence of having been chewed or mouthed by a young child. A chewed surface is usually a protruding, horizontal part of a building, such as an interior window sill. See also Accessible surface.

CLC: See Corrected Lead Concentration (CLC).

Cleaning: The process of using a HEPA vacuum and wet cleaning agents to remove leaded dust; the process includes the removal of bulk debris from the work area. OSHA prohibits the use of compressed air to clean lead-contaminated dust from a surface.

Clearance examination: Visual examination and collection of environmental samples by an inspector or risk assessor and analysis by an accredited laboratory upon completion of an abatement project, interim control intervention, or maintenance job that disturbs lead-based paint (or paint suspected of being lead-based). The clearance examination is performed to ensure that lead exposure levels do not exceed standards established by the EPA Administrator pursuant to Title IV of the Toxic Substances Control Act, and that any cleaning following such work adequately meets those standards.

Clearance examiner: A person who conducts clearance examinations following lead-based paint hazard control and cleanup work, usually a certified risk assessor or a certified inspector.

cm: Centimeter; 1/100 of a meter.

Code of Federal Regulations (CFR): The codification of the regulations of Federal agencies. The regulations are published in the *Federal Register*. See also ***Federal Register*** (FR).

Cohesion: Ability of a substance to adhere to itself; internal adhesion; the force holding a substance together.

Common area: A room or area that is accessible to all residents in a community (e.g., hallways or lobbies); in general, any area not kept locked.

Competent person: As defined in the OSHA Lead Construction Standard (29 CFR 1926.62), a person who is capable of identifying or predicting hazardous working conditions and work areas, and who has authorization to take prompt, corrective measures to eliminate the hazards. A competent person is not necessarily a risk assessor, inspector, or abatement project supervisor.

Complete abatement: Abatement of all lead-based paint inside and outside a dwelling or building and reduction of any lead-contaminated dust or soil hazards. All of these strategies require preparation; cleanup; waste disposal; postabatement clearance testing; recordkeeping; and, if applicable, reevaluation and on-going monitoring. See also Abatement.

Compliance plan: A document that describes the types of tasks, workers, protective measures, and tools and other materials that may be employed in lead-based paint hazard control to comply with the OSHA Lead Exposure in Construction standard.

Composite sample: A single sample made up of individual subsamples. Analysis of a composite sample produces the arithmetic mean of all subsamples.

Containment: A process to protect workers and the environment by controlling exposures to the lead-contaminated dust and debris created during abatement. See Worksite preparation level.

Contingency plan: A document that describes an organized, planned, and coordinated course of action to be taken during any event that threatens human health or the environment, such as a fire, explosion, or the release of hazardous waste or its constituents from a treatment, storage, or disposal facility.

Corrected Lead Concentration (CLC): The absolute difference between the Apparent Lead Concentration and the Substrate Equivalent Lead. See also **Apparent Lead Concentration (ALC)** and **Substrate Equivalent Lead (SEL)**.

Detection limit: The minimum amount of a substance that can be reliably measured by a particular method.

Deteriorated lead-based paint: Any lead-based paint coating on a damaged or deteriorated surface or fixture, or any interior or exterior lead-based paint that is peeling, chipping, blistering, flaking, worn, chalking, alligatoring, cracking, or otherwise becoming separated from the substrate.

Digestion blank: A mixture of the reagents used for digesting of paint, soil, or dust matrixes but without the matrix. The blank undergoes all the steps of the analysis, starting with digestion. The blank is used to evaluate the contamination process from a laboratory.

Direct-reading XRF: An analyzer that provides the operator with a display of lead concentrations calculated from the lead K x ray intensity without a graphic of the spectrum usually in mg/cm^2 (milligrams of lead per square centimeter of painted surface area). See also **XRF analyzer**.

Disposal (of hazardous waste): The discharge, deposit, injection, dumping, spilling, leaking, or placement of solid or hazardous waste on land or in water so that none of its constituents can pollute the environment by being emitted into the air or discharged into a body of water, including groundwater.

Disposal facility: A facility or part of one in which hazardous waste is placed on land or in water to remain there after the facility closes.

Door mat: See **Walk-off mat.**

Dust removal: A form of interim control that involves initial cleaning followed by periodic monitoring and recleaning, as needed. Depending on the severity of lead-based paint hazards, dust removal may be the primary activity or just one element of a broader control effort.

Dust trap: A surface, component, or furnishing that serves as a reservoir where dust can accumulate.

EBL child: See **Elevated Blood Lead level (EBL) child.**

Efflorescence: The salt rising to the surface of a material, such as masonry, plaster, or cement, caused by the movement of water through the material. Paint or encapsulants may not adhere to a surface contaminated with efflorescence.

Elastomeric: A group of pliable, elastic liquid encapsulant coatings. An elastomer is a macromolecular material which, at room temperature, is capable of substantially recovering its size and shape after the force causing its deformation is removed (see ASTM D 907, D-14).

Elevated Blood Lead level (EBL) child: A child who has a blood lead level greater than or equal to 20 µg/dL or a persistent 15 µg/dL. See also **Blood lead threshold**.

Encapsulation: Any covering or coating that acts as a barrier between lead-based paint and the environment, the durability of which relies on adhesion and the integrity of the existing bonds between multiple layers of paint and between the paint and the substrate. See also **Enclosure**.

Enclosure: The use of rigid, durable construction materials that are mechanically fastened to the substrate to act as a barrier between the lead-based paint and the environment.

Engineering controls: Measures other than respiratory protection or administrative controls that are implemented at the work site to contain, control, and/or otherwise reduce exposure to lead-contaminated dust and debris usually in the occupational health setting. The measures include process and product substitution, isolation, and ventilation.

Epoxy paint: Paint based on an epoxy resin. An epoxy resin is a cross-linking resin the reactivity of which depends on the epoxide group.

Evaluation: Risk assessment, paint inspection, reevaluation, investigation, clearance examination, or risk assessment screen.

Examination: See **Clearance examination**.

Examiner: A person certified to conduct clearance examinations or reevaluations, usually a certified inspector or certified risk assessor.

Exposure monitoring: The sampling and analysis of air both inside and outside the work area to determine the degree of worker and resident exposure to lead or other airborne contaminants, often involving air sampling inside a worker's breathing zone.

Exterior work area: For lead hazard control work, the exterior work area includes any exterior building components, such as a porch or stairway; the safety perimeter; and access barriers.

Facility (pertaining to hazardous waste): All buildings, contiguous land, structures, and other appurtenances, as well as any improvements, where lead-based paint or hazardous waste is treated, stored, or disposed. A facility may consist of several different treatment, storage, or disposal units, such as landfills and surface impoundments.

***Federal Register* (FR)**: A daily Federal publication that contains proposed and final regulations, rules, and notices.

Fibermat: A semirigid woven material attached with a liquid adhesive to a surface or substrate.

Field blank: A clean sample of the matrix (e.g., filter, or wipe) that has been exposed to the sampling conditions; returned to the laboratory; and analyzed as an environmental sample. Clean quartz sand, air sampling filters and cassettes, and clean wipes can be used as field blanks. The field blank, which should be treated just like the sample, indicates possible sources of contamination.

FR: See ***Federal Register (FR)***.

Friction surface: Any interior or exterior surface, such as a window or stair tread, subject to abrasion or friction.

Generator: Any person whose act or operation produces hazardous waste identified or listed in 40 CFR Part 261 or whose act causes a hazardous waste to come under regulation (40 CFR 260.10).

Generator identification number: The unique number assigned by EPA to each generator; transporter of hazardous waste; and treatment, storage, or disposal facility.

Hazardous waste: As defined in EPA regulations (40 CFR 261.3), *hazardous waste* is solid waste or a combination of solid wastes that because of its quantity; concentration; or physical, chemical, or infectious characteristics may cause or significantly contribute to increases in mortality, serious and irreversible or incapacitating but reversible illnesses, or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed. As defined in the regulations, solid waste is hazardous if it meets one of four conditions: (1) exhibits a characteristic of hazardous waste (40 CFR Sections 261.20 through 262.24); (2) has been listed as hazardous (40 CFR Section 261.31 through 261.33); (3) is a mixture containing a listed hazardous waste combined with a nonhazardous solid waste, unless the mixture is specifically excluded or no longer exhibits any of the characteristics of hazardous waste; and (4) is not excluded from regulation as hazardous waste. For lead-based paint abatement waste, hazardous waste is waste that contains more than 5 ppm of leachable lead as determined by the TCLP test, or is waste that is corrosive, ignitable, or reactive and not otherwise excluded.

Hazardous Waste Manifest: See **Manifest**.

Heat gun: A device capable of heating lead-based paint causing it to separate from the substrate. For lead hazard control work, the heat stream leaving the gun should not exceed 1,100 °F (some authorities may use a different temperature).

HEPA filter: See **High-Efficiency Particulate Air (HEPA) filter**.

HEPA/wet wash/HEPA cycle: The cleaning cycle that begins with HEPA vacuuming, followed by a wet wash with a lead-specific cleaning agent, such as trisodium phosphate detergent or another liquid cleaning agent, followed by a final pass with a HEPA vacuum over the surface.

High-Efficiency Particulate Air (HEPA) filter: A filter capable of removing particles of 0.3 microns or larger from air at 99.97 percent or greater efficiency.

High phosphate detergent: See **Trisodium phosphate (TSP) detergent**.

Impact surface: An interior or exterior surface (such as surfaces on doors) subject to damage by repeated impact or contact.

Incinerator: An enclosed device using controlled flame combustion that neither meets the criteria for classification as a boiler nor is listed as an industrial furnace.

Industrial hygienist: A person having a college or university degree in engineering, chemistry, physics, medicine, or a related physical or biological science who, by virtue of special training, is qualified to anticipate, recognize, evaluate, and control environmental and occupational health hazards and the impact of those hazards on the community and workers.

In-place management: See **Interim controls**.

Inspection (of paint): A surface-by-surface investigation to determine the presence of lead-based paint (in some cases including dust and soil sampling) and a report of the results.

Inspector: An individual who has completed training from an accredited program and been licensed or certified by the appropriate State or local agency to (1) perform inspections to determine and report the presence of lead-based paint on a surface-by-surface basis through onsite testing, (2) report the findings of such an inspection, (3) collect environmental samples for laboratory analysis, (4) perform clearance testing, and (5) document successful compliance with lead-based paint hazard control requirements or standards.

Interim controls: A set of measures designed to temporarily reduce human exposure or possible exposure to lead-based paint hazards. Such measures include specialized cleaning, repairs, maintenance, painting, temporary containment, and management and resident education programs. Monitoring, conducted by owners, and reevaluations, conducted by professionals, are integral elements of interim control. Interim controls include dust removal; paint film stabilization; treatment of friction and impact surfaces; installation of soil coverings, such as grass or sod; and land-use controls. See also **Monitoring**, **Reevaluation**, and **Abatement**.

Interior window sill: The portion of the horizontal window ledge that protrudes into the interior of the room, adjacent to the window sash when the window is closed; often called the window stool.

Investigation (pertaining to EBL case): The process of determining the source of lead exposure for a child or other resident with an elevated blood lead level. Investigation consists of administration of a questionnaire, comprehensive environmental sampling, case management, and other measures.

Investigator: A person who conducts an investigation of a dwelling where a resident has an elevated blood lead level. The investigator must be proficient in interviewing techniques, environmental sampling, and the interpretation of risk assessment and environmental sampling data.

Laboratory analysis: A determination of the lead content by atomic absorption spectroscopy, inductively coupled plasma emission spectroscopy, or laboratory-based K or L x-ray fluorescence, or an equivalent method.

Landfill: A State-licensed or State-permitted disposal facility that meets municipal solid waste standards (see Federal regulations at 40 CFR 258).

Landfill liner: A continuous layer of natural or synthetic materials placed beneath and sometimes around a surface impoundment, landfill, or landfill cell. The layer restricts the downward or lateral escape of hazardous waste, hazardous waste constituents, or leachate (40 CFR Part 258).

Latex: A waterborne emulsion paint made with synthetic binders, such as 100-percent acrylic, vinyl acrylic, terpolymer, or styrene acrylic; a stable emulsion of polymers and pigment in water.

Lead: Lead includes metallic lead and inorganic and organic compounds of lead.

Lead-based paint: Any paint, varnish, shellac, or other coating that contains lead equal to or greater than 1.0 mg/cm^2 as measured by XRF or laboratory analysis, or 0.5 percent by weight (5,000 µg/g, 5,000 ppm, or 5,000 mg/kg) as measured by laboratory analysis. (Local definitions may vary.)

Lead-based paint hazard: A condition in which exposure to lead from lead-contaminated dust, lead-contaminated soil, or deteriorated lead-based paint would have an adverse effect on human health (as established by the EPA Administrator under Title IV of the Toxic Substances Control Act). Lead-based paint hazards include for example, deteriorated lead-based paint, leaded dust levels above applicable standards, and bare leaded soil above applicable standards.

Lead-based paint hazard control: Activities to control and eliminate lead-based paint hazards, including interim controls, abatement, and complete abatement.

Lead-based paint abatement planner/designer: An individual who has completed an accredited training program on planning and designing lead-based paint abatement projects.

Lead-based paint abatement worker: See **Worker**.

Lead carbonate: A pigment used in some lead-based paints as a hiding agent; also known as white lead.

Lead-contaminated dust: Surface dust in residences that contains an area or mass concentration of lead in excess of the standard established by the EPA Administrator, pursuant to Title IV of the Toxic Substances Control Act. Until the EPA standards are set, the HUD-recommended clearance and risk assessment standards for leaded dust are 100 µg/ft^2 on floors, 500 µg/ft^2 on interior window sills, and 800 µg/ft^2 on window troughs. The recommended standard for lead hazard screens for floors is 50 µg/ft^2 and for window troughs is 400 µg/ft^2.

Lead-contaminated soil: Bare soil on residential property that contains lead in excess of the standard established by the EPA Administrator, pursuant to Title IV of the Toxic Substances Control Act. The HUD-recommended standard and interim EPA guidance is 400 µg/g for high-contact play areas and 2,000 µg/g in other bare areas of the yard. Soil contaminated with lead at levels greater than or equal to 5,000 µg/g should be abated by removal or paving.

Lead-free dwelling: A lead-free dwelling contains no lead-based paint and has interior dust and exterior soil lead levels below the applicable HUD and EPA standards.

Lead hazard screen: A means of determining whether residences in good condition should have a full risk assessment. Also called a risk assessment screen.

Lead-poisoned child: A child with a single blood lead level that is greater than or equal to 20 µg/dL or consecutive blood lead levels greater than or equal to 15 µg/dL. Local definitions may vary.

Lead-specific detergent: A cleaning agent manufactured specifically for cleaning and removing leaded dust or other lead contamination.

Leaded dust: See **Lead-contaminated dust**.

Leaded zinc: A paint primer made from zinc oxide and lead sulfates.

Licensed: Holding a valid license or certification issued by EPA or by an EPA-approved State program pursuant to Title IV of the Toxic Substances Control Act. The license is based on certification for lead-based paint hazard control work. See also **Certified**.

Listed waste: A hazardous waste that has been placed on one of three lists developed by EPA: nonspecific source wastes, specific source wastes, and commercial chemical products. The lists were developed by examining different types of waste and chemical products to determine if they exhibited one of the four characteristics of hazardous waste (toxicity, corrosivity, ignitability, or reactivity), met the statutory definition of hazardous waste, were acutely toxic or acutely hazardous, or were otherwise toxic.

Maintenance: Work intended to maintain adequate living conditions in a dwelling, which has the potential to disturb lead-based paint or paint that is suspected of being lead-based.

Manifest: The shipping document (EPA Form 8700–22 or a comparable form required by the State or locality) used for identifying the quantity, composition, origin, routing, and destination of hazardous waste during its transport from the point of generation to the point of treatment, storage, or disposal. Also, a shipping document used to keep track of items being transported. All hazardous waste must be accompanied by a manifest. See **Hazardous waste**.

Mat: See **Walk-off mat**.

Matrix blank: A sample of the matrix (paint chips, soil, or dust) that does not contain the analyte lead. This sample goes through the complete analysis, including digestion.

MDL: See **Method detection limit (MDL)**.

Mean: The arithmetic average of a series of numerical data values; for example, the algebraic sum of the data values divided by the number of data values.

Medical removal: The temporary removal of workers from the job because of the occurrence of elevated blood lead levels as defined in the OSHA Lead Exposure in Construction standard (29 CFR 1926.62).

Method blank: See **Digestion blank**.

Method detection limit (MDL): The minimum concentration of an analyte that, for a given matrix and method, has a 99-percent probability of being identified, qualitatively or quantitatively measured, and reported to be greater than zero.

mg: Milligram; 1/1,000 of a gram.

Microgram: See **µg**.

Mil: 1/1,000 of an inch; used to measure thickness.

Milligram: See **mg**.

Monitoring: Surveillance to determine (1) that known or suspected lead-based paint is not deteriorating, (2) that lead-based paint hazard controls, such as paint stabilization, enclosure, or encapsulation have not failed, (3) that structural problems do not threaten the integrity of hazard controls or of known or suspected lead-based paint, and (4) that dust lead levels have not risen above applicable standards. There are two types of monitoring activities; visual surveys by property owners and reevaluations by certified risk assessors. Visual surveys are generally conducted annually for the purpose of making the first three determinations listed above. Reevaluations are conducted in accordance with the Standard Reevaluation Schedule (or more frequently, if needed) for the purpose of making all four determinations. Monitoring is not required in properties known to be free of lead-based paint. See also **Reevaluation** and **Standard reevaluation schedule.**

Monofil: A State-approved landfill that accepts only construction debris.

Mouthable surface: See **Chewed surface**.

Multifamily housing: Housing that contains more than one dwelling unit per location.

NLLAP requirements: Requirements, specified by the EPA National Lead Laboratory Accreditation Program (NLLAP), for accreditation for the lead analysis of paint, soil, and dust matrixes by an EPA-recognized laboratory accreditation organization.

Offsite paint removal: The process of removing a component from a building and stripping the paint from the component at an offsite paint-stripping facility.

Ongoing monitoring: See **Monitoring**.

Owner: A person, firm, corporation, guardian, conservator, receiver, trustee, executor, government agency or entity, or other judicial officer who, alone or with others, owns, holds, or controls the freehold or leasehold title or part of the title to property, with or without actually possessing it. This definition includes a vendee who possesses the title, but does not include a mortgagee or an owner of a reversionary interest under a ground rent lease.

Oxidation: A chemical reaction that occurs upon exposure to oxygen. Some coatings cure by oxidation; oxygen enters the liquid coating and crosslinks (attaches) the resin molecules. This film-forming method is also called “air cure” or “air dry.” Oxidation also causes rust to form on metals and paint to chalk.

Paint film stabilization: The process of wet scraping, priming, and repainting surfaces coated with deteriorated lead-based paint; paint film stabilization includes cleanup and clearance.

Paint removal: An abatement strategy that entails the removal of lead-based paint from surfaces. For lead hazard control work, this can mean using chemicals, heat guns below 1,100 °F, and certain *contained* abrasive methods. Open flame burning, open abrasive blasting, sandblasting, water blasting, and extensive dry scraping are prohibited paint removal methods. (Methylene chloride paint removers and dry scraping are also not recommended.)

Patch test: A test method or procedure to assess the adhesion of an encapsulant coating to a substrate covered with a layer or layers of lead-based paint.

Personal breathing zone samples: Air samples collected from the breathing zone of a worker (within a 1-foot radius of the worker’s mouth) but outside the respirator. The samples are collected with a personal sampling pump operating at 2 liters per minute, drawing air through a 37 mm mixed cellulose ester filter housed in a closed-face cassette with a pore size of 0.8 microns. See **Exposure monitoring**.

Personal Protective Equipment (PPE): Equipment for protecting the eyes, face, head, and/or extremities; includes protective clothing, respiratory devices, and protective shields; used when hazards capable of causing bodily injury or impairment are encountered.

PHA: See **Public Housing Agency (PHA)**.

Pigment: Insoluble, finely ground materials that give paint its properties of color and hide.

Pigment Volume Concentration (PVC): Pigment volume as a percentage of the total nonvolatile ingredients.

Pilot project: In multifamily housing, the testing of a lead-based paint hazard control strategy on a limited number of dwellings, usually those that are vacant, to determine the feasibility of carrying out such a strategy in the entire multifamily housing development; usually involves paint testing, air sampling, wipe sampling, worksite preparation, and a variety of lead-based paint hazard control treatments.

Plastic: See **Polyethylene plastic**.

Polyethylene plastic: All references to polyethylene plastic refer to 6-mil plastic sheeting or polyethylene bags (or doubled bags if using 4-mil polyethylene bags), or any other thick plastic material shown to demonstrate at least equivalent performance. Plastic used to contain waste should be capable of completely containing the waste and, after being properly sealed, should remain leak-tight with no visible signs of discharge during movement or relocation.

Polyurethane: An exceptionally hard and wear-resistant coating created by the reaction of polyols with a multifunctional isocyanate; often used to seal wood floors following lead-based paint hazard control work and cleaning.

Precision: The degree to which a set of observations or measurements of the same property, usually obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed in either absolute or relative terms as standard deviation, variance, or range. Often known as "reproducibility."

Primary prevention: The process of controlling lead hazards to prevent exposure *before* a child is poisoned. See **Secondary prevention** and **Tertiary prevention**.

Primary standard: A substance or device with a property or value that is unquestionably accepted, within specified limits, in establishing the value of the same or related property of another substance or device.

Public Housing Agency (PHA): Any State, county, municipality, or other government entity or public body, or agency or instrumentality thereof, authorized to engage or assist in the development or operation of housing for low-income families.

PVC: See **Pigment Volume Concentration (PVC)**.

Quality Assurance (QA): An integrated system of activities involving planning, quality control, quality assessment, reporting, and quality improvement to ensure that a product or service meets defined standards of quality within a stated level of confidence.

Quality Control (QC): The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the needs of users. The aim is to provide a level of quality that is satisfactory, adequate, dependable, and economical.

Random sample: A sample drawn from a population in a way that allows each member of the population to have an equal chance of being selected. Random sampling is a process used to identify locations for the lead-based paint inspections in multifamily dwellings. See also **Targeted sample** and **Worst-case sample**.

RCRA: See **Resource Conservation and Recovery Act (RCRA)**.

Reevaluation: In lead hazard control work, the combination of a visual assessment and collection of environmental samples performed by a certified risk assessor to determine if a previously implemented lead-based paint hazard control measure is still effective and if the dwelling remains lead-safe.

Reference material: A material or substance that has at least one sufficiently well established property that can be used to calibrate an apparatus, assess a measurement method, or assign values to materials.

Reinspection: See **Reevaluation**.

Removal: See **Paint removal**.

Renovation: Work that involves construction and/or home or building improvement measures such as window replacement, weatherization, remodeling, and repainting.

Replacement: A strategy of abatement that entails the removal of building components coated with lead-based paint (such as windows, doors, and trim) and the installation of new components free of lead-based paint.

Representative sample: A sample of a universe or whole (e.g., waste sample pile, lagoon, groundwater, or waste stream) that can be expected to exhibit the average properties of the entire universe or whole.

Resident: A person who lives in a dwelling.

Resource Conservation and Recovery Act (RCRA): The primary Federal statute governing waste management from generation to disposal. RCRA defines the criteria for hazardous and nonhazardous waste.

Risk assessment: An onsite investigation of a residential dwelling to discover any lead-based paint hazards. Risk assessments include an investigation of the age, history, management, and maintenance of the dwelling, and the number of children under age 6 and women of child-bearing age who are residents; a visual assessment; limited environmental sampling (i.e., collection of dust wipe samples, soil samples, and deteriorated paint samples); and preparation of a report identifying acceptable abatement and interim control strategies based on specific conditions.

Risk assessment screen: A type of risk assessment performed only in buildings in good condition using fewer samples but more stringent evaluation criteria (standards) to determine lead hazards.

Risk assessor: A certified individual who has completed training with an accredited training program and who has been certified to (1) perform risk assessments, (2) identify acceptable abatement and interim control strategies for reducing identified lead-based paint hazards, (3) perform clearance testing and reevaluations, and (4) document the successful completion of lead-based paint hazard control activities.

Sample site: A specific spot on a surface being tested for lead concentration.

Saponification: The chemical reaction between alkalies and oil that produces a type of soap. Because of saponification, oil and alkyd coatings will not adhere to masonry substrates, galvanized metals, or zinc-rich primers. Also a form of incompatibility between types of coatings.

Screen: See **Risk assessment screen** or **Lead hazard screen**.

Screening: The process of testing children to determine if they have elevated blood lead levels.

Secondary prevention: The process of identifying children who have elevated blood lead levels through screening and controlling or eliminating the sources of further exposure. See also **Primary prevention** and **Tertiary prevention**.

SEL: See **Substrate Equivalent Lead (SEL)**.

Site: The land or body of water where a facility is located or an activity is conducted. The site includes adjacent land used in connection with the facility or activity.

Small-quantity generator: Owners, contractors (generators), or both who produce less than 100 kg of hazardous waste per month and accumulate less than 100 kg of hazardous waste at any one time, or who produce less than 1 kg of *acutely* hazardous waste per month and accumulate less than 1 kg of *acutely* hazardous waste at any one time.

Soil: See **Bare soil**.

Solid waste: As defined by RCRA, the term *solid waste* means garbage; refuse; sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; or other discarded materials, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations or from community activities. The term does not include solid or dissolved material in domestic sewage or solid or dissolved material in irrigation return flows or industrial discharges (which are point sources subject to permits under the Clean Water Act), nor does the term include special nuclear or byproduct material as defined by the Atomic Energy Act of 1954.

Spectrum analyzer: A type of XRF analyzer that provides the operator with a plot of the energy and intensity, or counts of both K and L x-ray spectra, as well as a calculated lead concentration. See also **XRF analyzer**.

Spiked matrix: See **Spiked sample**.

Spiked sample: A sample prepared by adding a known mass of the target analyte (e.g., leaded dust) to a specific amount of matrix sample (e.g., one dust wipe) for which an independent estimate of the target analyte concentration is available. Spiked samples are used to determine, for example, the effect of the matrix on a method's recovery efficiency. See also **Blind sample**.

Spot-prime: To apply a paint primer to localized areas of exposed substrate.

Standard deviation: A measure of the precision of a reading; the spread of the deviation from the mean. The smaller the standard deviation, the more precise the analysis. The standard deviation is calculated by first obtaining the mean, or the arithmetic average, of all of the readings. A formula is then used to calculate how much the individual values vary from the mean—the standard deviation is the square root of the arithmetic average of the squares of the deviation from the mean. Many hand calculators have an automatic standard deviation function. See also **Mean**.

Standard reevaluation schedule (SRS): A schedule that determines the frequency that reevaluations should be performed on a property.

Standard reference material (SRM): A certified reference material produced by the National Institute of Standards and Technology (U.S. Department of Commerce) and characterized for absolute content independent of analytical method. See also **Certified reference material**.

Subsample: A representative portion of a sample. A subsample may be either a field sample or a laboratory sample. A subsample is often combined with other subsamples to produce a composite sample. See also **Composite sample**.

Substrate: A surface on which paint, varnish, or other coating has been applied or may be applied. Examples of substrates include wood, plaster, metal, and drywall.

Substrate effect: The radiation returned to an XRF analyzer by the paint, substrate, or underlying material, in addition to the radiation returned by any lead present. This radiation, when counted as lead x-rays by an XRF analyzer contributes to substrate equivalent lead (bias). The inspector may have to compensate for this effect when using XRF analyzers. See also **XRF analyzer**.

Substrate Equivalent Lead (SEL): The XRF measurement taken on an unpainted surface; used to calculate the corrected lead concentration on a surface by using the following formula: Apparent Lead Concentration–Substrate Equivalent Lead = Corrected Lead Concentration. See also **Apparent Lead Concentration (ALC)**, **Corrected Lead Concentration (CLC)**, and **XRF analyzer**.

Target housing: Any residential unit constructed before 1978, except dwellings that do not contain bedrooms or dwellings that were developed specifically for the elderly or persons with disabilities—unless a child younger than 6 resides or is expected to reside in the dwelling. In the case of jurisdictions that banned the sale or use of lead-based paint before 1978, the Secretary of HUD may designate an earlier date for defining target housing.

Targeted sample: A sample of dwelling units selected from an apartment building or housing development using information supplied by the owner. The units selected are likely to have the greatest probability of containing lead-based paint hazards. A targeted sample is usually selected for performing risk assessments in multifamily housing when it is not possible to select a worst-case sample. See also **Worst-case sample** and **Random sample**.

TCLP: See **Toxicity Characteristic Leaching Procedure (TCLP)**.

Tertiary prevention: Providing medical treatment to children with elevated blood lead levels to prevent more serious injury or death.

Testing combination: A unique surface to be tested that is characterized by the room equivalent, component, substrate, and visible color.

Test location: A specific area on a testing combination where XRF instruments will test for lead-based paint.

Toxicity Characteristic Leaching Procedure (TCLP): A laboratory test to determine if excessive levels of lead or other hazardous materials could leach from a sample into groundwater; usually used to determine if waste is hazardous based on its toxicity characteristics.

Trained: Successful completion of a training course in a particular discipline. For lead hazard control work, the training course must be accredited by EPA or by an EPA-approved State program, pursuant to Title IV of the Toxic Substances Control Act.

Transporter: A person who transports hazardous waste, requiring a manifest under 40 CFR Part 260.10, within the United States by air, rail, highway, or water.

Treatment: In residential lead-based paint hazard control work, any method designed to control lead-based paint hazards. Treatment includes interim controls, abatement, and removal. Hazardous waste "treatment" is a method, technique, or process (such as neutralization) that is designed to change the physical, chemical, or biological character or composition of hazardous waste to neutralize it; render it nonhazardous or less hazardous; recover it; make it safer to transport, store, or dispose; or allow for easier recovery, storage, or volume reduction.

Treatment, Storage, and Disposal (TSD) facility: A facility licensed to handle hazardous waste.

Trisodium phosphate (TSP) detergent: A detergent that contains trisodium phosphate.

Trough: See **Window trough**.

Truck-mounted vacuum unit: A vacuum system whose components, except for hoses and attachments, are located outside the building undergoing dust removal. The exhaust is vented outside so that the interior dust is not disturbed.

TSD: See **Treatment, Storage, and Disposal (TSD) facility**.

TSP: See **Trisodium phosphate (TSP) detergent**.

µg (or ug): Micrograms. The prefix micro- means 1/1,000,000 (or one-millionth); a microgram is 1/1,000,000 of a gram and 1/1,000 of a milligram; equal to about 35/1,000,000,000 (35 billionths) of an ounce (an ounce is equal to 28,400,000 µg).

Urethane-modified alkyd: An alkyd molecule that has been chemically modified by the incorporation of a urethane; a coating, often a varnish, that uses a urethane-modified alkyd resin in the binder.

Useful life: The life expectancy of a coating before it requires refinishing or some other form of maintenance.

VOC: See **Volatile Organic Compound (VOC)**.

Volatile Organic Compound (VOC): Substances that vaporize or evaporate from a coating during the coating or curing process.

Walk-off mat: A washable, fibrous material (preferably with a rubber or vinyl backing) positioned at main entryways to reduce transport of lead dust and lead soil into a building or residence.

White lead: A white pigment, usually lead carbonate. See also **Lead carbonate**.

Window sill: See **Interior window sill**.

Window stool: See **Interior window sill**.

Window trough: For a typical double-hung window, the portion of the exterior window sill between the interior window sill (or stool) and the frame of the storm window. If there is no storm window, the window trough is the area that receives both the upper and lower window sashes when they are both lowered. Sometimes inaccurately called the window "well." See also **Window well**.

Window well: The space that provides exterior access and/or light to a window that is below grade, i.e., below the level of the surrounding earth or pavement. See also **Window trough**.

Worker: An individual who has completed training in an accredited program to perform lead-based paint hazard control in housing.

Worksite: Any interior or exterior area where lead-based paint hazard control work takes place.

Worksite preparation level: A set of measures designed to protect residents and the environment from leaded dust, paint chips, or other forms of lead contamination through the erection of barriers and the establishment of access control, resident relocation or movement restrictions, warning signs, ventilation, and other measures.

Worst-case sample: A sample of dwelling units having the greatest probability of containing lead-based paint hazards selected by a risk assessor on the basis of a visual examination of all dwelling units in a housing development or apartment building. See also **Targeted sample** and **Random sample**.

XRF analyzer: An instrument that determines lead concentration in milligrams per square centimeter (mg/cm^2) using the principle of x-ray fluorescence (XRF). Two types of XRF analyzers are used—direct readers and spectrum analyzers. In these *Guidelines*, the term XRF analyzer only refers to portable instruments manufactured to analyze paint, and does not refer to laboratory-grade units or portable instruments designed to analyze soil.

Appendix 1: Units of Measure Used in the Lead-Based Paint Field

Many of the units, terms, and concepts used in these Guidelines are new to the users. Most of the measures cited are in the Metric System of measure, rather than the English System that most people in the United States use on a daily basis. For this reason, a brief discussion of the most important concepts will be helpful to the user to develop a feeling for the quantities and terms used.

Terms and Definitions

An atom is one of the smallest units of matter, identifying a specific element. Lead is an element and is composed of atoms of lead; each lead atom behaves the same way when it interacts with other atoms. A molecule is a cluster of bound atoms which behave as a unit when interacting with atoms or other molecules. Materials made up of molecules are called compounds. The chemical and physical properties of compounds are unlike those of the elements which are present in them. Lead oxide, lead chromate, and lead acetate are all molecules formed when lead atoms combine with atoms of other elements to form molecules. These molecules are called lead compounds or sometimes lead salts. Lead acetate is a lead compound which has a sweet taste and is called "sugar of lead."

An electron is a negatively charged particle that orbits the positively changed nucleus of the atom. Every element requires a different number of electrons to neutralize the atom's positive nuclear charge. If an electron is removed from an atom then the atom becomes positively charged and is called an ion.

An X-ray is a type of high energy electromagnetic radiation. Heat and light are other forms of electromagnetic radiation. Atoms of a particular element emit a characteristic set of X-rays when excited. No two elements emit identical sets of X-rays. The unit of energy we use in talking about X-rays is the kiloelectron volt (one thousand electron volts), abbreviated keV. Lead "K" X-rays have energies between 72 to 87 keV. A gamma ray is electromagnetic radiation which is emitted from the nucleus of a radioactive atom. Most gamma rays emitted by radioactive Cobalt 57 have an energy of 122 keV, more than enough energy to interact with lead atoms in paint and produce lead "K" X-rays. A 122 keV gamma ray will penetrate through many paint layers and into the substrate. Lead "K" X-rays can also penetrate many layers of paint and even through some walls or doors.

Mass Units

Large units of mass and their abbreviations:

> Gram (g or gm): A unit of mass in the metric system. A nickel weighs about 1 gram. A gram is equal to about 35/1000 (thirty-five thousandths of an ounce. Another way to think of this is that 28.4 g are equal to 1 ounce.

Kilogram (kg): The prefix "kilo-" means "1000 times". A kilogram is a unit of mass in the metric system that refers to 1000 grams or about 35 ounces. 35 ounces is about 2.2 pounds. 454 g are equal to 1 pound.

Small units of mass and their abbreviations:

Milligram (mg): The prefix "milli-" means "1/1000 of " (one thousandth of). A milligram is 1/1000 of a gram or about 35/1,000,000 (thirty-five millionths) of an ounce. 28,400 mg are equal to 1 ounce.

Microgram (µg): The prefix "micro-" means "1/1,000,000 of" (one millionth of). A microgram is 1/1,000,000 of a gram or 1/1000 of a milligram. A microgram is equal to about 35/1,000,000,000 (thirty-five billionths) of an ounce. 28,400,000 µg are equal to 1 ounce.

Length Units

Large units of length and their abbreviations:

Meter (M): A meter is a metric unit of length equal to about 39.37 inches, which is 3 and 37/100 of an inch longer than a yard.

Decimeter (dm): The prefix "deci-" means "1/10 of". A decimeter is 1/10 of a meter. Another way to say this is that one meter will contain 10 decimeters. A decimeter is about 3.937 inches.

Centimeter (cm): The prefix "centi-" means "1/100 of". A centimeter is about 39/100 of one inch. 1 inch contains about 2.54 centimeters.

Small units of length:

Millimeter (mm): The prefix "milli-" means "1/1000 of". There are 1000 mm in 1 M. There are 10 mm in 1 cm. 25.4 mm equals 1 inch.

Micrometer (µm): The prefix "micro-" means "1/1,000,000 of". There are 1,000,000 µm in 1 M. There are 1000 µm in 1 mm and 10,000 µm in 1 cm. The term micron is also used interchangeably for µm. There are 25,400 microns is 1 inch.

Nanometer (nm): The prefix "nano-" means "1/1,000,000,000 of" (one billionth of). A meter can be divided into 1 billion nanometers. The wavelength of the light that is visible to us is in the range from about 350 to 700 nanometers; 450 nm is the wavelength of blue light; 550 nm, green light; 650 nm, red light. X-rays have much shorter wavelengths than visible light because they have more energy.

One more small unit encountered in discussing paint films is not a Metric unit but an English unit. The unit that paint film thicknesses are usually measured in is the "mil". A mil is equal to 1/1000 of one inch. A 2 mil paint film per coat is considered average, assuming that the paint contains about 50% solids and has a spreading rate of 400 ft^2/gallon. This would correspond to a paint film thickness of about 50 µm for a single coat of paint. 1 mil is equal to about 25.4 microns. Plastic films are also measured in mil.

Conversion to Areas and Volumes

An area is a measure of the length times the width of some object. The area is expressed as a "square unit" (^{2}). Square feet (ft^2) is an area unit. Similarly, in the metric system we can have square meters (M^2) or square centimeters (cm^2).

$$1\ ft^2 = 929\ cm^2$$
$$1 \text{ square cm} = 1\ cm^2$$
$$1 \text{ square inch} = 1\ in^2$$

The volume is a measure of an area times a height of a cylindrical object. The volume is expressed as a cubic unit (^{3}) such as a cubic foot (ft^3). A liter is a metric unit of volume equivalent to 1000 cm^3 or 1000 cubic centimeters, abbreviated cc. A milliliter is 1/1000 of a liter and is abbreviated ml. The terms cm^3, cc and ml are used interchangeably to refer to small liquid volumes. In the English System we use quarts, gallons, etc., as volume measures. A liter is equal to 1.057 quarts.

Concentration Units

Weight per cent or % by weight (%w/w): The weight of lead in some mass unit per 100 weights of the total sample (in the same mass units). For example, if a 1 gram paint sample contains 0.1 g of lead, then the paint is 10.0% lead by weight (w/w). Also, 1 ounce of lead in 10 ounces of paint is 10% w/w lead. All weight per cent measurements refer to the dried paint film.

Parts per million (ppm): The weight of lead per 1,000,000 weights of the total (including lead) sample. For example, if a paint sample contains 5,000 µg of lead in 1 g of paint, then the lead concentration is 5,000 PPM or 0.5% w/w.

Area concentration: A mass of lead per unit area of the total paint sample, sometimes called "loading". This is independent of the volume (or thickness) of the paint sample. This unit is encountered in measuring paint by portable X-ray fluorescence instruments and laboratory techniques. The HUD regulatory level is 1.0 mg/cm^2 or 1000 $\mu g/cm^2$. Area concentration (loading) is also used to describe settled leaded dust levels in $\mu g/ft^2$ (micrograms of lead per square foot of surface area). 200 $\mu g/ft^2$ equals 1.85 mg/m^2 (milligrams of lead per square meter).

One cannot convert from ppm or % by weight to area concentration (mg/cm^2) as measured by an X-ray fluorescence instrument in any predictable way unless the total mass per unit area of the sample is known. One reason is that the dilution factor of adding more non-leaded paint layers over an existing leaded one will not change the area concentration. However, adding additional layers of paint will change the % by weight. The area concentration is independent of the thickness of the paint layers. The XRF determines the lead mass per unit area as measured by X-ray emission from a lead layer (mg/cm^2). The weight percent method measures the percent of lead in the bulk paint films by determining the weight of lead in the total paint sample.

Consider the case of many layers of paint each containing 0.5% lead by weight. The theoretical concentration limit for all the layers together cannot exceed 0.5% but if (about) 20 or more layers are present then the corrected XRF response may indicate 1.0 mg/cm² or higher. The 1 mg/cm² regulatory level is, in this case, a more stringent standard than the 0.5% standard. Conversely, consider the case of a leaded paint layer with 10% lead by weight. If another layer of non-leaded paint of the same thickness and density is added to the leaded paint layer, the concentration of both layers together would be: 10%/2 layers=5%.

Also, one <u>cannot</u> convert ppm in leaded dust to loading (µg/ft²) unless the total weight of the dust is known. The total weight of dust cannot be determined by wipe sampling.

Some examples will serve to illustrate the concepts and quantities indicated in the previous discussion.

If we assume that a gallon of paint (12 lbs/gallon) having almost 50% solids and 12% lead is applied over 400 square feet, the area lead concentration would be

$$\frac{(0.5)(0.12)(12\ \text{pounds/gallon})(1000\ \text{mg/g})}{(400\ \text{ft})^2\text{gallon})(2.54\ \text{cm/in})^2\ (12\ \text{in/ft})^2\ (0.0022\ \text{pounds/g})} = 0.88\ \text{mg/cm}^2$$

This example illustrates that, in theory, 1 mg/cm² corresponds to a lot of lead in a single layer of paint (about 12% lead). Because of the presence of many layers of paint in target housing, on average 1 mg/cm² is about equal to 1% lead.

To conceptualize quantities of lead in paint we can make some reasonable assumptions. If one assumes a lead pigment particle size of about 1 mm in diameter, and that the particles are about the size of grains of salt (but heavier) and that one of these pigment grains weighs about 30 µg, only about 30 of these grains distributed in an area of 1 cm² will be required to give an area concentration near 1 mg/cm². The lead pigment particles will actually occupy only a small fraction of the total 1 cm² area. This small amount will usually be visible to the eye, under conditions of good light and contrast, on an abated surface, if present as a post-abatement residue.

Can painting over leaded dust create a lead-based paint? While one could conceivably apply the definition of lead-based paint (5,000 ppm) and assume a certain thickness in the new paint film to calculate the weight concentration of lead in the new paint film from the dust loading in µg/ft², the result is well above the dust clearance standards. Consider the following example: If, after treatment, 35,000 µg/ft² of leaded dust remains on the surface, and it is painted over with a lead-free new paint at a rate of 400 ft²/gallon with a density of 12 lbs/gallon and 50%

solids by weight, the total weight of the paint solids per unit area is 7.3 mg/cm². Thus, the weight percent concentration of lead in the new paint film would be about 5,000 ppm:

$$\frac{(12 \text{ pounds/gallon})(0.5)(0.488 \text{ g/cm}^2 / \text{pounds/ft}^2)(1000 \text{ mg/g})}{400 \text{ ft}^2\text{/gallon}} = 7.3 \text{ mg/cm}^2$$

$$35{,}000\ \mu\text{g/ft}^2\ (0.001\ \text{mg}/\mu\text{g})\ (1\ \text{ft}/12\ \text{inches})^2\ (1\ \text{inch}/2.54\ \text{cm})^2 = 0.038\ \text{mg/cm}^2$$

$$\text{ppm by weight} = \frac{0.039 \text{ mg/cm}^2}{7.3 \text{ mg/cm}^2} \times 1{,}000{,}000 = 5{,}200 \text{ ppm}$$

Since the current HUD standard for lead-based paint is 5,000 ppm (0.5%), this means that the new lead-free paint would become lead-based paint. However, it is extremely unlikely that 35,000 µg/ft² would be found on stripped surfaces if the surfaces have been stripped and cleaned adequately.

If one relied on XRF testing to determine lead contamination of surfaces where the lead paint had been removed, it would almost certainly be necessary to correct for substrate effects, since the readings would probably be quite low. If some of the lead did soak into the substrate during the removal process, determination of the true substrate effect would be quite difficult, if not impossible. Current XRF instruments have detection levels well above 0.038 mg/cm².

The diameter of a lead particle found in paint will be on the order of 0.1 to 10 micrometers (µm). Scraping, sanding, and heating lead-based paint will result in the formation of small particles. These particles are usually much smaller than the salt grain examples used above. These very small particles actually float in the air and can be inhaled as we breathe. Very small particles do not settle very rapidly. For this reason very stringent worker protection and clean-up measures are needed for lead hazard control work in lead-based paint abatement.

Heat gun removal at temperatures below 1,100°F will not melt and vaporize lead into the air. It could, however, produce paint "soot" particles from the paint film which will trap the tiny lead particles and allow them to become airborne. Welding and open flame burning temperatures melt and vaporize lead compounds in paint; these temperatures are much higher than those generated by heat guns.

Biological Quantities of Lead in Lead-Based Paint

Blood lead levels are expressed in micrograms of lead (µg) per deciliter of blood (dl). A deciliter is one tenth of a liter. Blood lead levels are reported in µg/dl. A child can eliminate approximately 5 micrograms of lead for each kilogram of body weight in one day. If a ten kilogram (22 lb) child ingested a paint chip containing 1.0 mg of lead, that child would ingest approximately 20 times more lead than could be eliminated by his body in one day (assuming that the digestive system were able to digest the entire paint chip). If we allow that only 10% of the lead in the paint chip is absorbed into the child's body then the child would still ingest twice as much lead, from one paint chip, as his body could eliminate in 24 hours.

Dr. Julian Chisholm in "Lead Based Paint in Housing", National Institute of Building Sciences LBP Task Force Report, February 20, 1988, pp. 23-24, writes:

> *Experimental and human data indicate that chronic average daily ingestion of lead of 16.8 µg Pb/kg of body weight or 168 µg Pb/day in a 10 kg child from paint could raise blood lead concentrations from 20 to 54 µg/dl.*

Currently, the definition of an elevated blood lead level in children is 10 µg/dL.

Appendix 2: CDC's Childhood Lead Poisoning Prevention Program

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Listed alphabetically (year first funded)
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Harold Knight, CDC Public Health Advisor
Baltimore City Health Department
Childhood Lead Poisoning Prevention Program
1211 Wall Street - 2nd Floor
Baltimore, MD 21230
(410) 396-8595
FAX (410) 752-1490

MASSACHUSETTS (90)
Mary Jean Brown, Assistant Director
Childhood Lead Poisoning Prevention Program
Massachusetts Department of Public Health
305 South Street
Jamaica Plain, MA 02130
(617) 522-3700, extension 180
FAX (617) 522-8735

MICHIGAN (92)
Alethia Carr, Lead Program Coordinator
Division of Child and Adolescent Health
Bureau of Child and Family Services
Michigan Department of Public Health
3423 N. Logan, P.O. Box 30195
Lansing, Michigan 48909
(517) 335-9263
FAX (517) 335-9222

DETROIT, MICHIGAN (92)
Harriett Billingslea, Director
Lead Poisoning Control Program
Detroit Health Department
1151 Taylor
Detroit, Michigan 48202
(313) 876-4212
FAX (313) 876-0400

MISSOURI (93)
Mike Carter, Program Coordinator
Missouri Childhood Lead Poisoning Prevention Program
Missouri Department of Health
P.O. Box 570
Jefferson City, MO 65102
(314) 751-6404
FAX (314) 751-6010

Daryl W. Roberts, Chief
Bureau of Environmental Epidemiology
Missouri Department of Health
P.O. Box 570
Jefferson City, MO 65102
(314) 751-6102
FAX (314) 751-6010

MONTANA (93)
Maxine Ferguson, Bureau Chief Family/
Maternal and Child Health Services Bureau
Montana Dept. of Health and Environ. Svcs.
Cogswell Building, 1400 Broadway
Helena, Montana 59620-0901
(406) 444-4743
FAX (406) 444-2606

Lisa Cain, Program Director
Montana Lead Program
Butte-Silver Bow Health Department
25 West Front Street
Butte, Montana 59701
(406) 723-0041
FAX (406) 723-7245

NEW HAMPSHIRE (92)
Martha T. Wells, Program Coordinator
Childhood Lead Poisoning Prevention Program
New Hampshire Div. of Public Health Svcs
Health and Welfare Building
6 Hazen Drive
Concord, New Hampshire 03301
(603) 271-4507
FAX: (603) 271-3745

NEW JERSEY (90)
Kevin McNally, Program Coordinator
Statewide Childhood Lead Poisoning
Prevention Grant Program
Accident Prevention & Poison Control
New Jersey State Department of Health
363 West State Street, CN 364
Trenton, NJ 08625-0364
(609) 292-5666
FAX (609) 292-3580

NEW MEXICO (93)
Dan Merians, Program Coordinator
New Mexico Childhood Lead Poisoning
Prevention Program
State of New Mexico Department of Health
1190 St. Francis Dr.
Runnels Building - Rm N1350
Santa Fe, NM 87502-6110
(505) 827-0006
FAX (505) 827-0013

C. Mack Sewell, DrPH, MS, Director
Division of Epidemiology
State of New Mexico Department of Health
P.O. Box 26110
Santa Fe, NM 87502-6110
(505) 827-0006 FAX (505)827-0013

NEW YORK STATE (91)
Michael D. Cohen, M.D., Director
Bureau of Child and Adolescent Health
New York State Department of Health
P.O. Box 2077
E.S.P. Tower Building, Room 208
Albany, NY 12237
(518) 473-4441 or (518) 474-2084
FAX (518) 473-7158

Nancy Robinson, PhD., Director
Childhood Lead Poisoning Prevention Program
Bureau of Child and Adolescent Health
New York State Department of Health
P.O. Box 2077
E.S.P. Tower Building, Room 208
Albany, NY 12237
(518) 474-2762
FAX: (518)473-7158

WESTCHESTER COUNTY, NY (92)
Dena Fisher, Ph.D., Asst Comm
Planning and Evaluation
Westchester County Department of Health
19 Bradhurst Avenue
Hawthorne, NY 10532
(914) 593-5080
FAX (914) 593-5261 or (914) 593-5090

Dona Bernard, Health Care Prog Administrator
Childhood Lead Poisoning Prevention Program
Westchester County Department of Health
19 Bradhurst Avenue
Hawthorne, NY 10532
(914) 593-5203
FAX (914) 593-5261 or (914) 593-5090

NEW YORK CITY (90)
Diana L. Kiel, Director
Lead Poisoning Prevention Program
New York City Department of Health
65 Worth Street, 5th Floor (Box 58)
New York City, NY 10013
(212) 334-7771 or (212) 334-7709
FAX (212) 788-4920

Tim Morta, CDC Public Health Advisor
Lead Poisoning Prevention Program
New York City Department of Health
65 Worth Street, 5th Floor (Box 58)
New York City, NY 10013
(212) 334-7843 FAX (212) 941-1582

OHIO (90)
Richard Bunner, Project Director
Childhood Lead Poisoning Prevention Program
Bureau of Maternal and Child Health
Ohio Department of Health
246 North High Street, 6th Floor, PSU
Columbus, OH 43266-0588
(614) 466-5332
FAX (614) 644-9850

Cynthia French, CDC Public Health Advisor
Childhood Lead Poisoning Prevention Program
Bureau of Maternal and Child Health
Ohio Department of Health
246 North High Street, 6th Floor, PSU
Columbus, OH 43266-0588
(614) 466-1374
FAX: (614) 644-9850

OREGON (92)
Chris Johnson, Program Coordinator
Childhood Lead Poisoning Prevention Program
426 S.W. Stark - 2nd Floor
Portland, OR 97204
(503) 248-5240
FAX (503) 248-3407

Margot Barnett
Office of Epidemiology and Health Statistics
Oregon Health Division
800 NE Oregon Street, Suite 730
Portland, OR 97232
503-731-4025

PENNSYLVANIA (90)
Helen Shuman, Director
Childhood Lead Poisoning Prevention Program
Division of Maternal and Child Health
Pennsylvania Department of Health
Health & Welfare Building
Commonwealth & Foster St., Rm 725
PO Box 90
Harrisburg, PA 17108
(717) 783-8451
FAX: (717) 772-0323

Dan Dohony, CDC Public Health Advisor
Childhood Lead Poisoning Prevention Program
Philadelphia Department of Public Health
321 University Ave
Philadelphia, PA 19104
215-823-7497
FAX 215-382-1210

RHODE ISLAND (90)
Catherine O'Malley, Program Coordinator
Childhood Lead Poisoning Control Program
Rhode Island Department of Health
3 Capitol Hill, Room 302
Providence, RI 02908
(401) 277-2312
FAX (401) 277-6548

CHARLESTON, SOUTH CAROLINA (91)
Jackie Dawson, RN, Project Coordinator
Childhood Lead Poisoning Prevention Program
Trident Health District
Charleston County Division
334 Calhoun Street
Charleston, SC 29401
(803) 724-5891
FAX (803) 724-5814

SOUTH CAROLINA (92)
Evelyn Phillips, LMSW, Program Director
Childhood Lead Poisoning Prevention
SC Dept. of Health and Environmental Control
Michael D. Jarrett Bldg, Box 101106
Columbia, SC 29201
(803) 737-4061
FAX (803) 734-3255

TENNESSEE (93)
Mary Yarbrough, M.D., M.P.H., Director
Division of Environmental Epidemiology
Tennessee Department of Health
C1-130 Cordell Hull Building
Nashville, TN 37247-4912
(615) 741-5683
FAX (615) 532-2286

HOUSTON, TEXAS (92)
Sulabha Hardikar, MD, MPH
Houston Childhood Lead Poisoning Prevention Project
City of Houston Health and Human Svcs Dept
Maternal and Child Health
Harris County
8000 N. Stadium Dr.
Houston, Texas 77054
(713) 794-9371
FAX (713) 794-9348

Sonja A. Vodehnal, MPA, Proj Mgr
Childhood Lead Poisoning Prevention Project
City of Houston Health and Human Services
8000 N. Stadium Dr.
Houston, TX 77054
(713) 794-9349

VERMONT (93)
Karen Garbarino, Project Coordinator
P. O. Box 70
108 Cherry Street
Chittenden County
Burlington, VT 05402
(802) 863-7226

VIRGINIA (92)
Eileen Mannix, Project Director
Childhood Lead Poisoning Prevention Program
Division of Maternal and Child Health
1500 East Main Street, Suite 137
Richmond, VA 23218-2448
804-786-7367
FAX (804) 371-6031

WISCONSIN (91)
Meg Ziarnik or Jody Diedrich
Program Coordinator
Childhood Lead Poisoning Prevention Program
1414 E. Washington Avenue, Room 128
Madison, WI 53703
(608) 266-8154 or Jody: (608) 266-1826
FAX (608) 267-3696

Appendix 3: U.S. EPA Regional Offices

EPA Region I - (CT, MA, ME, NH, RI, VT)
State Waste Programs Branch
JFK Federal Building
Boston, MA 02203
(617) 223-3468

EPA Region II - (NJ, NY, PR, VI)
Air & Waste Management Division
26 Federal Plaza
New York, NY 10278
(212) 264-5175

EPA Region III - (DE, MD, PA, VA, WV, DC)
Waste Management Branch
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-9336

EPA Region IV - (AL, FL, GA, KY, MS, NC, SC, TN)
Hazardous Waste Management Division
345 Courtland Street, NE
Atlanta, GA 30365
(404) 347-3016

EPA Region V - (IL, IN, MI, MN, OH, WI)
RCRA Activities
230 South Dearborn Street
Chicago, IL 60604
(312) 353-2000

EPA Region VI - (AR, LA, NM, OK, TX)
Air & Hazardous Materials Division
1201 Elm Street
Dallas, TX 75270
(214) 767-2600

EPA Region VII - (IA, KS, MO, NE)
RCRA Branch
726 Minnesota Avenue
Kansas City, KS, 66101
(913) 236-2800

EPA Region VIII - (CO, MT, ND, SD, UT, WY)
Waste Management Divsion (8HWM-ON)
One Denver Place
999 18th Street, Suite 1300
Denver, CO 80202-2413
(303) 293-1502

EPA Region IX - (AZ, CA, HI, NV, American Samoa, Guam, Trust Territories of the Pacific)
Toxics & Waste Management Division
215 Fremont Street
San Francisco, CA 94105
(415) 974-7472

EPA Region X - (AK, ID, OR, WA)
Waste Management Branch-MS 530
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-2777

Appendix 4: OSHA Regional Offices

Region I: CT, ME, MA, NH, RI, VT
U.S. Department of Labor - OSHA
133 Portland Street, 1st Floor
Boston, MA 02114
(617) 565-7164
Fax: (617) 565-7157

Region II: NJ, NY, PR
U.S. Department of Labor - OSHA
201 Varick Street, Room 670
New York, NY 10014
(212) 337-2325
Fax: (212) 337-2371

Region III: DE, DC, MD, PA, VA, WV
U.S. Department of Labor - OSHA
Gateway Building, Suite 2100
3535 Market Street
Philadelphia, PA 19104
(215) 596-1201
Fax: (215) 596-4872

Region IV: AL, FL, GA, KY, MI, NC, SC, TN
U.S. Department of Labor - OSHA
1375 Peachtree Street, SE, Suite 587
Atlanta, GA 30367
(404) 347-3573
Fax: (404) 347-0181

Region V: IN, IL, MI, MN, OH, WI
U.S. Department of Labor - OSHA
230 South Dearborn Street, Room 3244
Chicago, IL 60604
(312) 353-2220
Fax: (312) 353-7774

Region VI: AR, LA, NM, OK, TX
U.S. Department of Labor - OSHA
525 Griffin Street, Room 602
Dallas, TX 75202
(214) 767-4731
Fax: (214) 767-4137

Region VII: IA, KS, MO, NE
U.S. Department of Labor - OSHA
911 Walnut Street, Room 406
Kansas City, MO 64106
(816) 426-5861
FAX: (816) 426-2750

Region VIII: CO, MT, ND, SD, UT, WY
U.S. Department of Labor - OSHA
Federal Building, Room 1576
1961 Stout Street
Denver, CO 80294
(303) 844-3061 x301
FAX: (303) 844-5310

Region IX: AZ, CA, HI, NV, American Samoa, Guam, Trust Territory of Pacific Islands
U.S. Department of Labor - OSHA
71 Stevenson Street, Suite 420
San Francisco, CA 94105
(415) 744-6670
FAX: (415) 744-7114

Region X: AK, ID, OR, WA
U.S. Department of Labor - OSHA
1111 Third Avenue, Suite 715
Seattle, WA 98101-3212
(206) 553-5930
FAX: (206) 553-6499

Appendix 5: EPA-Sponsored Regional and Local Lead Training Centers and Providers

Regional Centers

EPA Regions I & II
Northeast Regional Environmental Public Health Center
School of Public Health
Public Health Building
University of Massachusetts
Amherst, MA 01003
Phone: (413) 545-4222
Fax: (413) 545-4692

EPA Regions III & V
Department of Environmental Health
University of Cincinnati
3223 Eden Avenue, ML-056
Cincinnati, OH 45267-0056
Phone: (513) 558-1749
Fax: (513) 558-1756

University of Maryland at Baltimore
Regional Lead Training Center
28 East Ostend Street
Baltimore, MD 21230
Phone: (410) 706-1849
Fax: (410) 539-2087

EPA Regions IV & VI
Georgia Tech Research Institute
Environmental Science & Technology Laboratory
Georgia Institute of Technology
Atlanta, GA 30332
Phone: (404) 894-3806
Fax: (404) 894-2184

EPA Regions VII & VII
University of Kansas
12600 Quivira Road
P.O. Box 25936
Overland Park, KS 66225-5936
Phone: (913) 491-0221
Fax: (913) 491-0509

EPA Regions IX & X
Environmental Health & Safety
University of California, San Diego
University Extension, 0176
9500 Gilman Drive
La Jolla, CA 92093-0176
Phone: (619) 534-6157
Fax: (619) 558-8156

Environmental Hazard Management Program
University of California, Davis
University Extension
1333 Research Park Drive
Davis, CA 95616-8727
Phone: (916) 757-8606
Fax: (916) 757-8558

Local Centers
Assistant Director, Health & Safety
Department of Research
American Federation of State, County & Municipal Employees
1625 L Street, NW
Washington, DC 20036-5687
Phone: (202) 429-1000
Fax: (202) 429-1293

Center for Neighborhood Technology
2125 West North Avenue
Chicago, IL 60647
Phone: (312) 278-4800
Fax: (312) 278-3840

School of Public Health East
University of Illinois at Chicago
2121 West Taylor Street
Chicago, IL 60612
Phone: (312) 996-5756
Fax: (312) 996-5356

Indiana C.A.P. Directors' Association, Inc.
902 North Capitol Avenue
Indianapolis, IN 46204-1005
Phone: (317) 636-8819

Environmental & Occupational Safety Trng
Division of Continuing Education
Louisiana State University
177 Pleasant Hall
Baton Rouge, LA 70803
Phone: (800) 256-6948
Fax: (504) 388-6324

The New England Consortium
Work Environment Laboratory
University of Massachusetts-Lowell
Lowell, MA 01854
Phone: (508) 934-3257
Fax: (508) 452-5711

Alice Hamilton Occupational Health Trng Ctr
8200 Professional Place, Suite 104
Landover, MD 20785
Phone: (301) 731-8530/(202) 543-0005
Fax: (202) 543-1327

Southeast Michigan Coalition on
Occupational Safety & Health
2727 Second Avenue
Detroit, MI 48201
Phone: (313) 961-5685
Fax: (313) 961-3588

Chicago Area Committee on Occupational
Safety & Health
37 South Ashland Avenue
Chicago, IL 60607
Phone: (312) 666-1611
Fax: (312) 996-5356

Midwest Center for Occupational
Health and Safety
University of Minnesota
640 Jackson Street
St. Paul, MN 55101
Phone: (612) 221-3992
Fax: (612) 292-4773

Minnesota Building Research Center
330 Wulling Hall
86 Pleasant Street, SE
Minneapolis, MN 55455
Phone: (612) 626-7419

Cornell University
New York State School of Industrial and
Labor Relations
Chemical Hazard Information Program
Capital District Office
146 State Street, 4th Floor
Albany, NY 12207-1605
Phone: (518) 449-4161
Fax: (518) 426-0643

Cleveland Lead Hazard Abatement Center
Department of Public Health
City of Cleveland
1925 St. Clair Avenue
Cleveland, OH 44114
Phone: (216) 664-3202
Fax: (216) 664-2197

Energy Conservation Program
Corp. for Ohio Appalachian Development
P.O. Box 787, 1 Pinchot Place
Athens, OH 45701-0787
Phone: (614) 594-8499
Fax: (614) 594-8499

Greater Cincinnati Occupational Health Ctr
Jewish Hospital Evendale Medical Building
10475 Reading Road, Suite 405
Cincinnati, OH 45241
Phone: (513) 769-0561
Fax: (513) 769-0766

The University of Findlay
1000 North Main Street
Findlay, OH 45840
Phone: (419) 424-4647
Fax: (419) 424-4822

Oregon State University
OSU/342 Snell Hall
Corvallis, OR 97331
Phone: (503) 737-1288
Fax: (503) 737-2734

Consortium of Occupational Health Professional
857 Valley View Road
Flourtown, PA 19031
Phone: (215) 842-6540

Pennsylvania College of Technology
One College Avenue
Williamsport, PA 17701-5799

Occupational & Environmental Safety
 Training Division
Texas Engineering Extension Service
Texas A&M University System
College Station, TX 77843-8000
Phone: (409) 845-7952
Fax: (409) 845-3419

Rocky Mountain Center for Occupational &
 Environmental Health
University of Utah
Building 512
Salt Lake City, UT 84112
Phone: (801) 581-5710
Fax: (801) 581-7224

Office of Continuing Education
College of Health Sciences
Old Dominion University
Norfolk, VA 23529-0290
Phone: (804) 683-4256

Wisconsin Energy Conservation Corp.
2158 Atwood Avenue
Madison, WI 53704
Phone: (608) 249-9322
Fax: (608) 249-0339

Institute for Safety & Health Training
West Virginia University
130 Tower Lane
P.O. Box 6615
Morgantown, WV 26506-6615
Phone: (304) 293-3096
Fax: (304) 293-5905

Marshall University
School of Medicine
Division of Occupational & Environmental
 Health
1801 6th Avenue
Huntington, WV 25755-9420

Appendix 6: Other Organizations Providing the EPA Lead-Based Paint Abatement Supervisor and Inspector Course Curriculum

This list is not complete and is simply a compilation of training providers made available to HUD at the time of publication. All training providers who contacted HUD and indicated a desire to be included are listed below. HUD does not recommend one training provider over any other. This listing is for informational purposes only. Other training providers can be identified through the local telephone directory or trade publications.

AFSCME
1625 L Street, NW
Washington, DC 20036
(202) 429-1232

The Aulson Company, Inc.
191 S. Main St
Middleton, MA 01949
800 - 998-0212

Insulation Industry Apprentice and Training Fund
1680 E. Gude Drive
Rockville, MD 20850
(301) 294-3193

Leadtec Services
8841 Orchard Tree Lane
Baltimore, MD 21286
410-682-5323

International Brotherhood of Painters
1750 New York Avenue, NW
Washington, DC 20006
(202) 637-0740

Laborers' Health & Safety Fund
905 16th Street, NW
Washington, DC 20006
(202) 628-2596

National Ironworkers & Employers
1750 New York Avenue, NW #400
Washington, DC 20006

National Training Fund/SM&ACI
Edward Carlough Plaza
601 N. Fairfax Street, #240
Alexandria, VA 22314
(703) 739-7200

United Brotherhood of Carpenters
101 Constitution Avenue, NW
Washington, DC 20001
(202) 546-6206

Committees on Occupational Safety and Health that provide Lead Abatement Training

Alaska Health Project
1818 W. Northern Lights Blvd., Ste 103
Anchorage, AK 99517
(905) 279-3089

Alice Hamilton Occupational Health Center
408 7th Street, SE
Washington, DC 20003
(202) 543-0005/(301) 731-8530

Maine Labor Group on Health
Box V
Augusta, Maine 04330
(207) 622-7823

MASSCOSH
555 Amory Street
Boston, MA 0 2130
(617) 524-6686

SEMCOSH
2727 Second Street
Detroit, MI 48206
(313) 961-3588

WASHCOSH
677 E. Marginal Way South
Building D
Seattle, WA 98108
(206) 433-4721

Western MASSCOSH
458 Bridge Street
Springfield, MA 01103
(413) 731-0760

NORTHEAST REGION

CON-TEST Education Resource Center
39 Spruce Street, P.O. Box 591
East Longmeadow, MA
(800) 626-8378

Environmental and Occupational Health Sciences Institute (EOHS)
45 Knightsbridge Road
Piscataway, NJ 08854-3923
(908) 235-5062

FailSafe Risk Management Alternatives, Inc.
433 River Street, Bldg. E
Troy, NY 12180
(518) 270-8391

Quality Control Services, Inc.
10 Lowell Junction Road
Andover, MA 01810
(508) 475-0623

US Lead Training Institute, Inc.
206 S. Third Street, 2nd Floor
Philadelphia, PA 19106
(215) 625-3512

GREAT LAKES & MID-ATLANTIC REGION

Industrial Training Company
551 W. Grace Street
Richmond, Va 23220-1132
(804) 648-7836

Occupational Training Services
700 S. Pulaski Road, Bldg. 200
Chicago, IL 60652
(708) 385-1325

Professional Service Industries, Inc.
510 East 22 Street
Lombard, IL 60148
(708) 990-8282

Retraining Centers/USA 2000
34 South High Street
Akron, OH 44308
(800) 849-4083

SOUTHERN REGION

Environmental Resource Center
101 Centre Point Drive
Cary, NC 27512
(919) 469-1585

Gebco Associates, Inc.
669 Airport Freeway
Hurst, TX 76053-3962
(817) 268-4006

Health & Hygiene
420 Gallimore Road
Greensboro, NC 27409
(910) 665-1818

NATEC of Texas, Inc.
8981 Interchange Drive
Houston, TX 77054
(800) 446-2832

Seagull Environmental Training
903 Northwest Sixth Avenue
Fort Lauderdale, FL 33311
(800) 966-9933

University of Alabama
College of Continuing Studies
Box 870388
Tuscaloosa, AL 35487
(205) 348-3028

University of Florida
TREEO Center
3900 SW 63rd Boulevard
Gainesville, FL 32608
(904) 392-9570

University of North Carolina
Occupational Safety and Health Educational Resource Center
109 Connor Drive, Suite 1101
Chapel Hill, NC 27514
919-962-2101

WESTERN REGION

Occupational Knowledge, Inc.
2030 Franklin Street, Suite 220
Oakland, CA
(510) 444-0163

Health & Environmental Technology Center
Moore-Norman Area Vo-Tech Center
4701 12th Ave NW
Norman, OK 73069
800-872-4623

University of California
UC Berkeley Extension, Environmental Management
2223 Fulton Street
Berkeley, CA 94720-7012
(510) 643-7143

Appendix 7.1: Elements of Inspection and Risk Assessment RFPs

A. Scope of Work—A detailed description of the services to be provided.

1. List of Housing Locations, Site Plans, and Location Maps.
2. Description of Structures: Describe building type, construction, painting history (if known), special conditions.
3. Unit Size Breakdowns for Each Development: Require that sampling include all bedroom sizes in the proportion that they occur in each development.
4. List of Common Areas, Management and Community Facilities, and Other Areas to Be Included (For Risk Assessment—Playgrounds and Large Parking Areas).
5. Inspection Report Requirements.

   The Risk Assessment Protocol in Chapter 5 and the Inspection Protocol in Chapter 7 provide specific report formats for risk assessments and inspections. Report requirements may be governed by EPA regulations issued pursuant to Section 402 and 404 of TSCA, or by local authorities.

   For inspection reports, the following may be required: Executive summary (includes a listing of components that tested positive), sections on regulatory compliance, overall scope of work, unit selection methods, field procedures, laboratory and field quality control procedures, Substrate Equivalent Lead determination, data analysis and reduction, laboratory procedures, and application of HUD decisionmaking rules.

B. Standards—References or regulatory standards to be met in providing services.

1. *HUD Guidelines for the Evaluation and Control of Lead Hazards in Housing*.
2. State or Local Regulations, if applicable.
3. Environmental Protection Agency (EPA) regulations.
4. HUD regulations.
5. Occupational Safety and Health Administration (OSHA) Regulations.
6. Nuclear Regulatory Commission (XRF radiation sources).

C. General Instructions.

1. Submission Time and Dates.
2. Notice of Preproposal Conferences and Site Reviews. (Such conferences are strongly recommended so that proposers can review conditions in the field.)
3. Opportunities and Form for Submitting Questions or Comments.

4. Conditions for Issuance of Addenda and Other Clarifications.

5. Conditions for Award of Contract.

6. Proposed Form of Contract. The applicable HUD Handbook includes a model consultant contract for use by housing authorities and other public agencies.

D. Financial, Insurance, and Legal Requirements: If not included in proposed contract, special requirements should be defined.

E. Proposal Format and Content.

1. Required Presentation Format.

2. Transmittal Letter Contents.

3. Statements of:

a. qualifications—certification and training are required (some jurisdictions may also require certifications).

b. related experience—directly applicable experience in performing these services for comparable housing.

c. references.

d. proposed staffing and project organization.

e. work plan/technical approach.

f. base price and unit prices for additional work (e.g., paint chip samples and collection).

F. Proposal Evaluation and Contract Award.

1. Evaluation Criteria Factors.

a. Qualifications, experience, and references.

b. Staffing and organization.

c. Quality of proposed work plan/technical approach.

d. Cost and price.

2. Other Special Requirements—Local preferences, minority participation.

G. Other Issues.

1. Qualifications—For both inspection and risk assessment, qualifications must include certification and/or licensing by a specific State or local agency.

2. Experience—Experience in inspection/risk assessment of similar housing in accordance with HUD protocols.

3. Related Qualifications, Experience, and Training.

a. Experience in inspection (other than lead-based paint), maintenance, renovation, or management of housing similar to the housing units for which services are being sought. This experience is most relevant for risk assessment.

b. Experience in the planning, design, and monitoring of lead-based paint hazard control projects. This experience is most relevant to inspection services.

c. Experience in collecting environmental samples and interpreting test results. Collection and analysis of lead samples such as dust wipes, soil, paint chips, and water samples in housing environments. Applicable to both risk assessment and inspection.

d. Experience in environmental report writing. Ability to outline a lead hazard control strategy with an order of priorities and recommended methodologies.

4. Price.

a. Inspection—Proposals should contain an estimate of the number of XRF measurements and a brief description of locations where XRF measurements will be made in order to demonstrate that costs are reasonable. If this cost breakdown is provided, it will be possible to compare proposals on a systematic basis. The proposal should also contain unit prices for:

i) collection and analysis of paint chip samples if necessary for confirmatory purposes; and
ii) addition or deletion of XRF measurements.

b. Risk Assessment—Proposals should include a breakdown of the total price into:

i) the cost for laboratory analysis of the estimated number of environmental samples to be collected; and
ii) the cost for all other services, including the cost of collecting the samples and other field work and report writing. If this cost breakdown is provided, it will be possible to compare proposals on a systematic basis. The proposal should also contain a unit price for the collection and analysis of additional environmental samples in case they are needed.

5. Proposal Evaluation.

a. Certification, training, and price should be considered in evaluating proposals.

b. Understanding and experience in using HUD Lead-Based Paint Testing and/or Risk Assessment Protocols are essential requirements.

Appendix 7.2: Types of Lead-Based Paint Enclosure Systems

General Notes

The following notes apply to several of the Enclosure Systems used to seal interior and exterior surfaces of walls, ceilings, floors, doors, windows and trim which contain lead-based paint.

a. Application of gypsum board, plywood paneling, or solid board paneling directly to existing wall or ceiling surfaces requires anchorage to structural wood or steel joists or ceiling joists or rafters by suitable screws penetrating the structure at least¾". Attachment may also employ a combination of screws and construction adhesive. For application directly to masonry surfaces, case-hardened masonry nails, of sufficient length to extend into the masonry, and construction adhesive are required.

b. Furring may be required to produce a true and even support for panel or board finish materials. Furring may be wood 1" x 2" strips or metal channels. Resilient metal channels may be used where additional sound attenuation is desired. Furring may be applied vertically or horizontally to accommodate the direction of the finish material. Furring shall be anchored to structural studs, ceiling joists or rafters preferably with bugle-head screws or annular-ringed nails; to steel studs or channel framing, anchorage shall be by bugle-head screws. Anchorage of furring strips to concrete or masonry walls shall be by case-hardened masonry nails, anchors, or toggle bolts. Furring shall not be more than 16" on center of walls or 24" on center for ceilings.

c. Gypsum, cement, or metal lath shall be anchored to structural wood or steel studs, joints, or rafters, or to wood or metal furring by bugle-head screws. Anchorage of metal lath to concrete or masonry walls shall be by case-hardened masonry nails, power or hand drive.

d. All enclosure systems (wood panels, boards, plaster and stucco systems, siding and tile) shall include the sealing of all joints, edges and corners with suitable materials. Penetrations of walls and ceilings serving electrical outlets, switches and fixtures, heating and cooling duct registers, plumbing and heating pipes shall be sealed by collars, foam or other approved devices to prevent dust from lead-based painted surfaces escaping enclosed surfaces. All sealing materials shall have an expected service life of a minimum of twenty years.

e. Enclosing systems shall leave interior space dimensions, areas and ceiling heights sufficient to meet all building codes and minimum property standards. Exterior enclosure systems shall permit structures to meet zoning restriction for set back requirements.

f. For enclosure systems which do not produce an air-tight enclosure such as plaster and stucco systems with control joints, wood paneling, and aluminum and vinyl siding, the covering of the surface by a breathable wrap such as Tyvek® should be required to prevent lead-containing dust particles from migrating. Where breathable cloth is used to enclose existing wall surfaces, required ventilation strips and openings shall not be covered but shall remain open.

1. Gypsum Board Applied Directly to Existing Walls or Ceiling Surfaces

Enclosure of lead-based paint on gypsum board or plaster surfaces may be achieved by application of ¼" or 3/8" thick standard gypsum board directly to existing walls and ceilings. Gypsum board with tapered edges shall be attached with drywall screws or a combination of screws and construction adhesive. If quarter inch thick drywall is used, the surface to be enclosed must be essentially free of holes.

Screws shall be of sufficient length to pass through the existing drywall or plaster and intrude into the structural wood studs or ceiling joist 5/8" - 3/4".

Finishing materials including joint tape, corner and edge beading and spackle shall be as approved by gypsum board manufacturers and installed in accordance with their recommendations.

In high moisture areas, such as laundries and baths, moisture-resistant gypsum board shall be used. In bathtub or shower enclosures to be covered by tile, cement board shall be used.

All joints, corners, and edges and all surface penetrations for electrical outlets, switches, light fixtures, pipes and duct grilles and registers shall be sealed by means of collars, foam, or other approved devices to prevent dust from lead-contaminated surfaces from reaching newly enclosed areas.

Gypsum board shall be applied in accordance with the General Notes.

2. Gypsum Board Applied to Furring Strips

Where existing plaster or gypsum board surfaces are not suitable for direct application, a new layer of gypsum board may be applied over furring strips. Furring may be designated where the surface is uneven or has deteriorated or to cover existing surface moldings.

Furring may be wood 1" x 2" strips or metal channels shimmed as required to produce a true and even surface. Resilient metal channels may be used where additional sound attenuation is desired. The thickness of gypsum board shall be a minimum of ½" and spacing of furring shall meet industry standards.

Furring shall be anchored to structural studs, ceiling joists or roof rafters not more than 16" on center preferably with annular ringed nails penetrating the members approximately ¾".

Gypsum board panels shall be applied to furring strips as described in Section 1 and in accordance with the General Notes.

3. Lath and Plaster Applied Directly to Existing Wall and Ceiling Surfaces

Where existing wall and ceiling surfaces are sound and even, enclosure may be achieved by application of expanded metal lath or gypsum lath and required base and finish plaster coats. Selection of a plaster system depends on the desired surface and finish characteristics such as a smooth, sanded, hard or moisture resistant. Plasters may be job-mixed or ready-mixed systems as needed to satisfy the requirement of the job. Job-mixed plasters include lime plasters, sand gauging plasters, and Keenes cement.

Lath systems include gypsum lath and a variety of metal laths. Gypsum lath is usually available in sheets 16" x 48". Lath shall be applied as described in the General Notes.

4. Lath and Plaster Applied Over Furring strips

Where instability or unevenness of the existing surface requires, furring shall be installed prior to application of lath and plaster.

Furring may be 1" x 2" x 2" x 2" wood strips, metal hat-shaped channels, resilient metal channels or plaster lath strips. Anchorage of furring shall be to structural members, studs, joists or rafters by suitable nails, screws or other devices as described in the General Notes.

Lath may be gypsum lath, 16" x 48", or expanded metal or ribbed metal.

As an alternative to a conventional 3-coat plaster system, a veneer system of one or two veneer coats to a thickness of 1/16" to 1/8" may be used. Veneer plaster is applied to a specially prepared gypsum baseboard.

For spaces where high-moisture is expected, such as steam rooms or swimming pool enclosures, Keenes cement lime-sand plaster is recommended. Edges, corners, joints, and spaces around openings for electrical, plumbing and heating devices shall be properly sealed by materials with a life-expectancy of not less than 20 years from the passage of dust particles.

Application shall also be in accordance with the General Notes.

5. Stucco and Metal Lath Applied Directly in Wall and Ceiling Surfaces

Where greater surface durability, water resistance, variety of texture or integral color is desired, stucco systems may be used in place of gypsum plaster. When used as a lead-based paint enclosure system, stucco - a wet mixture of portland cement and lime - is trowel or spray applied to anchored expanded metal lath to produce a complete seal of wall or ceiling surfaces.

Stucco may also be used to enclose lead-based paint surfaces over expanded metal lath or over rigid foam board. The latter systems using polymer-based or polymer-modified plasters are spray or trowel applied to insulation board to which a mesh reinforcement has been attached. These systems are known as Exterior Insulation Finish (EIF) and should be installed in accordance with recommendations of the Exterior Insulation Manufacturers Association (EIMA). In order to prevent lead-contaminated dust from leaving the surface and migrating through control joints a breathable wrap material such as Tyvek® may be required.

All stucco systems for interior or exterior lead-based paint enclosures shall provide control joints to prevent surface cracking. Other recommendations in General Notes shall also apply.

6. Stucco Applied to Metal Lath on Furring Strips

Stucco may be used to cover lead-based paint on interior walls and ceilings and exterior surfaces of many construction systems where the condition of the substrate requires furring strips for adequate anchorage of the lath.

Stucco, usually applied to lath in three coats - scratch, brown, and a finish coat - produces a highly water-resistant surface. Finish coats are available in a variety of textures and colors.

Lath for stucco is available in expanded metal, ribbed and self-furring lath. Accessories for control joints, reinforcing and corner beads are available.

Furring may be wood, 1" x 2" or 2" x 2" strips or metal hat-shaped channels. Rigid foam board for EIF systems may also be used.

Recommendations included in General Notes should be followed for stucco systems.

7. Plywood Paneling Applied Directly to Existing Wall and Ceiling Surfaces

Prefinished plywood panels or panels to be finished after installation, usually ¼" thick, may be installed to walls and possibly to ceiling surfaces where the condition of the surface is suitable for application using annular-ringed nails and construction adhesive.

Care must be exercised in sealing all joints and edges to prevent passage of lead-containing dust particles. Non-hardening sealants such as silicone or urethane having a minimum 20 year life expectancy must be used for this purpose.

Lead-painted exterior surfaces may be enclosed with plywood panels such as Texture 1-11 or other plywood sheets, usually 5/8" to ¾" thick. Application of these panels directly to existing surfaces requires anchorage to structural members using suitable nails or a combination of nails and construction adhesive. Passage of lead-containing dust must be prevented by sealing all edges and joints by suitable sealants and where necessary a surface wrap with a breathable cloth such as Tyvek®.

Additional recommendations listed under General Notes should also be followed.

8. Plywood Paneling Applied Over Furring Strips

Where plywood is used to enclose lead-based painted surfaces, which are unsuitable for direct attachment of plywood, furring strips, shimmed as required, may be used to provide a sound, level base to which plywood may be secured.

Wood furring, usually 1" x 2" or 2" x 2" strips, 16" to 24" on center is securely anchored using nails or screws to exiting structural members or by means of masonry anchors, nails or toggle bolts to brick or masonry block walls.

All edges and corners of plywood panels must be sealed and surfaces wrapped where required to prevent dust migration. Other appropriate recommendations listed under General Notes must also be followed.

9. Solid Board Paneling Applied Directly to Wall or Ceiling Surfaces

Solid board paneling may be used to enclose lead-based painted interior wall and ceiling surfaces and exterior wall surfaces by application directly to suitable substrates.

Interior paneling may be unfinished or prefinished softwoods such as cedar, cypress, redwood, fir, and pine and hardwoods such as oak, elm, ash, fruitwoods, maple and walnut.

Exterior woods are usually the more insect-resistant woods such as cedar, cypress and redwood.

Most solid wood paneling is finished with tongue and groove or shiplapped edges for horizontal or vertical application or with interlocking edges, tapered for horizontal application. Some particle board material for horizontal application is also manufactured. Wood shingles, usually cedar, may also be used for exterior enclosure. Anchoring devices may be suitable nails or staples often used with a construction adhesive.

For most systems a breathable cloth wrap, such as Tyvek® is recommended as are other General Note suggestions.

10. Solid Board Paneling Applied Over Furring Strips

Where the condition of the surface to be enclosed lacks stability or evenness, the solid board paneling materials, minimum thickness of 5/8", as described in Section 9 above, may be installed over furring strips shimmed to produce an even, stable surface.

Furring may be wood 1" x 2" or 2" x 2" strips applied horizontally to accommodate vertical paneling or vertically to accommodate horizontal paneling. A wrap of the lead-based painted surface is usually required prior to installing furring. A breathable plastic cloth such as Tyvek® is used as wrap material to prevent lead-contaminated dust particles from migrating. Application shall also be in accordance with the General Notes.

11. Extruded or Shaped Sheet Metal over Existing Trim

In some construction situations, door and window frames and trim containing lead-based paint may be enclosed by the use of extruded vinyl shapes more cost effectively than removal and replacement of the in-place trim. Enclosure of the existing trim surfaces must completely seal all edges, corners and joints of the new trim covers with sealants such as silicone or urethane having a life expectancy of at least 20 years. Attachment may be accomplished by suitable nails, screws or clips and construction adhesive.

12. Ceramic Tile Applied in "Thin-Set" Mastic Directly to Existing Surfaces

Where condition of existing walls or floors allows, ceramic tile may be applied by "thin-set" method to surfaces containing lead-based paint to be enclosed. Tile should be pressed into a full-covering layer of mastic and allowed to set before applying grout to all surface joints. Sufficient grout shall be used to fill all spaces around and between tiles.

13. Ceramic Tile Applied in Mud Coat to Lath Directly to Existing Surfaces

Where it is desired to set ceramic tile in a mud coat, expanded metal lath or cement board lath is applied to existing lead-based painted surfaces. Tile is then set in a mud coat to the lath, allowed to set and then grouted with full joint grout. General Notes requirements also apply.

14. Ceramic Tile Applied in "Thin-Set" Mastic Over Furring

Where the surface of existing lead-based painted walls requires furring to achieve a sound, level support for application of ceramic tile, a cement board panel may be anchored to wood strip, metal channel or cement board strips shimmed as required. Ceramic tile is then set in mastic on the furred cement board base. After the mastic has set up, all edges and joints between the tile are grouted with grout forming a full joint in all voids. General Notes requirements also apply.

15. Ceramic Tile Applied in "Mud Coat" Over Furring

Ceramic tile to be used for enclosing lead-based painted surfaces may require a "mud coat" setting bed on a furred base. This may be especially true of the less precise hand-formed floor tile which requires a thicker setting bed permitting adjustments to produce an even floor.

On walls, metal lath or cement board lath may be attached to furring as a base for mud-coat setting bed. Furring should be shimmed as required to produce a level base for tile.

On floors, cement board, furred or shimmed as required to produce a true and level surface, is a suitable based for a "mud coat" application. General Note requirements apply.

After the tile has set, joints are grouted with suitable joint materials. Ceramic tile on floors requires a sand-mixed grout to produce a strong joint.

16. Brick Veneer Used to Enclose Lead-Based Painted Surfaces

A single width of brick may be applied as a brick veneer to enclose lead-based painted surfaces on both interior and exterior surfaces.

The first course of brick must be provided with the adequate structural support of a beam or steel shelf angle designed and attached to carry the load of the brick veneer wall without excessive deflection. The brick shall be laid in full beds or mortar, with full head joints attached to existing walls by suitable galvanized or stainless anchors imbedded in masonry joints, 24" on center, vertically and horizontally. All joints shall be tooled to produce a dense mortar joint.

At returns to frames, jambs, heads and sills of window and door openings, provision shall be made to seal existing surfaces from dust migration. A wrap cloth of breathable material such as Tyvek® may be required on exterior walls, especially where weep holes are provided to control moisture which has penetrated brick surfaces.

All building code room size and area requirements and exterior set-back restrictions must not be violated by the addition of the brick veneer.

17. Masonry Block Veneers Used to Enclose Lead-Based Painted Walls

A nominal 4" concrete masonry veneer may be applied to enclose lead-based painted surfaces on both interior and exterior wall surfaces.

All requirements listed above for brick veneer including structural support, anchorage to existing structure, treatment of joints and sealing of voids and joints shall also apply as shall requirements of codes and zoning.

18. Underlayment Grade Plywood, Oriented Strand Board or Particle Board Applied Over Existing Flooring

Underlayment grade plywood, oriented strand board or particle board, nominal thickness of ¼" may be used to enclose lead-based painted wood floors. The underlayment should be applied just prior to the finish material and should be protected from damage its surface. Panel end joints should be staggered with respect to each other, and all joints should be offset with respect to joints in the subfloor. Panel edges and ends should be butted to a close but not tight fit (1/32" space). Panels should be nailed 6" along edges and 8" on center each way throughout the remainder with 3d annular-ringed nails or 16 gauge staples, 3" on center along edges and 6" on center throughout. End joints shall be filled and thoroughly sanded.

Underlayment is suitable as a base for resilient tile such as rubber, vinyl and cork, sheet flooring and carpeting usually with a pad. It may also be used as a base for think, mastic-set strip or parquet wood finish systems.

19. Vinyl Siding

Prefinished vinyl siding, having a life expectancy of at least 20 years, may be installed over a variety of existing exterior wall surfaces to enclose lead-based paint. Installation of a building wrap system using breathable cloth such as Tyvek® and sealing all joints with silicone or urethane sealers should be used to ensure that dust particles cannot migrate through the vinyl siding system.

All siding panels, components and trim shall be installed in accordance with manufacturer's recommendations using appropriate fastening devices for proper anchorage.

20. Aluminum Siding

Prefinished aluminum, siding having a life expectancy of at least 20 years, may be installed over a variety of existing exterior wall surfaces to enclose lead-based painted surfaces. Siding installation application recommendations are similar to those for vinyl siding in Section 19 above.

Anchorage of all siding panels, trim and components for aluminum siding shall employ the use of aluminum nails. All siding panels, components and trim shall be installed in accordance with manufacturer's recommendations using appropriate fastening devices for proper anchorage.

Appendix 7.3:
Lead-Based Paint Abatement Specification Example

The following is an example of a detailed specification for lead-based paint abatement work in a large multifamily public housing development. Because all specifications are site-specific, its provisions may not be suitable for other situations. This level of detail may not be appropriate for all lead-based paint hazard control work.

This specification has been provided by Mr. Neal Freuden of EnviroScience Consultants, Inc., its chief author. It was formulated over the course of several projects and includes contributions from Fred Eberle of Dewberry and Davis, the staffs of the Cambridge, Massachusetts Housing Authority and the Dover, New Hampshire Housing Authority, the staff of Housing Environmental Services, Dennison Environmental, Dan LaBrie of the Housing Authority Risk Retention Group and Dave Jacobs. A model specification may be available from the National Institute for Building Sciences in the future.

PART 1 - GENERAL

1.01 SUMMARY OF WORK

A. The work under the contract consists of the following:

1. Exterior lead abatement and comprehensive modernization consisting in total of xxx existing occupied units in _____ buildings.

2. Removal of all windows, sashes and window systems, exterior doors and door casings/ jambs and installation of new replacement windows and doors and door casings/jambs as indicated in the specifications and drawings. All removal and installation shall be performed and coordinated as indicated in the specifications and drawings.

3. Exterior Lead Paint Abatement by component removal as indicated in the specifications and drawings. All abatement work shall be coordinated with the general Construction Work and as indicated in the specifications and drawings.

4. Replacement of components removed under lead abatement.

5. Installation of wood clapboard and wood shingle siding and replacement of exterior building components as indicated in the specifications and drawings.

6. Creation of handicapped accessible entries to certain designated units.

7. All other work and items either shown on the drawings or included in the specifications.

8. Protection where appropriate of all temporary facilities and utilities and property outside the designated work areas and zones.

9. Maintaining existing occupancy and use: Except as indicated in the specifications, work of the project includes keeping all occupied buildings and units in full complete year round operation. Work of the project includes providing all temporary facilities and utilities needed to insure that occupied units are safely accessible and supplied with electricity, water, sewers, heat, telephone service and other utilities which may currently be present. Occupancy will remain in all units.

10. The Contractor shall be responsible for all means and methods required to perform the work in accordance with the Contract Documents and within the time limits established in the Contract and this Section.

11. There will be a Pre-Bid Walk-through held at a time and place identified in the Bidding Documents. All general Bidders and Abatement Subcontractors should attend this Pre-Bid Walk-through to acquaint themselves with the existing conditions and required scope of work.

1.02 WORK INCLUDED

A. The requirements of this Section govern specific aspects of the administration of the Work. The Contractor is responsible for compliance of his own forces and of his subcontractors with the requirements in this Section.

B. The Contractor is responsible for all corrections of and changes in the Work, and for any delays resulting from his failure to conform with these requirements, and for all costs arising there from.

C. Individual requirements for work provided for under this Section are described in other Sections of the Specifications.

1.03 PERFORMANCE OF WORK

A. <u>Work of the Lead Hazard Control Contractor</u>: The Contractor or subcontractor to perform the following work shall be a Lead hazard control Contractor licensed to perform lead hazard control.

1. Removal of exterior unit components containing lead-based paint as identified in the Lead Paint Inspection Reports provided by Owner according to the specifications and drawings.
2. Removal of the exterior components containing lead-based paint as listed in Section X.
3. On-site stripping of the exterior components containing lead-based paint as listed in Section X.
4. All work performed by the Lead hazard control Subcontractor shall be in accordance with applicable federal and state and local regulations and the specifications and drawings.

B. Work of the General Contractor: All other work described in these specifications shall be performed according to applicable codes and standards, federal, state and local regulations and the specifications and drawings.

1.04 PILOT BUILDINGS

A. Except as provided herein, all materials used on the Sample Buildings shall conform to the Contract Documents and shall have been submitted to and approved by the Architect in accordance with Section X of the Specifications. Where submittals of materials have been made to the Architect but have not been approved, the Contractor may request approval to employ such materials in the Sample Buildings at its own risk and the Architect may permit such use on condition that if any material is later disapproved it shall be removed and replaced with approved material.

In the case of equipment and material which have long lead times for delivery, the Architect may accept the use of the "mock-up" construction simulating the appearance of the completed work upon the condition that as soon as the actual materials and equipment become available the contractor shall promptly install these items in place of the simulations, at no additional cost to the Owner.

B. Upon acceptance of the Sample Buildings by the Owner, Architect, and Consultant, the quality of finish and details thereon shall constitute the minimum level of acceptable workmanship for all other buildings throughout the site. The Contractor shall provide adequate maintenance and security for the Sample Buildings from the start of work thereon until the time of final acceptance by the Owner or until such earlier time as may be established in writing by the Owner. The Sample Buildings will be re-occupied by project residents upon completion.

1.05 EXISTING SITE CONDITIONS

A. Existence of Lead-Based Paint

1. All Buildings under this Contract have lead-based paint identified on the exterior components, noted herein.

2. Lead-based paint is either known or assumed to exist on the following components considered for the purposes of this project to be on the exterior of the units:

a. Front and back doors - exterior side
b. Front and back exterior door jambs, casings, and flashing
c. Window troughs, sashes, stops, mullions, casings, headers, and flashing
d. Basement windows
e. Exterior wood siding, trim, soffit and thresholds, molding, skirt
f. Electrical conduit
g. Roof rakeboard and other exterior painted wood components as shown on the drawings
h. Roof drainage system components
i. Bulkheads

j. Brick and Concrete surfaces
k. Exterior railings, guards and balusters
l. Attic vents

B. All renovation activities to remove or strip the components on the exterior of these units shall be performed according to all lead abatement procedures of the specifications and drawings and federal, state and local regulations.

C. It is the intent of the Contract Documents to include the abatement of all exterior components with lead-based paint. Nothing shall be charged back to the Owner for the Contractor's failure to include removal and disposal of all items under the Base Bid and any applicable Add Alternates.

1.06 DEFINITIONS

A. Applicable provisions of the General Conditions and Supplementary Conditions of the Contractor and General Requirements are given in this Section. For the purposes of these Specifications and the Contract:

1. "Owner" shall refer to the owner and its designated, authorized representatives.

2. "Funding Source" shall refer to ____________________________

3. "Contractor" as used in these Contract Documents refers to the General Contractor for the Work under contract with Owner.

4. "Lead Hazard Control Subcontractor" shall refer to the Licensed Lead hazard control Contractor.

5. "Environmental Consultant" shall refer to ____________________________

6. "Architect" and "Landscape Architect" shall refer _______________________

7. "Inspector" shall refer to the on-site licensed lead inspector as employed.

8. "Product" as used in these Contract Documents refers to materials, systems and equipment provided by the Contractor or Subcontractor.

9. "Project Manual" as used in these Contract Documents includes bidding requirements, Conditions of Contract, and Specifications.

10. "Family Unit" as used in these Contract Documents refers to dwelling units known by Owner to be occupied by at least one child under the age of six years at the time of the Contract.

11. The words "shall" or "will" means "must" as used in these Contact Documents.

B. If the Lead Hazard Control Abatement Subcontractor is the General Contractor, the use of the term "Contractor" shall also refer to the "Lead Hazard Control Abatement Subcontractor". If the Lead Hazard Control Abatement Subcontractor is a subcontractor of the General Contractor, the General Contractor shall oversee and be responsible for the work of the Lead Hazard Control Abatement Subcontractor as stated in the drawings and specifications.

C. Owner has retained the Consultant for the purposes of project management during Lead-Based Paint Abatement. The Consultant will represent the Owner in all phases of the lead-based paint abatement project at the discretion of the Owner. The Lead Hazard Control Abatement Subcontractor will regard Consultant’s direction as authoritative and binding as provided herein, in matters particularly but not limited to approval of work areas, review of monitoring results, completion of the various segments of work, final completion of the lead-based paint abatement, submission of data, and daily field punchlist items.

1.07 TENANT COORDINATOR

A. Contractor shall employ, for the duration of the Contract, one Tenant Coordinator who resides at the Development. This Tenant Coordinator shall serve as the contact person between the occupants of the Developments and the Contractor, and shall assist in the coordination of the scheduling.

B. The Owner shall review and approve of the person proposed for employment as the Tenant Coordinator.

C. The Contractor shall pay the Tenant Coordinator for time not to exceed 40 hours per week and shall pay him/her a minimum of $12.00 per hour. This hourly pay rate shall include all insurance and benefits as required by the Owner.

D. The Contractor shall employ the Tenant Coordinator for the time period from the initiation of the Contract to the completion of the Contract. It is estimated that the duration of the Contract will be approximately ten (10) months, or as the Contract Time is specified elsewhere in the bid documents.

E. The cost of the Tenant Coordinator shall be included in the Contract Price. There shall be no additional cost to the Owner for the Tenant Coordinator.

1.08 USE OF THE CONTRACT DOCUMENTS

A. It has been indicated on the Drawings and in the Specifications what existing items are to be removed, what are to remain, and what new work is required to fulfill the intent of the Contract Documents. It shall be incumbent upon the Contractor to visit the Site and determine existing conditions and what will be required to accomplish the Work intended by the Contract Documents. No increase in the Contract Sum will be permitted as a result of the Contractor’s failure to accomplish any or all of the above requirements.

B. An attempt has been made to identify all work related under each Section of the Specifications. It is the Contractor’s responsibility to coordinate with all trades involved irrespective of whether the same are listed under "Related Work".

C. All work shall comply with the Contract Documents and with all applicable Codes, laws, regulations, and ordinances wherever applicable. The most stringent of all the foregoing shall govern.

D. It is not intended that the Drawings and Specifications show every detail of the Work, but the Contractor shall be required to furnish within the Contract Sum all material and labor necessary for the completion of the Work in accordance with the intent of the Drawings and Specifications.

E. In case of ambiguity between any of the Contract Documents, the better quality and/or the greater number will be required.

F. The Drawings are to be understood as diagrammatic and are not intended to be rigid in details where such detail may be in conflict with the recommendations of the manufacturers of equipment to be installed or the requirements of the Work. The Work of this Contract includes making such modifications as may be necessary, subject to approval by the Architect, Consultant, and Owner, to correct such conflicts.

G. Equipment and materials specified herein shall be furnished complete with all features normally provided with such items and any features or accessories required by the special conditions of the Work thereunder performed, whether or not specified or drawn in complete detail. Such equipment or materials shall be subject to the approval of the Architect, and shall in all cases be suited to the purpose for which it is intended and shall bear guarantees and certifications as specified herein or required by law regardless of the manufacturer's standard practice.

H. General Notes appearing on the Drawings are hereby made part of these Specifications. Conflicts between these notes and the Specifications shall be resolved in accordance with the General Conditions, as amended.

I. Drawings shall not be scaled. Field verification is required, since actual conditions may vary from recorded data.

J. Should the Drawings not agree in themselves or not agree with the Specifications, the greater quantity or superior quality of work or materials shall be estimated upon and included in the bid price. The Contractor shall call such discrepancies to the attention of the Architect as soon as they are noted.

K. All items, not specifically mentioned in the Specifications or noted in the Drawings but implied by trade practices to form part of the complete installation, shall be included.

1.09 EXAMINATION OF THE SITE

A. It is understood that the Contractor has examined the Site and made his own estimates of the facilities and difficulties attending the execution of the Work, and has based his price thereon.

B. Except for unforeseeable concealed conditions as determined by the Architect or Consultant, the Contractor shall make no claim for additional cost due to the existing conditions at the site, which, in the opinion of the Architect, with reasonable diligence could have been ascertained by the Contractor in his examination of the Site.

C. In the case of certain materials and work where quantities are not precisely established, the use of Allowances and Unit Prices is intended to establish a cost basis for a certain quantity of work and variations therefrom.

1.10 CONSTRUCTION PROGRESS SCHEDULE

A. To assure adequate planning and execution of the Work, and to assist the Architect and Consultants in appraising the reasonableness of the Contractor's applications for payment, the Contractor shall prepare and maintain a detailed Progress Schedule. This schedule shall be prepared by the Contractor in accordance with requirements stated in Section xxx Scheduling and Phasing of this Specification and be approved by the Architect and Owner prior to the commencement of any work on this project.

B. Schedule of work of this Contract shall include the notification requirement of 5 days prior notification to tenants and regulatory agencies for the work of Section 02080 and 02090 and other related sections. This notice shall be given individually for each apartment and shall not be given all at one time for all the apartments, but a maximum of seven (7) days prior to the start of the work at each apartment.

C. The Contractor shall supervise and direct the work of his and other trades using his best skill and attention. The Contractor shall be solely responsible for all construction means, methods, techniques, sequences and procedures and for coordinating all portions of the work under the Contract.

1.11 TESTING LABORATORY SERVICES

A. Product testing shall meet current UL standards. Contractor shall submit to the Architect the product data as required by Section 01300 or employ a testing laboratory to perform product testing to confirm the use of acceptable materials and methods.

B. Refer to Section XX for testing and analysis of waste generated during the work of this and related sections.

1.12 RUBBISH AND WASTE MATERIAL

A. All rubbish and waste material from the Work shall be neatly stacked or kept in suitable containers and removed regularly from the premises. The premises shall be kept clean and in an orderly condition at all times to the reasonable satisfaction of the Owner, the Consultant and Architect.

B. Frequency of removal shall be made satisfactory to the Architect, Consultant and the Owner. At no time shall waste be removed from the site without the following documentation submitted for approval by Consultant:

1. Waste manifest, as waste is generated and contained for disposal.
2. TCLP Testing results, as required by the specification.
3. Clerk sign-off of a copy of the manifest.

1.13 DELIVERY AND STORAGE

A. Materials for all trades shall be delivered to the job site in manufacturer's original unopened containers with manufacturer's brand name clearly marked thereon.

B. Contractor shall handle and store materials carefully in accordance with manufacturer's recommendations and protect them from moisture and extremes of heat and cold.

C. Copies of Purchase Orders, Shipping Manifests and Bills of Lading shall be available to the Architect and Owner upon request.

1.14 SUBSTANTIAL COMPLETION

A. Interim Substantial Completion dates will be declared according to the following schedule:

1. For work on the exterior of each building, including installation of new materials, as well as any required patching or work on the interior of any unit in that building Interim Substantial Completion will be declared upon completion of the work at each building.

2. For work of this contract, Substantial Completion will be declared upon completion of the entire work of the Contract.

B. In order for an Interim Substantial Completion date to be declared, the applicable submittal requirements of Section XX shall have been met.

C. At the conclusion of the Project, a Final Substantial Completion date will be declared which will constitute acceptance of the project as a whole and which must be achieved within the time allotted for the work of this Contract.

1.15 CLOSE-OUT AND PUNCHLIST

A. Refer to Section XX for additional close-out requirements.

B. The Contractor shall carefully check his own work and that of Subcontractors as the work is being performed. Unsatisfactory work shall be corrected immediately.

C. During the finishing stages of the Project, the Contractor shall make frequent inspections with Subcontractors and the Architect, Project Inspector, Project Monitor, and/or Clerk-of-the-Works (Project Representative) to progressively check for and correct faulty work.

D. When the Contractor determines that the work is substantially complete, that is, has less than one percent of his Contract remaining to be completed, he shall prepare for submissions to the Architect a list of items to be completed or corrected. The failure to include any items on such list does not alter the responsibility of the Contractor to complete all work in accordance with the Contract Documents.

E. Upon receipt of the Contractor’s list of items to be completed or corrected, the Architect and/or Clerk will promptly make a thorough inspection and prepare a "punchlist", setting forth in accurate detail any items on the Contractor’s list and any additional items that are not acceptable.

F. When the "punchlist" has been prepared, the Architect and/or Clerk will arrange a meeting with the Contractor and Subcontractor to identify and explain all punchlist items and answer questions on the work which must be done before final acceptance.

G. If the Contractor gives notice that a Subcontractor has completed his "punchlist" items, the Architect and/or Clerk shall inspect that portion of the work, and, if the items are found to be satisfactorily completed, advise the Contractor accordingly.

H. The General Contractor shall correct all "punchlist" items or shall cause the correction of the "punchlist" items within a time frame to be established when the "punchlist" is made. The time frame for the completion of the "punchlist" shall not exceed the completion date phase of the Contract as agreed to in the project scheduling. Should the "punchlist" not be completed within the specified time frame, the Owner may invoke the rights given under the General Conditions.

I. The Architect shall not be expected to inspect any building more than once to inspect for the preparation of the "punchlist" items, or if fifteen or more distinct deficiencies are discovered by the Architect during such inspections. If, during an inspection under this Paragraph, the Architect does discover fifteen deficient conditions at the building, then the building shall be declared Not Ready for Inspection.

J. For all work associated with each building, all punchlist items shall be complete prior to declaration of Interim Substantial Completion and full-time reoccupancy of the units.

K. All inspections required for lead hazard control compliance will be performed by the Project Monitor and Project Inspector respectively.

1.16 CLEANING

A. Throughout the construction period, maintain the building and site free of rubbish, debris, surplus materials, and other items not required for the construction of the Work. Remove such materials from the site regularly to prevent accumulations. Remove all construction debris from work areas, and remove all hazardous items as required by the most current federal, state and local regulations and the requirements of the specifications. In areas where finish work is being conducted, remove dust, dirt and other matter as required to provide safe and proper working conditions.

B. Final Site Cleaning - At the time of the Architect’s inspection for Substantial Completion, all materials, surfaces, and finishes shall be completely clean to the satisfaction of the Architect. The completed structures shall be left thoroughly clean and ready for occupancy as described in Section XX.

C. Final Unit Cleaning shall occur as described in Section XX. Cleaning activities required for lead hazard control abatement, and selective demolition shall be performed in accordance with the most current federal, state and local regulations and these specifications.

1.17 SETS OF DOCUMENTS FURNISHED

A. In addition to the executed set of Contract Documents, the Owner will furnish six (6) sets of prints of the Contract Documents. The Owner may, on request of the Contractor, provide other sets of the Contract Documents used in the bidding for use of the Contractor on condition that the Contractor shall accept these sets as is, without warrantee from the Owner, and that any marking or notations found on these sets shall have no meaning. The Contractor shall also make arrangements with the Architect to secure and to pay for one set of "wash-off mylar" reproducible Drawings from which the Contractor may make additional prints, at its expense, and which will be used for the Record Documents in accordance with this Section.

B. Contractor will receive a copy of the Lead Paint Inspection reports for the units tested.

C. Contractor will receive a copy of the Asbestos Containing Material Report for the units tested.

1.18 WEEKLY CONSTRUCTION MEETINGS

A. Contractor shall attend weekly project construction meetings throughout the project, to be held at a time convenient to Owner and Contractor.

B. Consultant and/or Architect and Clerk will attend weekly meetings and record the information discussed. Meeting notes will be produced and distributed to all attendees.

C. Contractor shall review and submit, in writing, comments to the Clerk on any disagreements with items or statements in the meeting notes, within five (5) days of the receipt of the meeting notes. The Architect and/or Consultant will review and make changes as applicable.

D. Meeting notes will be made part of the permanent record for the project. Any clarification or changes in the intent or interpretation of the specification documents will be made in writing as discussed in the construction meeting.

E. The following personnel shall attend all construction meetings:

1. General Contractor’s Superintendent
2. Lead Hazard Control Subcontractor’s Supervisor
3. Tenant Coordinator

F. Representatives of any subcontractors shall attend the weekly construction meetings as requested by the Architect and Owner.

1.19 ADDITIONAL GENERAL REQUIREMENTS

A. The Contractor shall employ a competent individual with at least five years rehabilitation experience on similar building types as superintendent who shall be in responsible charge of the work and have full time daily supervision of same.

B. The Lead Hazard Control Subcontractor shall employ a competent Licensed Supervisor with at least three years lead hazard control supervisory experience on projects of similar scope and magnitude who shall be responsible for all work involving lead-based paint abatement as described in the specifications and defined in applicable regulations, and have full-time daily supervision of the same.

C. The Contractor shall allow the work of this contract to be inspected if required by local, state, federal and any other authorities having jurisdiction over such work. Contractor shall immediately notify Owner and Architect and shall maintain written evidence of such inspection for review by the Architect, Consultant and Owner.

D. The Contractor shall obtain the approval of the local fire department, if necessary, for all finish materials, and the use of lead hazard control work area isolation materials.

E. The Contractor shall incur the cost of all fines resulting from regulatory non-compliance as issued by federal, state, and local agencies. Contractor shall incur the cost of all work requirements mandated by federal, state, and local agencies as a result of regulatory noncompliance or negligence.

F. The Contractor shall immediately notify the Consultant and Architect of the delivery of all permits, license, certificates of inspection, of approval, of occupancy, etc., and any other such instruments required under codes by authorities having jurisdiction, regardless of to whom issued, and shall cause them to be displayed to the Consultant and Architect for verification and recording.

G. The Contractor shall submit all drawings, samples, product information, testing results, and all other submittals and information required by the Contract to the Architect who will process the submittals for Consultant, Architect and Owner approval.

H. The Contractor shall supply to the Owner Record Drawings as described in Section XXX.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide and maintain all services, materials, equipment and labor required for the Work of this Section.

B. Comply with all applicable requirements of the Specifications for materials and assemblies required for Work of this Section.

C. Construction and materials required for the Work of this Section and not provided for in the Specifications shall be made acceptable to the Architect and Consultant.

D. Remove from the site all materials and supplies provided in this Section when no longer required.

E. If requested by the Consultant or Architect, submit Record Drawings or Product Data, as applicable, for products used in the work of this Section in accordance with section XX.

END GENERAL CONDITIONS
LEAD-BASED PAINT ABATEMENT SPECIFICATIONS

PART 1 GENERAL

1.0 GENERAL PROVISIONS

A. Attention is directed to the Contract and General Conditions and all Sections within Division 1, General Requirements, which are hereby made a part of this Section of the Specifications.

B. Time, Manner, and Requirements for Submitting Sub-Bids:

1. Sub-Bids for Work under this Section shall be for the complete Work and shall be filed in a sealed envelope with the Owner at a time and place as stipulated in the Notice to Contractors.

The following shall appear on the upper left-hand corner of the envelope:

NAME OF BIDDER: ___________________________
SUB-BID FOR SECTION: Lead Based Paint Abatement

2. Each Sub-Bid submitted for Work under this section shall be on forms furnished by the Owner as required by local law or federal regulations. Sub-Bid forms may be obtained at the office of the Owner, or may be obtained by written or telephone request.

3. Sub-Bids filed with the Owner shall be accompanied by Bid Bond or Cash or Certified Check or a Treasurer's or Cashier's Check issued by a responsible bank or trust company payable to the Owner in the amount of Five Percent (5%) of the Bid. A Sub-Bid accompanied by any other form of Bid Deposit than those specified will be rejected.

C. Reference to Drawings: Work to be performed is shown on Drawings.

1.1 SCOPE OF WORK

A. Summary. Work outlined includes the complete abatement of all exterior lead-based painted building components on xx residential buildings located at the xxx housing site, Any Town, USA. Work is shown on the Hazardous Materials and Selective Demolition drawings. Abatement work is being performed as an integral portion of the overall exterior modernization (housing rehabilitation) of both sites. Strict coordination of all general industry trades, as well as lead-based paint abatement and asbestos removal work will be extremely important.

Abatement work will include, but not be limited to, removal and disposal of exterior trim, windows, doors, canopies, porch lattice, electrical conduit, attic and roof vents, soffits and drainage components. Additional building components requiring abatement will include, but not be limited to, bulkheads, flashing and steel lintels at all masonry openings, porch railings and balusters, and round crawlspace vents. Lead-based paint abatement work will be integrated into the construction work and the asbestos removal work on all buildings.

Removal of lead-based paint-covered exterior trim components, windows, doors, canopies, and drainage components will be closely coordinated with the Asbestos Abatement Subcontractor. Abatement work is being performed as an integral portion of the overall exterior modernization of the sites. Strict coordination of all general industry trades, as well as all subtrades will be extremely important.

Abatement work will include, but not be limited to, removal and disposal of exterior clapboard and wood shingle siding and associated trim, windows, doors, canopies, porch lattice, electrical conduit, attic and roof vents, soffits and drainage components. Additional building components requiring abatement will include, but not be limited to, bulkheads, flashing and steel lintels at all masonry openings, porch railings and balusters, and round crawlspace vents.

1.1.1 Overview. This project is being carried out to eliminate hazards relating to the presence of lead-based paint. The work to be carried out, together with the steps to be taken to adequately protect the workers, assure a safe workplace, and provide for a safe adjoining environment are described in the following section.

1.1.2 Owner's Role. The performance and execution of the project shall be monitored by Owner or Owner's designated representative to ensure full compliance with these Specifications and applicable regulations. Owner will assume the cost associated with the independent laboratory and inspection work required in this Specification for the final clearance testing and random analyses as specifically noted.

1.1.3 Consultant's Authority. The Owner has retained an environmental consultant for the purposes of the management of the Lead-Based Paint Abatement described herein. The Consultant will represent the Owner in all phases of the lead-based paint abatement project at the discretion of the Owner. The Abatement Subcontractor will regard the Consultant's direction as authoritative and binding as provided herein, in matters particularly, but not limited to, the following:

A. Approval of work areas.
B. Review of monitoring results.
C. Completion of the various segments of work.
D. Final completion of lead-based paint abatement.

E. Submission of data.
F. Daily field punchlist items.

1.1.4 Division 1 applicability. The Conditions of the Contract and Division 1, General Requirements shall be part of this Section.

A. Document Review. Contractors shall examine all Drawings and all other Sections of the Specifications for requirements affecting the work of this Section. Questions on interpretations, omissions, and methods should be referred to the Owner.

1.2 GENERAL REQUIREMENTS

1.2.1 Definitions. Applicable provisions of the General Conditions and Supplementary Conditions of the Contract and General Requirements are given in this Section. For the purposes of this Section:

A. Abatement: Means any measure designed to permanently eliminate lead-based paint hazards in accordance with standards established by the EPA Administrator pursuant to Title IV of the Toxic Substances Control Act (TSCA). Abatement strategies include: removal of lead-based paint; enclosure of lead-based paint; encapsulation of lead-based paint (with a product that has been shown to meet standards established or recognized pursuant to Title IV of TSCA); replacement of building components coated by lead-based paint; removal of lead-contaminated dust; removal or covering of lead-contaminated soil with a durable covering (not grass or sod, which are considered interim control measures); as well as all preparation, cleanup, disposal, post-abatement clearance testing, record-keeping, and monitoring (if applicable).

B. Abatement Area: Means the exterior of the building or an area isolated from the building interior by containment.

C. Accessible Surface: Means any surface which is below five (5) feet in height from the floor or ground or is exposed in such a way that a child can come in contact with the surface.

D. Biological Monitoring: Is the analysis of a person's blood to determine the level of lead contamination in the body. Biological monitoring for lead hazard reduction work includes blood sampling and analysis for lead and zinc protoporphyrin levels.

E. Certified Industrial Hygienist: Is a person certified by the American Board of Industrial Hygiene and who has at least four years experience and a graduate degree or five years experience; and who has passed a two-day examination offered by the Board (see also industrial hygienist).

F. Change Room: The area of a worker decontamination facility used for removing protective equipment prior to entering the clean room.

G. Clean Room: The area of a worker decontamination facility used for donning protective equipment and storing street clothes.

H. Code Enforcement Agency: Means the State Lead Poisoning Prevention Program or its agent, or the local board of health or other agency responsible for enforcing the State Sanitary Code or sections thereof.

I. Commissioner: means the Commissioner of Public Health

J. Common Area: Means a room or area that is accessible to more than one tenant in a building (e.g., common hallways, stairwells, laundry rooms).

K. "Consultant": Shall refer to the Environmental Consultant, and its designated, authorized representatives.

L. Containment: Means a process for protecting other workers, residents, and the environment by isolating areas from exposures to lead dust and debris created during abatement in a work area.

M. Decontamination of Personnel: Shall include, at a minimum, HEPA vacuuming of disposable personal protective clothing according to the provisions in 29 CFR 1926.62.

N. Decontamination of Work Areas: Shall be as specified in Section 3.1.

O. Defective Surface: Means peeling, flaking, chalking, scaling, or chipping paint; or, paint over crumbling, cracking, or falling plaster, or plaster with holes in it; paint over a defective or deteriorating substrate; paint that is separating from the substrate; and paint that is damaged in any manner such that a child can be exposed to the paint from the damaged area.

P. Employee: Any person employed or hired by an employer in any lawful employment.

Q. Employer: Any person, firm, corporation, partnership, association, or other entity engaged in a business or providing services, including the State and any of its political subdivisions, or any person acting in the direct interest of any of the foregoing in relation to any employee or place of employment.

R. Elevated Blood Lead Level: In adult workers, means a blood lead concentration equal to or greater than twenty-five (25) micrograms per deciliter (µg/dl) or an increase of ten (10) µg/dl above baseline levels.

S. Enclosure: Means covering surfaces and sealing or caulking with durable materials so as to prevent or control chalking, peeling, or flaking substances containing toxic levels of lead from becoming part of house dust or accessible to children.

T. Entity: Means any person, partnership, firm, association, corporation, sole proprietorship, or any other business concern, state or local government agency or political subdivision or authority thereof, or any religious, social, or union organization, whether operated for profit or otherwise.

U. "General Trades Contractor": Shall refer to the contractor responsible for coordination of all filed sub-bids and general construction.

V. Hazardous Level of Lead for Waste Disposal: Is 5.0 parts per million (ppm) as defined by RCRA Toxicity Characteristic Leachate Procedure (TCLP) or other requirement set by local or state authorities.

W. High Efficiency Particulate Air (HEPA) Filter: Means a type of filtering system capable of filtering out particles of 0.3 microns or greater diameter from a body of air at 99.97% efficiency or greater.

X. High Phosphate Detergent: Is detergent which contains at least five percent (5%) tri-sodium phosphate (TSP) or other equally effective cleaning agent.

AA. Intact Surface: Means a defect-free surface with no loose, peeling, chipping, or flaking paint. Painted surfaces must be free from crumbling, cracking, or falling plaster and must not have holes in them. Intact surfaces are not damaged in any way.

BB. Lead-based: Refers to paints, glazes, and other surface coverings containing a toxic level of lead.

CC. "Owner": Shall refer to the Owner and its designated, authorized representatives.

DD. Paint Removal: Means a strategy of abatement which entails stripping lead paint from surfaces.

EE. Qualified Abatement Subcontractor: A sub-contractor capable of providing a properly trained and equipped work force for abatement work. All workers employees to perform abatement activities shall have successfully completed a minimum of 24 hours of training in the potential hazards of abating lead based paint. Abatement contractors must possess the appropriate license or certification from the State or local government.

FF. Removal: Means a strategy of abatement which entails the removal of components, such as windows, doors, and trim that contain toxic levels of lead such that new components which are lead free may be installed.

GG. "Subcontractor": Shall refer to the Abatement Contractor.

HH. Toxic Level of Lead in Surface Coatings: Is 1.0 milligrams or more per square centimeter (mg/cm^2) by XRF methods or 5,000 µg/g (0.5%) by laboratory testing, as defined in HUD Regulation and the Lead-Based Paint Poisoning Prevention Act.

II. Toxicity Characteristic Leachate Procedure (TCLP): Is the EPA required sample preparation for determining the hazard characteristic of a waste generated at a lead abatement site.

JJ. "Wet Wall": Shall refer to walls which contain plumbing fixtures and/or pipes, including both supply and sanitary lines;

1.3 APPLICABLE DOCUMENTS/REFERENCES

1.3.1 Safety Regulations. The following are some applicable Federal regulations:

Occupational Safety and Health Administration

29 CFR 1910	General Industry Standards
29 CFR 1910.1025	Lead Standard for General Industry
29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1200	Hazard Communication
29 CFR 1910.245	Specifications for Accident Prevention (Sign and Tags)
29 CFR 1926	Construction Industry Standards
29 CFR 1926.62	Construction Industry Lead Standard

Environmental Protection Agency

40 CFR Part 261	United States Environmental Protection Agency Regulations

Department of Housing and Urban Development

24 CFR Parts 35, 36, 37	HUD Lead-Based Paint Regulations

HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing

1.3.2 Codes and Standards. All work shall conform to the standards set by applicable federal, state and local laws, regulations, ordinances, and guidelines in such form in which they exist at the time of the work on the contract and as may be required by subsequent regulations including the following:

A. ASTM - American Society for Testing Materials.

B. ANSI - American National Standards Institute.

1. ANSI Z288.2-8 Practices for Respiratory Protection

2. ANSI Z9.2 1979 Fundamentals Governing the Design and Operation of Local Exhaust Systems.

C. U.L. - Underwriters Laboratories, Inc.

1.3.3 Abatement Regulations and Guidelines. In addition to any detailed requirements of the Specifications, the Abatement Subcontractor shall, at his own cost and expense, comply with all laws, ordinances, rules, and regulations of federal, state, regional and local authorities regarding handling and storing of lead waste material. The Contractor and Subcontractor must also comply with the provisions of the HUD Guidelines for the Evaluation and Control and Lead-Based Paint Hazards in Housing

1.3.4. Abatement Subcontractor's Responsibility

A. All regulations by the above and other governing agencies in their most current version are applicable throughout this project. Where there is a conflict between this Specification and the cited federal, state or local regulations or guidelines, the more restrictive or stringent requirements shall prevail. This Section refers to many requirements found in these references, but in no way is it intended to cite or reiterate all provisions therein or elsewhere. It is the Abatement Subcontractor's responsibility to know, understand, and abide by all such regulations, guidelines and common practices.

1.4 Abatement SUBCONTRACTOR

1.4.1 Qualification Criteria. The Owner requests that documentation be provided for all aspects of the work at the Bid opening detailing the firm's qualifications on the following criteria:

A. License Requirements. Firm(s) shall be qualified to perform abatement operations as defined by the HUD Guidelines and Local Law and have workers and supervisors who have successfully completed training courses covering abatement issues. This course shall cover all topics required by HUD, EPA and Local Law. These topics should include, but not be limited to, the following:

1. Toxicity of Lead
2. How Can I Protect Myself? (Respirators, Personal Protective Equipment and Decontamination Procedures)
3. Other Chemical and Safety Hazards
4. Using Tools
5. Completing the Project
6. Role of the Inspector
7. Lead in Construction and Abatement
8. Monitoring and Medical Removal
9. Signs and Labels
10. Preparing the Work Area
11. Cleanup: How and Why
12. Clearance
13. Worker Responsibilities

All Contractors are also advised that licenses in other trades may be required. The Subcontractors are responsible for insuring that all licensing requirements for appropriate trades and procedures are met.

B. Demonstrated Ability of Workers. Firm(s) must demonstrate that they have (or will have) a sufficient number of trained abatement workers who have successfully completed training in accordance with the topics listed above to complete all aspects of work covered in this Specification.

C. Previous Experience

1) Abatement Subcontractor. The Abatement Subcontractor for abatement must have successfully completed at least three abatement projects involving all requirements elements of abatement work, including worker protection, medical monitoring, work area preparation, clean-up and clearance, valued at a minimum of one hundred thousand dollars ($100,000.00) for each project.

2) <u>Abatement Subcontractors</u>. If a Subcontractor for caustic paste, needlegun and pre-fabricated metal window wraps or other subtask in the abatement process will be used, the Subcontractor must be identified by name and contract amount on the bid form. If the Abatement Subcontractor plans to do this work, the firm's name and amount must be entered on the bid form. If the General Contractor plans to do this work, the firm's name <u>must</u> be entered in on the bid form, but the contract amount must be left blank.

1.4.2 <u>Insurance</u>

The following insurance requirements may not be obtainable in all areas and may need to be relaxed depending on availability.

A. Prior to the start of work, the Abatement Subcontractor will secure and maintain, the following insurance.

Workers compensation and employers liability insurance subject to the laws of the state of _______. Such insurance shall include "All States and Voluntary endorsements as well as other endorsements that may be required by applicable jurisdictions.

Workers Compensation Limit	Statutory
Employers Liability Limit	$100,000/person

Abatement liability policy including completed operations liability. The completed operations liability will extend for a minimum period of five years beyond completion of the abatement work. The Abatement contractor will be issued an occurrence policy with a minimum limit of $500,000 per occurrence and $1,000,000 aggregate.

Commercial general liability insurance insuring bodily injury, personal injury, and property damage with a combined single limit of $500,000 each occurrence and $1,000,000 aggregate including contractual liability and contractors protective liability.

Automobile bodily and property damage liability insurance, covering all owned and non-owned automobiles, with a minimum of $500,000 combined single limit per accident. Such insurance shall include the transportation of any hazardous material generated from the abatement work.

B. The Abatement contractor shall required its insurer(s) to waive all rights of subrogation against the Owner, Project Manager, Consultant, Architect and Engineer and all other contractors and their directors, officers and employees with respect to work or operations in connection with this abatement project. The policy(ies) shall be endorsed to name the Owner, as additional insured with respect to claims or injury arising from the work or operations for this abatement project.

C. The Abatement Contractor shall, prior to commencement of work at this project, furnish evidence of the insurance required above to the Owner. The abatement Contractor shall also provide proof of workers compensation, employers liability automobile liability and abatement liability insurance covering the operations related to this project. The required proof should be provided in the form of the ACCORD insurance certificate and the certificate shall provide for 30 days notice to the Owner of any material reduction in coverage.

D. Abatement Subcontractor shall indemnify, hold harmless, and defend the Owner and the Consultant and any of its affiliates, partially or wholly owner entities, and any of their agents, employees, or officers (hereinafter referred to as "Releases") from and against any and all losses, claims judgements, including legal fees and expenses, of any and every nature and description brought or recoverable against Abatement Subcontractor or Releases by reason of any act, intentional or otherwise, or employees, arising directly or indirectly from the nature of the work covered by this Agreement, including but not limited to, the removal, handling and disposal of hazardous material.

1.5 SPECIFIC ABATEMENT SUB-CONTRACTOR RESPONSIBILITIES

1.5.1 Notifications/Approvals

1. Provide in proper and timely fashion all necessary notifications to relevant Federal, State and local authorities and obtain and comply with the provisions of all permits or applications required by the work specified, as well as make all required submittals required under those auspices. The Abatement Subcontractor shall indemnify the Owner, Architect and Consultant from, and pay for all claims resulting from, failure to adhere to these provisions. The costs for all permits, applications, and the like, are to be borne by the Abatement Subcontractor. For each apartment, the Abatement Subcontractor shall notify in writing the following agencies, five (5) days prior to the date abatement will begin (in accordance with Local Law) and shall provide evidence of notifications to the Owner and General Trades Contractor at the preconstruction conference and on site at all times:

a. Certification or Licensing State Agency
b. Department of Public Health Childhood Lead Poisoning Prevention Program
c. Occupants of the Dwelling Unit to be abated and occupants of the Building to undergo abatement activities, in conjunction with Owner.

1.5.2 Fees, Permits and Licenses

A) The Abatement Subcontractor shall pay all licensing fees, royalties, and other costs necessary for the use of any copyrighted or patented product, design, invention, or processing the performance of the job specified in this Section. The Abatement Subcontractor shall be solely responsible for costs, damages or losses resulting from any infringement of these patent rights or copyrights. The Abatement Subcontractor shall hold the Owner, Architect and the Consultant harmless from any costs, damages, and losses resulting from any infringement of these patent rights or copyrights. If the Contract Specification requests the use of any product, design, invention, or process that requires a licensing fee or royalty fee for use in the performance of the job, the Abatement Subcontractor shall be responsible for the fee or royalty and shall disclose the existence of such rights.

B) <u>Applications and Permits</u>. The Abatement Subcontractor shall make all applicable and necessary notifications (in proper and timely fashion) to relevant federal, state, and local authorities and shall obtain and comply with the provisions of all permits or applications required by the work specified, as well as make all required submittals required under those auspices. The Abatement Subcontractor shall indemnify the Owner, Architect and Consultant from, and pay for all claims resulting from failure to adhere to these provisions. The costs for all permits, applications, and the like, are to be assumed by the Abatement Subcontractor.

C) The Abatement Subcontractor shall be responsible for securing all necessary permits for work under this Section, including hauling, removal, and disposal, fire, and materials usage, or any other permits required to perform the specified work.

1.5.3 <u>Coordination/Cooperation</u>. The Abatement Subcontractor shall meet with the Architect, Owner, and Consultant for a Pre-Construction meeting prior to commencing work on the project. The meeting shall be at the facility of Owner at a mutually convenient time and date to be determined by the Owner and Consultant. At the meeting, the Abatement Subcontractor shall be represented by authorized representatives and the field supervisors who shall run the project on a daily basis, and shall present evidence that <u>all</u> requirements for initiation of the work have been met. The minimum agenda for the meeting shall be:

A) Channels of communication;
B) Construction schedule, including sequence of critical work;
C) Designation of responsible personnel;
D) Procedures for safety, security, quality control, housekeeping, and related matters;
E) Use of premises, facilities and utilities;
F) Review of "Pre-Job Submittals;" and
G) Discussion of a detailed Project Specification Work Plan composed of at least the following:

- A sketch showing the detail, location and layout of the clean area, the dirty area (Decon System) and the work area.
- The sequencing of the work.
- The timing and projected completion of the work.
- Detailed description of the method to be employed in order to control airborne and waste water pollution.
- The type of equipment and amount of equipment available to the Abatement Subcontractor to be used on the project, including HEPA vacuums, etc.
- The procedures to contain, package and remove the waste from the work area and the procedures and locations of the disposal of hazardous and non-hazardous waste.
- An air sampling plan which includes:

    - Air sampling training and strategy, sampling locations, projected number of samples; and frequency, methodology, and duration of sampling.
- The type of respirators to be used, protective equipment to be used, and a respirator

program, if applicable.

- A safety precautions plan may include special precautions taken by the Abatement Sub or Subcontractors in performing their respective tasks, safety equipment to be worn by employees, frequency of safety meetings, and all other relevant functions to be performed by the abatement Contractors to ensure a safe workplace.
- Any other data that enhances this work plan. Innovative ideas and/or technology are encouraged.

1.5.4 <u>Documentation/Submittals</u>

A) <u>Pre-Abatement/Job</u>. The Abatement Subcontractor shall provide three (3) copies of the following Pre-Job Submittals at the Pre-Construction Conference for the acceptance of the Owner:

1) Copies of all notifications, permits, applications, licenses and like documents required by federal, state, or local regulations obtained or submitted in proper fashion.

2) Copies of medical records, including lead blood level monitoring data and a notarized statement by the examining medical doctor that such examinations took place, and when, for each employee to be used on the project.

3) Copies of Contractor's certificates, licenses, and copies of each supervisor's license and workers' certificates

4) Record of successful respirator fit testing performed by a qualified individual within the previous six months, for each employee to be used on this project with the employee's name and social security number with each record;

5) Proposed respiratory protection program for employees throughout all phases of the job, including make, model and NIOSH approval numbers of respirators to be used;

6) A detailed Project Specification Work Plan as described in Section 3.1.1.

7) Written description, for the Owner's review and acceptance, of all proposed procedures, methods, or equipment to be utilized that differ from the Contract Specifications, including manufacturers specifications on any equipment not specified for use by this Section; in all instances, the Subcontractor must comply with all applicable federal, state and local regulations.

8) Proposed electrical safeguards to be implemented by qualified Electrical Subcontractor, including but not limited to location of transformers, GFCI outlets, lighting, and power panels necessary to safely perform the job, including a description of electrical hazards safety plan for common practices in the work area.

9) Proposed worker orientation plan which at a minimum includes a description of lead hazards and abatement methodologies, a review of worker protection requirements, and the outline of safety procedures.

10) Chain-of-Command of responsibility at work site including supervisors, foreman, and competent person, their names, resumes and certificates of training.

11) List of all supervisors and workers intended to be assigned to the project.

12) Proposed Emergency Plan and route of egress from work areas in case of fire or injury, including the name and phone number of nearest medical assistance center. This shall be conspicuously posted at the work site.

13) The name and address of Abatement Subcontractor's blood lead testing lab, OSHA-CDC listing, and Certification in the state where work site is located.

14) The name and address of Abatement Subcontractor's personal air monitoring and waste disposal lead testing laboratory(ies) including certification(s) of accreditation for lead in the EPA National Lead Laboratory Accreditation Program, listing of relevant experience in air and debris lead analysis, and presentation of a documented Quality Assurance and Quality Control Program.

15) Material Safety Data Sheets (MSDS) on all materials and chemicals to be used on the project.

16) Name, address, and ID number of the hazardous waste hauler, waste transfer route, and proposed disposal site.

17) Name, address, and ID number of the proposed construction debris site.

18) Proposed heating system to be employed.

B) <u>During Job</u>. The Abatement Subcontractor is required to submit to the Owner and Consultant, a weekly status report including:

1) Number of buildings started
2) Number of buildings completed awaiting test results
3) Number of buildings failing clearance
4) Number of buildings passing clearance
5) Results from personal air samples
6) Results from TCLP testing
7) Results from other testing
8) Quantity of materials used during the abatement process. (Tyvek suits, poly, chemical, etc.)
9) Any other relevant data as requested by the Owner.
10) Medical, license, and Respirator Fit Test 24 hours in advance of any new employees starting on the project.

C) <u>Post-abatement</u>. The Abatement Subcontractor is required to submit to the Owner the following at a Post-Construction conference:

1) Copies of manifests and receipts acknowledging disposal of all hazardous and non-hazardous waste material from the project showing delivery date, quantity, and appropriate signature of landfill's authorized representative.

2) A notarized copy of the entry-exit logbook.
3) All personal monitoring results.
4) All TCLP test results.

1.6 PERSONAL PROTECTION

Respiratory Protection/Protective Clothing

A. Prior to commencing all work, all workers shall be instructed in all aspects of personnel protection, work procedures, emergency evacuation procedures and use of equipment including procedures unique to this project.

B. Respiratory protection shall meet the requirements of OSHA as presented in 29 CFR 1910.134 titled "Respiratory Protection" and 29 CFR 1926.62 titled "Lead in Construction." The protection factors shown in 29 CFR 1926.62 shall be used for this project.

C. Abatement Subcontractor shall provide appropriate respiratory protection equipment for each worker and ensure usage during potential lead exposure.

D. Abatement Subcontractor shall select respirators from among those jointly approved as being acceptable for protection by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

E. Abatement Subcontractor shall have adequate supply of HEPA filter elements or other necessary filter elements and spare parts on site for respirators in use.

Respiratory Protection Requirements

1. The Qualified Abatement Subcontractor shall provide respirators and all necessary maintenance materials at no cost to the employees. Employees shall wear the following respirators at all times while abatement work is underway or while present in the work area.

(a) For use while sanding, scraping or stripping with a heat gun, the minimum required respirator shall be the half-mask, air-purifying respirator equipped with HEPA filters or a powered, air-purifying respirator with high efficiency filters or the half mask supplied-air respirator operated in the positive-pressure mode, if required under local law.

(b) For use with caustics or in replacement, the minimum required respirator shall be the half-mask, air-purifying respirator equipped with high efficiency filters. Whenever a chemical preparation is used in conjunction with a mechanical or powered technique, the use of an additional combination cartridge, appropriate to the exposure, shall be used unless a supplied-air respirator is used.

(c) For use during removal or demolition of components with surfaces covered with lead-based paint, the minimum required respirator shall be the half-mask, air purifying respirator equipped with high efficiency filters.

1.7 SEQUENCING AND SCHEDULING

1.7.1 Work/Scheduling Requirements. Work shall be carried out in sequential phases. Inspection and approval of each phase by the Consultant shall be sought and gained before proceeding to the next phase and in accordance with the schedule agreed upon by Owner at the Pre-Construction meeting as amended. As a Contract requirement, any reasonable delay caused by this requirement will not constitute a basis for claim against the Owner or Consultant.

1.7.2 Job Sequences

A) The Abatement Subcontractor shall extend full cooperation to Owner in all matters involving the use of Owner's facilities. At no time shall the Abatement Subcontractor cause or allow to be caused conditions which may cause risk or hazard to the general public or conditions that might impair safe use of the facility. The use of the facility's electricity, water or like utilities by the Abatement Subcontractor shall be coordinated through the Owner.

B) The Abatement Subcontractor shall submit a time-line schedule, not date specific, to Owner and Consultant for integration into the overall project schedule. Coordinate the work of this section with that of all other trades. Phasing and scheduling of this project will be at the discretion of the Owner and Consultant and shall not proceed in any area without the express consent of the Owner and Consultant. The Abatement Subcontractor shall be available within 24 hours notice for additional work or rework if after acceptance of the work it is found that full abatement or clearance was not achieved from the initial work effort as determined by the Owner and Consultant.

It shall be understood by the Abatement Subcontractor that this project is being done on a building-by-building basis and delays between each building should be anticipated since the General Contractor must complete installation of the new electrical service conduit prior to starting a new building.

C) The proposed time line for the work in this Section, as noted above, shall show the time involved from start to finish of abatement operations, including preparation, removal, clean-up, and tear-down portions of the job.

D) A final written schedule shall be prepared for approval by the Owner and the Consultant.

1.7.3 Working Hours. Refer to Division 1 General Requirements Section 01020 1.02 for specific requirements.

A) The work in this Section shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Abatement Subcontractor shall cooperate with the Owner, Consultant, General Contractor, and sub-contractors and equipment suppliers working on the site, coordinate the work with them and proceed in a manner so as not to delay the progress of the project.

B) The Abatement Subcontractor shall coordinate the work with the progress of the work of other trades so that the work shall be completed as soon as conditions permit. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with General Contractor or other trades of the General Contractor by the Abatement Subcontractor shall be assumed by the Abatement Subcontractor without any additional cost to the Owner.

C) Any costs associated with repeated cleaning due to a failure to achieve clearance shall be borne by the Abatement Subcontractor without any additional cost to the Owner.

PART 2 PRODUCTS

2.1 SUBSTITUTION OF MATERIALS AND/OR METHODS

A. Any substitution in materials or methods to those specified shall be approved by the Consultant and Owner **prior** to use. Any requests for substitution shall be provided in writing to the Consultant and the Owner. The request shall clearly state the rationale for the substitution.

B. Submit to the Consultant and the Owner product data and samples of all materials to be considered as an alternate.

C. Product data shall consist of manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations, material safety data sheets (MSDS) and other standard descriptive data. Submittal data shall be clearly marked to identify pertinent materials, products or models and show performance characteristics and capacities. Samples shall be of sufficient size and quantity to clearly illustrate the functional characteristics of the product or material with integrally related parts and attachment devices.

D. No work shall begin which requires submittal for approval until the consultant has "approved" or "approved as noted" the submittal.

2.2 INTRODUCTION

2.2.1 Materials and Equipment

A. The work of this Section, without limiting the generality thereof, includes the furnishing of labor, materials, tools, equipment, services and incidentals necessary to complete all Lead Based Paint Abatement in accordance with the Plans and Specifications. These Plans and Specifications are intended to describe, and provide for a finished and complete piece of work; work which is described by any portion of these documents shall be complete in every detail and in accordance with established trade practice, notwithstanding whether or not every item or detail necessarily involved is particularly mentioned.

B. <u>Approvals and Inspections</u>. All temporary facilities, work procedures, equipment, materials, services, and agreements must strictly adhere to and meet this Section along with EPA, OSHA, NIOSH, HUD regulations recommendations, and guidelines, as well as any other federal state, and local regulations. Where there exists an overlap of these regulations and guidelines, the most stringent one applies. All work performed by the Abatement Subcontractor is further subject to approval of the Owner, and/or Consultant.

2.2.2 Materials

A. Deliver all materials in the original packages, containers, or bundles bearing the name of the manufacturer and the brand name and product technical description.

B. Damaged or deteriorating materials shall not be used and shall be removed from the premises.

C. Polyethylene sheet in a roll size to minimize the frequency of joints shall be delivered to job site with factory label indicating 6 mil.

D. Polyethylene disposable bags shall be six (6) mil with pre-printed label. Tie wraps for bags shall be plastic, five (5) inches long (minimum), pointed and looped to secure filled plastic bags.

E. Tape or adhesive spray will be capable of sealing joints in adjacent polyethylene sheets and for attachment of polyethylene sheet to finished or unfinished surfaces of dissimilar materials and capable of adhering under both dry and wet conditions, including use of amended water.

F. Impermeable containers are to be used to receive and retain any lead containing or contaminated materials until disposal at an acceptable disposal site. (The containers shall be labeled in accordance with EPA and DOT standards.

G. HEPA filtered exhaust systems shall be used during any dust generating abatement operations.

H. All caustics shall be properly labeled and containerized in leak-tight containers.

I. Machine Sanding Equipment - Sanders shall be of the dual action, rotary action, orbital or straight line system type, fitted with a high efficiency particulate air (HEPA) dust pick-up system.

Air compressors utilized to operate this equipment shall be designed to continuously provide 90 to 110 p.s.i. or as recommended by the manufacturer.

J. Heat Blower Gun Equipment - Electrically-operated, heat-blower gun shall be a flameless electrical paint softener type. Heat-blower shall have electronically controlled temperature settings to allow usage below a temperature of 1,100 degrees Fahrenheit. Heat-blower shall be DI type (non-grounded) 120 V, AC application. Heat-blower shall be equipped with various nozzles to cover all common applications (cone, fan, glass protector, spoon reflector, etc.).

K. Chemical Stripping Removers - Chemical removers shall contain no methylene chloride products. Chemical removers shall be compatible with, and not harmful to the substrate that they are applied to. Chemical removers used on masonry surfaces shall contain anti-stain formulation that inhibits discoloration of stone, granite, brick and other masonry construction. Chemical removers used on interior surfaces shall not raise or discolor the surface being abated.

L. Chemical Stripping Agent Neutralizer - Chemical stripping agent neutralizers may be used on exterior surfaces only. Neutralizers shall be compatible with and not harmful to the substrate that they are applied to. Neutralizers shall be compatible with the stripping agent that has been applied to the surface substrate.

2.2.3 TOOLS AND EQUIPMENT

A. Provide suitable tools for all abatement operations.

B. The Abatement Subcontractor shall have available sufficient inventory or dated purchase orders for materials necessary for the job including protective clothing, respirators, filter cartridges, polyethylene sheeting of proper size and thickness, tape, and air filters.

C. The Abatement Subcontractor shall have available power cables or sources such as generators (where required).

D. Vacuum units, of suitable size and capacities for project, shall have HEPA filter(s) capable of trapping and retaining at least 99.97% of all monodispersed particles of 0.3 micrometers in diameter.

E. The Abatement Subcontractor will have reserve units so that the station system will operate continuously.

PART 3 - EXECUTION

3.0 LOCATION AND WORK STATEMENT

The site for abatement and locations of the effected buildings are described in the summary of work. The Abatement Subcontractor shall retain full ownership of all lead waste and construction waste generated during abatement procedures outlined in this specification. Specific work locations and component schedules are listed on Drawings as well as the locations listed below.

3.01 Exterior Component Abatement Schedules and Locations

A. Gutters and Downspouts. Gutters, downspouts, and associated hardware shall be removed from all residential buildings.

B. Drainage Boots. Drainage boots shall be removed from all residential buildings with the exception of the following buildings:

C. Exterior Trim Components. Exterior trim components shall be removed from all residential buildings at both sites. These components shall include the following:

1. Facia Board
2. Rake Board

3. Corner Board
4. Freeze Board
5. Skirt Board
6. Miscellaneous Trim

D. Siding. Exterior siding material shall be removed from the following buildings in Alternate Bid #1 only:

E. Canopies. The following list of canopy components shall be removed from all residential buildings at both sites. These components include:

1. Asphalt shingles
2. Building felt paper
3. Aluminum drip edge
4. Fascia boards
5. Rake boards
6. Soffits
7. Wood siding
8. Moldings
9. Flashing

F. Window Components. All window components shall be removed from all residential buildings at both sites (see Drawing) These components shall include the following:

1. Window sashes
2. Window trough casings
3. Window stops
4. Basement windows
5. Flashing
6. Caulks and Sealants
7. Storms and Screens

G. Door Components. All exterior door components shall be removed from all residential buildings at both sites. (See Drawing) These components include the following:

1. Doors
2. Door jambs and headers
3. Exterior casings
4. Interior casings
5. Thresholds
6. Flashing
7. Caulks and Sealants
8. Storms and Screens

H. Attic Vents. All exterior attic vents and associated trim shall be removed from all residential buildings. (See Drawing) These components include:

1. Louvre vents
2. Associated trim components
3. Screens
4. Flashing

K. Electrical Conduit. All electrical conduits associated with lead-based painted wood surfaces only are to be removed from all residential buildings.

L. Bulkheads. Existing flashing at all bulkheads is to be removed and disposed.

M. Stripping. On-site stripping of the following exterior components containing lead-based paint:

1. Bulkheads
2. Flashing and steel lintels at all brick masonry openings
3. Round crawlspace vents
4. Drainage system boots
5. Splattered paint on concrete and brick surfaces as designated by on-site testing
6. Exterior railings, guards, and balusters, as shown on pages 79 through 95.
7. Flashing at canopies on brick walls
8. Flashing at triangular louvre units

3.1 WORK AREA SET UP

3.1.1 General

A. Site Safety. The Abatement Subcontractor is responsible for all safety at the work site. This includes, but is not limited to electrical safety, mechanical (tool) safety, fire safety, and personnel protective safety. Safety requirements are, for the most part, common sense and sound business practice; however, the Abatement Subcontractor is advised that federal, state and local regulations exist which govern safety on the work site. Therefore, in addition to the following, the Abatement Subcontractor is responsible for adhering to the most stringent requirements in affect by any of the following entities or these Specifications.

1. A primary concern in this type of work is to ensure that adequate exits exist in the event of an emergency and conversely, that adequate entrances exist for emergency personnel. The nature of this work requires sealing entrances and the extensive use of six-mil polyethylene sheeting; however, the Abatement Subcontractor should never permanently seal (i.e., nail, bolt, hard cover) any potential escape exits and should take extra care to clearly identify potential exits and inform the workers.

B. WORK SITE SAFETY PLAN

Prior to the initiation of the abatement work, the following tasks must be completed by the Contractor:

The Abatement Subcontractor shall establish a work site safety plan which includes a set of emergency procedures and shall post them in a conspicuous place at the work site. The safety plan should include provisions for the following:

1) Evacuation of injured workers
2) Emergency and fire exit routes from all work areas, including local telephone numbers for fire and medical emergency personnel
3) Copies of applicable insurance certificates
4) Employee work logs

The Abatement Subcontractor is responsible for training all workers in safety procedures. At a minimum, one employee on site shall be trained and certified in basic first aid by the American Red Cross or equivalent. A general first aid kit may be maintained in the containment for treating minor medical problems.

C. Access to Work Areas

1. The Owner will provide specific access as required during the project to the Abatement Subcontractor and personnel assigned to the project. The Abatement Subcontractor will be responsible for the security of each building or portion thereof involved in the abatement project. It will also be the Abatement Subcontractor's responsibility to allow only authorized personnel as defined below in Section 3.5 into the work area, and to secure all assigned entrances and exits at the end of the work day so as to prevent unauthorized entry.

2. The Abatement Subcontractor shall maintain a bound log book in which any person entering or leaving the lead abatement work area must sign and enter the dates and times of entry and departure.

3. Use of waste containers on-site shall be controlled under the following requirements:

(a) Location of waste containers on-site shall be coordinated with the Owner and Consultant.
(b) The waste containers shall be solid enclosed containers, lined with two layers of six-mil polyethylene sheeting and locked and secured at all times.

(c) The Abatement Subcontractor shall comply with all federal, state and local regulations and ordinances regarding lead waste storage.

4. The Abatement Subcontractor, supervisor will not allow anyone access to the dwelling unless they have successfully passed an approved training program.

3.1.3 Exterior Abatement Preparation

A. Prior to the commencement of any abatement procedures, notification requirements must be met; required signs shall be posted and moveable objects shall be moved a minimum of four feet from the perimeter walls of the room.

B. Pre-abatement work shall be performed prior to any abatement or component removal commencing on each side of the building.

C. Decontamination Unit. At a minimum, the Abatement Subcontractor shall construct a two-stage decontamination unit. This unit shall be directly adjacent to the abatement area for the decontamination of workers contaminated with lead. The decontamination unit shall consist of an equipment room, dirty room, and wash area in series. The Contractor shall ensure that employees use the worker decontamination chamber prior to leaving the work area.

1. The decontamination unit shall be constructed with six-mil polyethylene sheeting on floors, walls and ceiling. Doors through this unit shall be constructed as described in paragraph 7, above.

D. Clean Area. The Abatement Subcontractor shall select a clean area outside the abatement area for the workers to change into protective equipment. This area shall contain warm water hand washing facilities (potable water), clean cloths, storage for a HEPA vacuum, and respirator storage space. Table, chairs and a rest facility shall also be available at this location. Contaminated equipment or personnel shall not be permitted in this area.

E. Abatement Area.

1. The Abatement Subcontractor shall pre-clean all surfaces with a HEPA vacuum and protect occupants' belongings by covering with one layer of six mil polyethylene and have joints taped. All debris gathered during this clean-up shall be disposed of properly. In addition, any existing loose paint or paint bearing materials found in the buildings are to be assumed hazardous and packaged and disposed of properly. The amount of the material should be estimated during the pre-bid walkthrough.

2. For exterior work, the Abatement Subcontractor shall prepare the area as follows:

a) Doors and Windows: Doors and windows on the side of the building upon which a dust-generating method is being used, and on the same floor and all floors below, must be closed and covered with six-mil thick polyethylene sheeting.

b) Plants and Ground: The ground and any plants or shrubs in the area in which exterior abatement is occurring shall be covered with a waterproof canvas tarp and weighted at all edges so as to prevent blowing. Such covering shall cover from the side of the structure to a point at least eight feet away from the structure. The covering shall be taped or otherwise attached to the structure.

(1) The waterproof canvas tarp shall always be placed in a manner that traps all debris and water. This is best accomplished by elevating the edges.

(2) The waterproof canvas tarp shall be properly disposed of and not re-used.

3. Special Areas. Any abatement project being performed on any structure other than a building shall be arranged, equipped and operated in a manner which will eliminate the possibility of lead contaminants or lead contaminated materials escaping from the work area.

a) The Abatement Subcontractor shall maintain polyethylene barriers, and a clean area as long as needed for the safe and proper completion of the work. Any openings or tears in the work area barriers shall be corrected by the Abatement Subcontractor at the beginning of each work day and as necessary during the workday with such openings or tears reported immediately to the Owner. Work will not be allowed to commence until all barriers are in place and acceptable to the Consultant.

4. Barriers shall not be removed until the work areas are thoroughly cleaned, and the area approved by the Consultant. All debris must be properly bagged and removed from work areas, and the lead surface wipe samples must have passed final clearance tests, in accordance with provisions detailed in the Specification prior to barrier removal.

5. At the Owner's and Consultant's approval, the Abatement Subcontractor may utilize a portable mini-isolation chamber to create an isolated work area around single components to be removed. This chamber shall still be equipped with an adjacent clean room, and become an isolated work area sealed at all seams to where it is attached to adjacent surfaces. It shall also satisfy all requirements for a work area and satisfy all clearance criteria, as identified in this Section and Local Law.

G. <u>Signs</u>. Prior to the preparation of a dwelling for abatement, the Abatement Subcontractor shall place warning signs immediately outside all entrances and exits to the dwelling, warning that abatement work is being conducted in the vicinity. The signs shall be at least 20" x 14" and read:

WARNING:
LEAD PAINT REMOVAL HAZARD
UNAUTHORIZED ENTRY PROHIBITED
NO SMOKING, EATING OR DRINKING ALLOWED IN THE WORK AREA

Signs shall be in bold lettering with lettering not smaller than two inches tall.

H. Construct and maintain suitable polyethylene barriers within the building to isolate the exterior work area from the interior of the building.

I. The polyethylene barriers termed "critical barriers" for the removal of windows shall consist of the following:

1. Pre-Clean all interior window surfaces with a HEPA-equipped vacuum.

2. Seal duct tape lip to inner most sill, casing and header surfaces of the window.

3. Seal two layers of six mil polyethylene sheeting from the duct tape lip on the inside sill of the dwelling unit window and extend up to the inside surface of the top interior casing. The first layer of sheeting applied shall be sealed to the inside faces of the window casing. The polyethylene sheeting shall be sealed to a piece of three-inch wide duct tape forming a lip attached to the interior window perimeter of the window casing. Refer to Diagram.

4. There shall be no cavity in the polyethylene sheeting created that would allow lead dust to accumulate, which cannot be removed with HEPA vacuuming. This shall allow for

removal of this polyethylene sheeting from the exterior of the building, without the generation of lead dust, once the window is removed and cleanup is complete.

5. The second layer of polyethylene sheeting shall be applied over the first layer and sealed directly to the inner face of the cut tape lip and window sill and casing.

6. This sealing of windows shall be done from the interior prior to the beginning of any exterior work.

J. The critical barriers for the removal of front and back doors and front and back door jambs, casing, and associated trim, shall consist of the following:

1. After precleaning activities of HEPA vacuuming floor and surfaces to be abated, seal with duct tape one layer of polyethylene sheeting over a 4’ x 4’ floor area extending in from the entrance doorway. This floor sheeting shall extend a minimum of six inches up the adjacent wall.
2. Remove the entrance door as described in this section.
3. Construct a mini-containment chamber with a double layer of six-mil polyethylene sheeting to isolate the inside door frame from the interior of the unit.

4. Seal mini-containment chamber to the interior wall a minimum of six inches from the interior door casing. Seal walls of the chamber to the floor poly. Cover ceiling with one layer of six-mil polyethylene. A prefabricated containment system may be used if approved by the Consultant.

5. Allow sufficient clearance around the door frame and casing to permit workers adequate access to remove the components without breaching the containment system.

6. Containment chamber shall remain in place during door, door casing, and jamb replacement.

K. The exterior of the building and the ground surrounding the building shall be covered with plastic sheeting or tarpaulins from the edge of the building to a point at least eight feet away and secured to the ground.

L. The poly barriers shall not be removed until after all debris, dust, and chips are vacuumed up from the exterior.

M. Maintain polyethylene barriers, as long as needed for the safe and proper completion of the work. Any breeches in the work area barriers shall be corrected immediately and as necessary during the work day with such breeches reported immediately to the Owner. Work will not be allowed to commence until all barriers are in place and acceptable to the Consultant.

N. Window barriers shall not be removed until the window opening and polyethylene sheeting thoroughly cleaned as specified in this section, all debris has been properly bagged and removed from work areas, and the lead surface wipe samples have been taken in accordance with provisions detailed herein.

3.2 OCCUPANT PROTECTION

During the course of the abatement project, the protection of the building occupants and their belongings shall be the responsibility of both the Abatement Subcontractor and the occupants. Relocations of occupants and the use of engineering controls shall be employed throughout the entire project.

3.2.1 Owner's Responsibilities

The Owner shall be responsible for all aspects addressing the relocation of tenants during daily construction activities of the abatement project. This shall include, but not be limited to, the following:

A. Provision of supplementary living quarters for tenant displaced during daily construction activities.

3.2.2 Tenant's Responsibility

The tenants shall be responsible for providing an unobstructed work place for the Abatement Subcontractor prior to vacating the unit during daily construction activities. The tenants' responsibilities include, but are not limited to, the following:

A. Removal of all paintings, pictures, plaques, draperies, shelves, and otherwise applied items from outside wall surfaces within the apartment.

B. Removal of all furniture from around the perimeter of the outside walls to a location in the center of the room no closer than four (4) feet from the work area walls. If the room is too small to accomplish this, the furniture must be removed from the room.

C. If the tenants are not capable of moving large items, the Owner shall be notified forty-eight (48) hours in advance, and shall supply a work crew to do so.

3.2.3 Abatement Subcontractor's Responsibility

The Abatement Subcontractor shall be responsible for establishing and maintaining all engineering controls referenced herein and as required to prevent dispersal of lead contamination from the work area. While this is the prime responsibility of the Abatement Subcontractor, additional responsibility will include, but not be limited to, the following:

A. Provide notifications and posting as required by these specifications.

B. Protect tenants' personal possessions as specified in these specifications including, but not limited to, furniture and boxed items located in the center of work area rooms.

C. The Abatement Subcontractor shall be responsible for and bear all costs resulting from damage caused to the tenants' possessions during the abatement work.

3.3 PROTECTIVE PROCEDURES

3.3.1 Personal Air monitoring. Both personal air and area (ambient) air sampling will occur periodically throughout the project. The Abatement Subcontractor is advised of the following sampling:

A. Consultant will perform clean area air monitoring sampling and analysis for all phases of the work in this Section. This sampling will include personal air monitoring of Abatement Subcontractor employees and ambient air sampling within the work area.

B. Air samples may also be collected by the Consultant outside critical barriers of the work area in the clean room, and in areas adjacent to the clean room.

C. The Consultant will also collect wipe samples both within the abatement area and outside.

D. Any adjustment, tampering, and/or deliberate interference with Consultant air monitoring equipment by the Abatement Subcontractor's personnel will not be tolerated. Furthermore, the Abatement Subcontractor may be held liable for prosecution under applicable laws and regulations for attempting to falsify test results.

3.3.2 Worker Protection Requirements

A. Biological Monitoring. All workers must have baseline and post-abatement blood lead level measurements determined by the whole blood lead method, utilizing the Vena-Puncture technique with results provided to the Owner and Consultant. This screening shall be performed every two months for the first six (6) months, and every six months thereafter if blood lead levels do not increase by more than 10 µg/dl. In addition, the Abatement Subcontractor shall have a medical examination performed on each employee. This medical examination must be performed before workers begin lead contaminated work area and at the termination of an employee's employment or yearly, whichever comes first. A worker shall be removed from the job whenever three blood sampling tests average more than 25 µg/dl or if a single test exceeds 30 µg/dl. A formal investigation shall occur whenever a worker's blood lead level rises more than 10 µg/dl over the baseline level. The Abatement Subcontractor shall be responsible for medical surveillance and record keeping, as defined in the OSHA Lead in Construction Standard (29 CFR 1926.62) and Local Law.

B. Training Requirements. All workers and supervisors shall have successfully completed a course provided by a licensed training provider meeting all requirements of EPA and Local Law. Supervisors shall be licensed by the responsible Local State Agency responsible. The Abatement Subcontractor will adhere to the requirements of OSHA regulations CFR 1910.1200 and 1926.62.

C. Supervision. The Abatement Subcontractor shall provide one site supervisor whose responsibilities include coordination, safety, security and execution of all phases of the lead removal project. The supervisor shall not be used as a lead removal worker, and shall be assigned full time to the project. The supervisor shall be fully qualified in all aspects of lead abatement practices and procedures, and have a three-day training course provided by a certified training provider and approved by the responsible Local State Agency within the previous year prior to commencement of lead-related work.

D. Respirators and Personal Protective Equipment (PPE)

1) Personal protection in the form of disposable coveralls and NIOSH and MSHA approved respirators, is required for all workers, supervisors, and authorized visitors entering the work area during the abatement and cleaning operations. A half-face negative pressure respirator is required until air monitoring data proves otherwise. Authorized visitors (i.e., federal, state, and local inspectors) must provide a current health and medical report certifying them as approved to wear half-face respirators, and must wear PAPRs until air monitoring data permits the use of half face respirators.

2) Each worker shall be supplied with a minimum of two (2) complete disposable suits every day. Removal workers shall not be limited to two (2) suits, and the Abatement Subcontractor will be required to supply additional suits as is necessary. In addition to disposable suits for the workers, the Abatement Subcontractor shall also supply suits for the Consultant and other personnel who are authorized to inspect the worksite. Contractor must consider this cost in the bid. Disposable suits, such as TYVEK suits, and other personal protective equipment (PPE) must be donned prior to entering work area. A clean area will be provided for workers to put on suits and other personal protective equipment and to store their street clothes.

Suits will be worn inside the work area after the area passes pre-abatement inspection and shall remain in use until the area passes final clearance inspection. Light weight nylon clothes may be worn under the suit, but these clothes must be changed before leaving the work area and should be laundered separately.

3) Work clothes shall consist of moisture repellent, disposable full-body suits, head covers, gloves with cuffs extending outside the sleeves of the protective suit, boot or shoe covers, a face shield and eye protection. Hard hats shall be worn. In addition, when caustic paste is used as an abatement agent, full-body suits and gloves impervious to caustics, glove extenders, face shields and boot or shoe covers are required.

4) Eye protection to personnel engaged in lead operations shall be furnished when the use of a full face respirator is not required.

5) Goggles with side shields will be worn when working with a material that may splash or fragment, or if protective eye wear is specified on the Material Safety Data Sheet (MSDS) for that product.

6) Additional respiratory protection by supplemental filters, such as organic vapor cartridges, may be needed when handling some coating products. Consult the Material Safety Data Sheets (MSDS) and obtain the proper filters as necessary.

7) The Abatement Subcontractor shall provide portable eyewash stations inside all work areas where caustic paste is to be used.

The stations should be capable of providing a flow of water for at least five minutes. The Abatement Subcontractor shall provide another station capable of providing a flow of water for at least fifteen minutes in the clean area. Squeeze bottles are not sufficient eyewash stations.

8) The Abatement Subcontractor shall supply workers and supervisory personnel with NIOSH and MSHA approved respirators and HEPA filters. Respiratory protection shall be implemented for all work performed by the Abatement Subcontractor under this Section. The respirators shall be sanitized and maintained according to the manufacturer's specifications. Disposable respirators shall not be considered acceptable under any circumstances. The Abatement Subcontractor will maintain on-site a sufficient supply of HEPA filters to allow workers and supervisory personnel to change contaminated filters per manufacturer's recommendations or when breathing resistance is encountered. The Abatement Subcontractor is solely responsible for means and methods used and for compliance with applicable regulations:

(a) Half-mask, negative pressure, air purifying respirators equipped with high efficiency filters for airborne lead dust levels not in excess of 0.5 mg/m3 (10 times the Permissible Exposure Limit) shall be used during component removal and enclosure abatement methods, with the exception of surface preparation for enclosures.

(b) Full-face Powered Air Purifying Respirators (PAPRs) with high efficiency filters for airborne dust levels not in excess of 2.5 mg/m3 (50 time the Permissible Exposure Limit) will be required during all abatement demolition methods and encapsulation surface preparation methods and as required by OSHA 1926.62.

(c) Pressure demand, full face, supplied air respirators are required when airborne lead dust concentrations are expected to meet or exceed 50 mg/m3 (1000 times the Permissible Exposure Limit). Respirators will not be removed until the worker enters the washing area of the decontamination chamber.

9) Respirators shall be individually assigned to removal workers for their exclusive use. All respiratory protection shall be provided to workers in accordance with the approved respiratory protection program, which includes all items in OSHA 29 CFR 1910.134 (B),(D),(E), & (F), and the OSHA lead standard 29 CFR 1926.62. A copy of this program shall be kept at the worksite, and shall be posted in the clean area.

10) Workers must perform negative and positive pressure fit checks each time a respirator is put on, whenever the respirator design so permits.

11) Powered air purifying respirators (PAPR) shall be tested for adequate flow as specified by the manufacturer.

12) Workers shall be given a qualitative fit test in accordance with procedures detailed in OSHA 29 CFR 1910.1025, Appendix D, Qualitative Fit Test Protocols, for all respirators to be used on this abatement project. An appropriately administered quantitative fit test may be substituted for the qualitative fit test.

13) If a question exists as to the proper selection of respirators, the Contractor may consult the OSHA Lead in Construction Standard (29 CFR 1926.62).

14) Upon leaving the active work area, cartridges must be removed, and respirators cleaned in a disinfectant solution and clean water rinsed.

15) Clean respirators should be stored in plastic bags when not in use.

16) The Abatement Subcontractor shall inspect respirators daily for broken, missing, or damaged parts.

17) The Abatement Subcontractor shall provide personal sampling to check personal exposure levels. Samples shall be taken for the duration of the work shift or for eight hours, whichever is less. Personal samples need not be taken every day but must be taken in accordance with 29 CFR 1926.62. Sampling will determine eight-hour Time-Weighted Average exposures (TWA). Results shall be provided to the Owner and Consultants within 48 hours of the sampling.

18) Abatement Subcontractor shall comply with all OSHA, state, or other applicable requirements of worker medical examinations for approval to wear respiratory protection, and shall submit document of such approval to the Owner.

E. <u>Exposure Conditions</u>. If air monitoring data, gathered by the Abatement Subcontractor or Consultant shows that worker exposure to airborne lead exceeds 50 µg/m3, the following conditions apply:

1) <u>Clothing</u>. Street clothes cannot be worn into containment. Workers must wear nylon shorts, TYVEK shorts, or nothing under disposable suit.

2) <u>Showers</u>. Showers must be provided. Shower water must pass through at least a 5.0 micron filter before returning to the public waste system.

(a) All workers must shower upon leaving the work area.

(b) A five-stage decontamination unit must be constructed of six-mil polyethylene sheeting and consisting of a dirty room, airlock, shower, airlock, and clean room.

3.3.3 <u>Personal Air Sampling</u>

A. <u>General</u>. The Abatement Subcontractor is required to perform the personal air sampling activities during all lead paint abatement work. The results of such sampling shall be posted, provided to individual workers, and submitted to Owner and Consultant as described herein.

B. <u>Sampling</u>. Samples shall be taken for the duration of the work shift or for eight hours, whichever is less. Personal samples need not be taken every day after the first day if working conditions remain unchanged, but must be taken every time there is a change in the removal operation, either in terms of the location or the type of work. Sampling will be used to determine eight-hour Time-Weighted Averages (TWA). The Abatement

Subcontractor is responsible for personal sampling as outlined in OSHA Standard 29 CFR 1926.62. This sampling will determine the degree of respirator protection required, subject to the regulations.

C. Sampling Results. Air sampling results shall be transmitted to the Owner and individual workers in written form no more than forty-eight (48) hours after the completion of a sampling cycle. The reporting document shall list each sample's result, sampling time and date, personnel monitored and their social security numbers, flow rate, sample duration, sample yield, cassette size, and analysts' name and company, and shall include an interpretation of the results. Air sample analysis results will be reported in micrograms of lead per cubic meter of air (µg/m3).

D. Testing Laboratory. The Abatement Subcontractor's testing lab shall be certified for lead air sample by the American Industrial Hygiene Association. Abatement Subcontractor shall submit for the Owner's and Consultant's review and acceptance the name and address of the laboratory, certification(s) of accreditation for heavy metal analysis, and a listing of relevant experience in air lead analysis, and presentation of a documented Quality Assurance and Quality Control program.

E. Air Monitoring Frequency. The air monitoring frequency for Abatement Subcontractor operations will be established in accordance with the requirements set forth in 29 CFR 1926.62.

3.4 WORKER HYGIENE PRACTICES. In order to avoid possible exposure to dangerous levels of lead and to prevent possible contamination of areas outside the demarcated work area, work shall follow the general guidelines listed below:

3.4.1. Work Area Entry. At no time shall a worker or other authorized personnel entering the work area go further than the Clean Area without proper respiratory protection and protective clothing.

3.4.2. Work Area Departure. The worker shall remove all gross contamination, debris and dust from the disposable suit by completely HEPA vacuuming them before leaving work area.

3.4.3 Personal Protective Equipment. All persons leaving the work area must remove their personal protective equipment (except respirators) before leaving the containment. Suits shall be removed "inside out" to minimize the dispersal of lead dust.

3.4.4 Wash Facilities. All workers must wash upon leaving the work area. Wash facilities will be provided by the abatement Subcontractor. This wash facility will consist of, at least, warm running potable water, soap, and towels. All waste water must be contained and disposed of in accordance with this Specification.

3.4.5 Equipment. All equipment used by the workers inside the work area shall be either left in the work area or thoroughly decontaminated before being removed from the area. Extra work clothing (in addition to the disposable suits supplied by the Abatement Subcontractor) shall be left in the clean area until the completion of work in that area.

The clean area shall be cleaned of all visible debris and disposable materials daily.

3.4.6. Prohibited Activities. Under no circumstances shall workers or supervisory personnel eat, drink, smoke, chew gum, or chew tobacco or remove their respirators in the work area. To do so shall be grounds for the Owner and/or Consultant to STOP all removal operations. Only in the case of life threatening emergency shall workers or supervisory personnel be allowed to remove their protective respirators while in the work area. In this situation, respirators are to be removed for as short a duration as possible.

3.4.7 Footwear. As with additional clothing, all work footwear shall be left inside the decontamination area until the completion of the job and then shall be HEPA vacuumed and wiped or discarded as contaminated waste.

3.4.8 Shock Hazards. The Abatement Subcontractor is responsible for using safe procedures to avoid electrical hazards. Power will be shut off and checked before work begins when a hazard exists.

All extension cords and power tools used within the work area shall be attached to Ground Fault Circuit Interrupters (GFCI).

3.5 CONTROL OVER ABATEMENT WORK

All work procedures shall be continuously controlled and monitored by the Contractor to assure that the building will not be further contaminated. The following controls shall be instituted on each working day:

3.5.1 Start Up

Prior to work on any given day, the Contractor's designated project supervisor will discuss the day's work schedule with his work force to evaluate job tasks with respect to safety procedures and requirements specified to prevent contamination of the other parts of the building or the employees. This includes a visual survey of the work area and the decontamination enclosure systems.

3.5.2 Access

The Contractor shall maintain control of and be responsible for access to all work areas to ensure the following requirements:

A. Non-authorized personnel are prohibited from entering the area at all times of day and night;

B. All authorized personnel entering the work area shall be familiar with the worker protection procedures contained in this specification and shall be equipped with properly fitted respirators and protective clothing;

C. All personnel who are exiting from the decontamination enclosure system shall be properly decontaminated;

D. Lead waste which is taken out of the work area must be properly handled in accordance with these specifications. The surface of any waste containers, removed from the work area, shall be wiped down with a minimum of a 5% solution of tri-sodium phosphate or other equivalent cleaning agent prior to removing it from the work area.

E. Building components with lead painted surfaces shall be removed from the work area and placed directly into a labelled and secured disposal container or a designated storage area.

3.6 EXTERIOR ABATEMENT SEQUENCING

A. The established sequencing for hazardous material abatement for this project dictates that the Abatement Subcontractor performs the pre-removal work area preparation procedures for all buildings included in this project. This includes all buildings with asbestos-containing transit siding.

B. Exterior variations have also been established in regards to siding type, presence of exterior wood trim and drainage components painted with lead-based paint, and material composition of the existing building felt paper and associated adhesive. Each building type has a corresponding abatement sequence. The following list represents the three building variations identified and their corresponding building types:

1. Variation 1: Asbestos-containing transit siding with asbestos-containing building paper and lead-based paint covered trim and drainage components.

2. Variation 2: Lead-based paint covered wood siding with asbestos-containing building paper and lead-based paint covered exterior trim and drainage components.

3. Variation 3: Lead-based paint covered wood siding with nonasbestos-containing building paper and lead-based paint covered exterior trim and drainage components.

3.6.1 <u>Removal Sequencing of Building Exterior Variations</u>

Due to the layered composition of different hazardous materials (e.g., lead-based paint covered exterior trim applied onto transit siding), slightly different sequences of removal operation will be required. The following sequences are broken down by exterior variations.

3.6.1.1 <u>Variation 1 Sequence</u>

A. The Abatement Subcontractor will be first on the job.

B. The Abatement Subcontractor will provide work area set-up for one entire building in accordance with specifications.

C. The Abatement Subcontractor will perform all exterior lead trim component and drainage system components effecting the removal of the transit siding. These components will include, but not be limited to, the following:

1. Rake Boards	6. Downspouts Conduit	11. Roof & End
2. Facia Boards	7. Gutters	12. Soffit
3. Corner Boards Wall Vents	8. Associated Hardware	13. Electrical

4. Skirt Boards
5. Moldings
9. Drainage Boots
10. Canopies

D. Work shall be performed sequentially to allow the Asbestos Removal Contractor to start asbestos work as soon as possible.

E. The Abatement Subcontractor will perform preliminary clean-up and wipe barriers prior to the Asbestos Contractor working on that side of the building.

F. The Abatement Subcontractor will continue to work around the building as defined herein.

G. The Asbestos Removal Contractor will commence work on the initial side abated when the Lead Abatement Contractor has completed the initial clean-up on that side and component removal on the subsequent adjacent side.

H. The Asbestos Removal Contractor will remove and dispose asbestos shingle siding, felt paper, and associated tar adhesive.

I. The Asbestos Removal Contractor will then perform preliminary clean-up and wipe all barriers clean. The asbestos inspector will perform a visual inspection to ensure all asbestos containing materials have been removed before barriers are removed.

J. The Asbestos Removal Contractor will remove all barriers and dispose as construction debris.

K. The Abatement Subcontractor and Asbestos Abatement Subcontractor will continue work in a fashion that will not cause leaded waste products to be combined with asbestos waste products.

3.6.1.2 Variation 2 Sequence

A. The Abatement Subcontractor will be first on the job.

B. The Abatement Subcontractor will provide work area set-up for one entire building in accordance with Specifications.

C. The Abatement Subcontractor will perform all exterior lead component removal, as defined in these Specifications, including siding, but excluding felt paper and adhesive, and excluding doors, windows, and associated components (i.e., trim, sills) one side of the building at a time.

D. Work shall be performed sequentially to allow the Asbestos Removal Contractor to start his work as soon as possible.

E. The Abatement Subcontractor will perform preliminary clean-up and wipe barriers clean prior to Asbestos Contractor working on that side of the building.

F. The Abatement Subcontractor will continue to work around the building as defined herein.

G. The Asbestos Removal Contractor will commence work on the initial side when the Lead Abatement Contractor has completed the initial clean-up on that side and component removal on the subsequent adjacent side.

H. The Asbestos Removal Contractor will removal all felt paper and associated tar adhesive.

I. The Asbestos Removal Contractor will then perform preliminary clean-up and wipe all barriers clean.

J. The Asbestos Removal Contractor will removal all barriers and dispose as construction debris.

K. The Abatement Subcontractor and Asbestos Abatement Subcontractor will continue work in a fashion that will not cause leaded waste products to be combined with asbestos waste products.

3.7 ABATEMENT PROCEDURES

3.7.1 General

A. Overview. The information contained in this section indicates specific abatement procedures for designated components. The actual components to be abated are found on Drawings and schedules located in Section xxx of the Contract Documents.

B. Workmanship. All lead-based paint abatement activities shall be conducted in a professional workman-like manner.

3.7.2 Exterior Component Removal

A. General. Abatement procedures detail both specific components and the generalities of component removal. Generalities of abatement are detailed below. All resulting bundles of "containers" of removed components and/or debris shall be carefully handled to reduce the potential of ripping, bursting, or otherwise diminishing the integrity of the bundle of "container."

1. Provide work area preparation in accordance with Section 3.1.

2. Care must be taken so that leaded materials are neither burned, nor dusted, nor result in further exposure to workers, residents, children, or observers.

3. Care shall be taken to avoid damage to adjacent areas during the removal of components to be replaced. The Abatement Subcontractor shall run a utility knife around the edge (score) of the abatement substrate and the adjacent (non-abated) substrate to cut any bonding between the substrates and thereby eliminate damage.

4. If components to be removed contain gross areas of loose of peeling paint, these areas

shall be wet scrapped or HEPA vacuumed prior to removal. The paint chips shall be contained either in the HEPA vacuum or in a separate six (6) mil polyethylene bag. Temporary encapsulants expressly for this purpose are also acceptable.

5. Components that are removed for replacement shall be temporarily wrapped for transport to the dumpsters. Care shall be taken when transporting leaded components from the work area to the dumpster. All leaded components shall be sealed in air tight containers from transport to the dumpster. Once the material has been transferred, it shall be removed from the container and placed in the lined dumpster. Specific components and abatement procedures are:

a. <u>Drainage Components</u>

(1.) <u>Gutter and downspouts</u>. A pry device may be used to carefully remove all brackets and hardware providing support to the gutters and downspouts. Once the brackets have been removed, carefully remove and lower gutters and downspouts to the ground. To not drop or handle in a way that will cause additional damage to the painted surfaces. Once the gutters and downspouts are removed, cut into manageable lengths no greater than three (3) linear feet in length. Remove all nails prior to disposal.

(2.) <u>Drainage Boots</u>.

A pry device may be used to carefully remove all brackets and hardware providing support to the drainage boots. Carefully remove the drainage boots for disposal. Where required, excavate to a depth of six (6) inches below grade and snap cast iron boot to be capped by General Contractor. Boots may be stripped of lead-based paint on site and then disposed of as construction debris. All on-site stripping shall be performed in a secure area approved by the Consultant in accordance with Section 3.1.

b. <u>Exterior Trim</u>. A pry device shall be utilized to carefully remove the exterior trim. Once the exterior trim has been removed, the resulting material shall be cut into lengths that are easily managed for the purposes of containerization. Carefully lower trim boards to the ground; do not drop.

c. <u>Canopies</u>. A pry device shall be utilized to carefully remove the individual components of the canopies. Remove each component of the canopy and carefully lower to the ground. Care shall be taken to preserve the integrity of the structural elements of the canopies. Coordinate removal of existing lighting with the Electrical Subcontractor. Containerization shall be accomplished by removing or flattening all nails to prevent punctures or tearing.

d. <u>Attic Vents</u>. A pry device shall be utilized to carefully remove the attic vents. Remove each attic vent and associated trim components and carefully lower to the ground. Care shall be taken by the Abatement Subcontractor to avoid damaging existing roofing felts and shingles. If damaged shingles are observed by the Abatement Subcontractor before work commences, the Consultant must be informed. Failure to inform the Consultant will result in the Abatement Subcontractor assuming responsibility for the damage.

e. <u>Porch Lattice</u>. Carefully detach porch lattice from facade of building and porch landing for disposal.

f. Exterior Wood Shingles, Clapboards, and Soffit. A pry device shall be utilized to carefully remove the exterior wood shingles, clapboards, and soffit. When siding and soffits, avoid dropping a distance greater than ten (10) feet. Continuously control dust utilizing an airless spray or apply a light application of water. Avoid damaging felt paper at all buildings. Do not allow waste to accumulate. Remove or bend back all nails from existing sheeting. Cut clapboard to sections no greater than three (3) feet lengths. Containerization shall be accomplished by removing or flattening nails to prevent punctures or tears in container lining.

g. Electrical Conduit. On all lead painted surfaces, carefully remove electrical conduit by using a pry device (crow bar "pig's foot", etc.) in such a manner as to protect integrity of conduit and adjacent surfaces from damage. Coordinate and perform work under supervision of the Electrical Subcontractor.

1. The Abatement Subcontractor shall perform all procedures as defined in Section 02090 3.7.3 A.

2. All windows sashes, sills, jambs, and trim on basement windows shall be removed down to a base substrate surface (rough opening).

i. Removal of Window Components

1. Execution of component removal shall follow applicable methods specified in this section. Window component removal shall be limited to the individual components listed in Section 3.0 of this specification.

2. Preparation procedures identified in 3.1 and 3.2, shall be strictly adhered to. Using a HEPA vacuum equipped with a metal attachment, remove and vacuum all loose chips and flakes of paint from window trough components and remove existing exterior storm windows and screens and dispose of as construction debris.

3. Any damage to adjacent surfaces due to component removal shall be repaired and restored with similar or better materials to the approval of the Owner.

4. The sequence of work for component removal shall follow this prescribed order:

   a. Unscrew exterior stops and remove
   b. Remove top sash
   c. Remove parting beads with pry or pliers
   d. Remove bottom sash
   e. Using a pry, remove right and left side window trough casings
   f. Pry off head stop
   g. Remove existing mullions
   h. Remove exterior header
   i. Remove all loose dirt and debris, HEPA vacuuming all surrounding surfaces and window well
   j. Follow procedure of 5. below

5. After initial clean-up procedures are completed the following shall occur:

a. Inspector shall be notified of completion of window removal and clean-up
b. Inspector will perform a visual inspection
c. Once acceptable, encapsulate window components with white latex spray paint
d. Keep critical barriers intact
e. If no visible debris is found, window replacement shall proceed as specified in Section xx of Architectural Specifications.

J. Removal of exterior door jambs and casings and exterior doors.

1. Removal of doors, door jambs and casings shall be limited to the following:

   a. Front and back entrances

2. Any damage to adjacent surfaces due to component removal, shall be repaired and restored with similar or better materials to the approval of the Owner.

3. All door jambs and casings scheduled for abatement will be removed according to this prescribed sequence.

a. Preparation procedures shall be performed as described in 3.1 and 3.2.

b. Carefully score paint and caulk lines at walls adjoining casings with razor knife. Removal of jambs and casings shall not damage existing plaster or gypsum board and paint.

c. Carefully pry jambs and casings from wooden anchors and remove, using a wood block at the fulcrum point to protect the plaster.

d. Remove any protruding paint ridges. Scrape and HEPA vacuum all loose paint and debris.

e. Fill damaged spaces with plaster to make walls smooth.

4. After initial cleanup procedures are completed, the following shall occur:

a. Inspector shall be notified of completion of removal and proper cleanup.

b. Inspector will inspect for any visible dust or debris.

c. After approval is given by Inspector, door system installation shall occur without the removal of the mini-containment chamber.

d. Once door system is installed according to the specification, chamber may be removed after HEPA-vacuuming of the chamber surfaces.

3.7.3 <u>CAUSTIC PAINT REMOVAL - PROCEDURES</u>

A. <u>General</u>. Caustic paste application and use shall be in accordance with manufacturer's instruction for each product. Prior to beginning the application, all accumulated dust, dirt, and visible oil and grease shall be removed with a five percent TSP and water solution or other equally effective cleaning agent. When a caustic stripping agent is used as the abatement agent, the Abatement Subcontractor shall provide and ensure the use of the following items:

- Full-body coveralls with hood impervious to caustic substances;
- Gloves impervious to caustic substances;
- Glove extenders;
- Face shield;
- Appropriate boot or shoe covers;
- An eyewash station;
- A suitable and unrestricted wash area in the event of inadvertent exposure.

1. Paint Removal - A caustic stripping agent may require multiple applications, depending on a variety of circumstances. When this type of material is used, care should be taken to avoid drying of the agent. It may become necessary to lightly mist over area with water to keep it moist. Surfaces that come in contact with the stripping agents used in this methodology during washing or neutralizing shall be completely cleaned before the waste dries.

a. Each worker, in order to be allowed in the work area, must have received specific instructions on the procedures to remove material that inadvertently comes in contact with skin, and eyewashing procedures, together with information on the nature of the danger. This can be accomplished by general safety meetings that are regularly scheduled and with a "right-to-know" booklet that is in a location that is known to all persons and is readily accessible.

b. In addition to standardized work area preparation, to protect surrounding areas, polyethylene sheeting shall be placed flush to the surrounding walls for a firm seal to avoid leakage of waste below the polyethylene sheeting, and the joint shall be caulked. The Abatement Subcontractor may place absorbent pads or material below the surface being abated and/or place waterproof duct tape on the surface adjacent to that being abated, to prevent damage to the adjacent wall or floor surface. The Abatement Subcontractor is responsible for repairing any adjacent surfaces harmed by the chemical removal process. This includes contamination of these surfaces by chemical residue.

c. A dwell time may be a specified by the manufacturer. The Subcontractor shall run a series of test patches to determine the optimal amount of time for the chemical to work on a particular component.

d. Removal of the caustic stripping agent after dwell time shall be performed by scraping the waste off the substrate onto the paper, using a metal scraper. Application process shall be repeated if, in the opinion of the Consultant, complete removal of the paint is not attained. At no time shall dry scraping be used.

e. Once removal of paint from the abated surface is complete, clean-up procedures shall then follow and include wash-down of the surface and neutralization.

f. Once the neutralizing process is complete, the surface shall undergo normal clean-up procedures of HEPA vacuuming, wet wash and repeated HEPA vacuuming.

g. All worker protection equipment as specified shall be left within the work area during all phases of the work. This equipment may be transferred between work areas using double six (6) mil polyethylene bags to prevent contamination of clean areas.

h. All accumulated debris resulting from removal of caustic paste shall be treated as hazardous and shall be properly stored and disposed of according to EPA, DOT, and all other applicable federal, state, and local regulations.

i. Any wood flooring contaminated by the absorption of lead caustic shall be replaced by the Abatement Subcontractor at his/her expense.

B. Application and Removal

1. Spray or hand trowel paste according to manufacturer's specifications (no less than ¼" thick). The caustic stripping agent should be applied with recommended special spray equipment approved by the manufacturer to ensure proper application of product, if spray application is used.

a. During spray application no more than two workers (one person applying and one helper) shall be allowed in the work area. Security of work area is absolutely essential.

2. Never remove material with personnel below, or in a manner that would allow caustic to fall on, splatter or contact personnel in the vicinity of the removal.

- Minimize the fall distance of the paste/paint.

3. Work area shall be properly heated so as to meet temperature requirements outlined in the manufacturer's specifications. Heating procedures shall be subject to the approval of the Consultant and Owner, and shall be supplied by the G.C.

4. Abatement Subcontractor shall make certain that during the application, dwell time and removal of caustic paste, the work area is secured.

C. Clean Up

1. Collect caustic paste cloth with paste/paint along with remaining residue and put into six (6) mil polyethylene bags and dispose of in compliance with all regulations and specifications.

2. Spray surface lightly with water spray. Then with a nylon scrub brush, agitate surface to loosen all residue. Thoroughly scrub surface, being sure to get all crevices, grooves, cracks, etc.

3. Lightly spray clean water on surface, removing remaining residue. The use of a wet vacuum to assist in the clean-up is suggested. Make certain that entire surface is clean of any paint/paste residue.

4. Treat residue (paste, paper, water, etc.) as hazardous waste until results of TCLP tests are available. Disposal will be dependent upon these results.

D. <u>Neutralization</u>

1. Apply caustic stripping agent neutralizer in accordance with manufacturer's recommendations. Wash neutralizer off with clean water, per manufacturer's recommendations.

2. Apply second application of caustic stripping agent neutralizer if needed and allow to dry. After one to three (1-3) hours, wash neutralizer off with clean water and allow surface to dry completely.

3. Abatement Subcontractor should use pH paper to determine if neutralization is adequate. A dry surface showing a pH of between 6 and 8 after the proper drying out period, is ready to be recoated. A pH over 8 should be treated to another application of neutralizer and left to dry before retesting. It is most important that the surface properly dry out before recoating.

3.7.4 <u>Caustic Paint Specific Component Substrate</u>

A. The following shall be used as a guide by which certain specific components/substrates will be abated through the use of caustic pastes. Any specific component/substrate not herein mentioned, but so identified and designated, shall be abated according to manufacturer's recommendations. The exact locations of specific surfaces to be abated by this method are listed in Section 3.0.

1. <u>Removal of Paint from Bulkheads</u>. Paint shall be removed from all bulkheads in place. Special care must be taken to remove all paint from hinge mortises and frame to wall joints. A prefabricated plastic or metal drip pan may be placed on the floor at the junction of the bulkhead frame on top of any protective polyethylene sheeting. Drip pans may be placed at all sides of the bulkhead frame and abut the frame to create a seal to prevent leakage of the caustic paste below the work area seal. The drip pan shall be large enough to contain all leakage.

2. <u>Removal of Paint from Round Vents</u>

(a) Paint shall be removed from round vents as identified in Section 3.0. All paint shall be removed from entire surface on both sides.

3. <u>Removal of Paint from Stair Railings System</u>

(a) Paint shall be removed from railings, posts, guards, balusters, and all other metal stair surfaces.

(b) Paint shall be removed from the underside of flat surfaces of the railings, guards, or other surfaces.

(c) Great care shall be taken to prevent caustic paste from leaching into concrete landings utilizing work practices previously described.

(d) Each railing system shall be prepared for abatement by sealing off dwelling unit entrance doors. Waterproof tape shall be applied to every door at all seams. Each door shall then be covered with two layers of six-mil polyethylene sheeting and sealed to the door frames to create an airtight seal.

4. Removal of Paint from Window, Door, Vent, and Canopy Flashing, and Lintels

(a) Paint shall be removed from all visible metal surfaces of the window/door flashing and lintels as identified in Section 3.0.

(b) Caustic remover shall not come in contact with anodized aluminum windows.

(c) Work shall be performed only when weather conditions permit.

(d) If chemical is left on overnight, a barrier tape shall be erected and maintained until the chemical is removed.

3.8 DAILY CLEANUP

At the completion of each workday, the Abatement Subcontractor shall clean the inside of the work area. At a minimum, the following procedures shall be adhered to:

3.8.1 Cleaning

A. End of Day Cleaning. Thirty (30) minutes or more if necessary prior to the end of each work day, the lead work area must be cleaned of all debris. Under no circumstances will lead clean-up be permitted when active lead paint abatement work is proceeding. All abatement activity must cease during the cleanup period.

Such cleaning shall include a thorough HEPA vacuuming of all affected surfaces, as determined by the Consultant. Additionally, cleaning requires the use of a solution of five percent tri-sodium phosphate (TSP) or other equally effective cleaning agent. All waste materials generated during this daily clean-up shall be disposed of as hazardous waste, unless analytical testing proves otherwise.

B. Equipment Cleaning. Durable equipment, such as power and hand tools, generators, and vehicles shall be cleaned at least monthly or prior to removal from buildings undergoing abatement or the site. All equipment shall be cleaned by HEPA vacuuming and high-phosphate (tri-sodium phosphate) washing (or use of an equivalent cleaner).

1. High Efficiency Particulate Air (HEPA) vacuum: The Abatement Subcontractor will obtain training in the use of the HEPA vacuum from the manufacturer prior to use and submit evidence of this training to the Owner and Consultant. The Abatement Subcontractor shall obtain HEPA vacuum attachments, such as various size brushes, crevice tools, and angular tools to be used for varied applications and service the HEPA vacuum routinely to assure proper operation. Caution shall be used any time the HEPA is opened for filter replacement or debris removal. Operators shall wear a full set of protective clothing and equipment, including respirators, when using and emptying the HEPA vacuuming equipment.

C. Preliminary Clean-Up. Upon completion of the lead paint abatement and a satisfactory visual inspection by the Owner/Consultant in a given work area, a preliminary clean-up shall be performed by the Abatement Subcontractor. This clean-up includes removal of any contaminated material, equipment or debris including polyethylene sheeting from the work area, except for critical barriers. The polyethylene sheeting shall first be sprayed or misted with water for dust control, the resulting abatement debris removed, then the sheeting shall be folded in upon itself. All polyethylene sheeting used for critical barriers shall remain in place until final clearance testing results have passed the clearance criteria set forth herein.

1. Large Debris. Large debris from demolition (i.e. doors, windows, baseboards) shall be wrapped in polyethylene sheeting at least six-mil thick, sealed with heavy duty duct tape, and stored until proper disposal.

2. Small Debris. Prior to picking up or collecting small debris, the surfaces of this debris will be sprayed with a fine mist of water. The debris will be picked up, collected and placed into a single plastic bag, at least six-mils thick. The bags shall not be overloaded, shall be securely sealed, and shall be stored in the designated area until disposal. Dry sweeping is not permitted in the work area; wet sweeping will require approval by the Consultant.

3. Sheeting. Removal of surface six-mil polyethylene sheeting shall begin from upper levels, such as on cabinets, counters or shelves. Removal of floor polyethylene sheeting shall begin at the corners and folded into the middle to contain the dust or residue. All collected polyethylene sheeting shall be placed in six-mil polyethylene bags for proper disposal as described in this Specification.

4. HEPA Vacuuming. Once the six-mil polyethylene sheeting is removed from the work area, cleaning shall begin with a thorough HEPA vacuuming of all surfaces, starting at the ceilings, proceeding down the walls and including window, doors and door trim and floor. The floor shall be vacuumed last, beginning at the farthest corners from the entrance to the work area. HEPA vacuuming shall again be performed as noted above, after the following TSP wash.

5. TSP Wash. Abatement Subcontractor shall next wash or mop the same surfaces with a tri-sodium phosphate (TSP) detergent solution (five percent) or other equally effective cleaning agent and allow surfaces to dry. Then a second HEPA Vacuuming of the surfaces will be performed by the Abatement Subcontractor, as described above. By the conclusion of the cleaning phase, all visible dust and debris shall have been completely removed.

6. Hygiene, Cleaning Equipment and Supplies. Special attention shall be given to personal hygiene and the cleaning of supplies and/or equipment. All mop heads, sponges and rags shall be replaced or changed daily, at a minimum. Rags, mop heads or sponges may be reused if Abatement Subcontractor has them cleaned via a washing system specially equipped with HEPA filtration.

7. <u>Detergents</u>. The Abatement Subcontractor shall prepare and use detergents containing five to ten percent TSP according to the manufacturer's instructions. The manufacturer's recommended coverage will be followed. The waste water from clean up shall be contained and disposed of according to all applicable Federal, state, county and local regulations and guidelines. In no instance shall waste water be disposed in storm sewers (e.g., yard inlet or street drain) or sanitary sewers (e.g., toilet, sink, or any other household/residential/commercial type drain system) without specific governmental approval.

3.9 VISUAL INSPECTIONS

The Abatement Subcontractor shall request a visual inspection by the Owner or Consultant. If the area does not pass a visual inspection (e.g., no visible dust or debris), the Abatement Subcontractor shall reclean the area as outlined in Steps 4, 5, 6, and 7 in Section 3.8(c).

3.9.1 <u>Post-abatement Visual Inspection</u>. The Consultant shall confirm job completeness by determining whether all surfaces have been abated according to the approved abatement plan and project specification. The Consultant will then determine if the building has been adequately cleaned by examining all surfaces for dust and debris. If dust is found, the work area should be recleaned, and the damp cloth test repeated.

3.9.2 <u>Post-abatement Clearance</u>. When all surfaces have passed visual inspection, wipe samples as detailed in Section 3.8.4 (1) shall be performed by the Consultant. The standards for passing a wipe test are outlined in Section 3.8.4 (2). Should laboratory results indicate that the wipe test clearance level is exceeded, the Abatement Subcontractor shall re-clean the affected area, <u>at no additional cost to the Owner</u>, utilizing the methods specified above. Retesting will then be performed to verify compliance with the mandated levels. <u>Abatement Subcontractor shall pay for all additional testing and provide, at no additional cost, a recleaning of an effected area and personal belongings until the clearance level is achieved</u>.

3.9.3 <u>Finish Coatings</u>. Finished coatings including, but not limited to, stains, primer, sealers and polyurethane coatings, if used, shall only be applied upon approval by the Owner/ Consultant. Any surface requiring painting shall be primed with an approved primer. All primers or finish coating materials shall have labeling stating, in equal or appropriate wording, "does not contain lead-based paint greater than 600 parts per million" (0.06%) and "does not contain mercury." In lieu of label wording, a manufacturer's statement to this effect may be substituted.

3.9.4 <u>Inspection/Clearance Standards</u>. When clean-up has been completed and all surfaces have been final cleaned, wipe samples by the Consultant or Industrial Hygienist will be performed. The following standards must be met for all "clearance" requirements:

3.9.4.1 Wipe Tests

When only some component types are to be sampled in a specific area, the Consultant will ensure that the component types to be sampled are randomly selected. Within an area, the specific components to be sampled shall be selected at random and the specific sample location on a large component shall be selected at random.

In order to compare results with applicable federal clearance criteria, the following methods must be used.

A. The sampling location (a specific surface area) must be selected, and the surface area of that location carefully measured and recorded.

B. The wipe sampling procedure must ensure that a very high percentage of the surface dust present on the sample location is captured on the wipe.

C. Wipe sample collection criteria for abatement shall be as follows:

Step-by-Step Summary

Clearance: How To Do It

1. Decide who will conduct clearance. Clearance on all abatement projects and federally funded interim control work must be done by a certified risk assessor or inspector technician. The U.S. Department of Housing and Urban Development (HUD) strongly recommends the use of a certified risk assessor or inspector technician who is completely independent of the lead hazard control contractor to eliminate conflicts of interest. Some local jurisdictions may require a license to conduct clearance.

2. Finish the lead hazard control and cleanup effort. Seal floors before clearance testing (if necessary).

3. Wait 1 hour to allow any airborne dust to settle. Do not enter the room during that hour.

4. Conduct visual examination.

   a. Determine if *all* required work has been completed and *all* lead-based paint hazards have been controlled.

   b. Determine if there is visible settled dust, paint chips, or debris in the interior or around the exterior.

5. Complete the Visual Clearance Form contained in this chapter; if all specified work was not completed, inform the owner and order completion of work and repeated cleanup, if necessary.

6. Conduct clearance dust sampling of floors, interior window sills, and window troughs using the protocol in this chapter.

7. Conduct clearance soil sampling if bare soil is present that was not sampled previously, or if exterior paint work was completed as part of the lead hazard control effort.

8. Complete the Dust and Soil Sampling Clearance Form contained in this chapter.

9. Submit samples to an Environmental Protection Agency (EPA) recognized laboratory participating in the National Lead Laboratory Accreditation Program for analysis.

10. Interpret results by comparing them to the HUD Interim Clearance Standards contained in this chapter (until EPA issues its health-based leaded dust standards).

11. If clearance is achieved, go to step 15.

12. Order repeated cleaning if results are above applicable standards. Clean all surfaces the sample represents. If both window and floor samples fail, the entire unit must be recleaned.

13. Continue sampling and repeated cleaning until the dwelling achieves compliance with all clearance standards.

Step-by-Step Summary (continued)

14. Complete any related construction work that does not disturb a surface with lead-based paint (all work that does disturb painted surfaces or that could generate leaded dust should be completed as part of the lead hazard control effort).

15. Issue any necessary certificates of lead-based paint compliance or releases and maintain appropriate records.

16. Permit residents into the cleared work area.

Clearance criteria shall be as follows:

Surface	Leaded Dust Loading (µg/ft²) (micrograms per square foot)
	Wipe Only
Floors	100
Interior Window Sills (Stools)	500
Window Troughs	800
Exterior Concrete Or Other Rough Surfaces	800

3.9.4.3 Retests. Should laboratory results indicate that the wipe test clearance level is exceeded, the Abatement Subcontractor shall reclean the affected area, at no additional cost to the Owner, utilizing the methods specified above. Retesting will then be performed to verify compliance with the mandated levels. Abatement Subcontractor shall pay for all additional testing and provide, at no additional cost, a recleaning of an affected area until the clearance level is achieved.

3.9.5 Inspections. In addition to various daily inspections of the lead work area and abatement practices, the Consultant will make four (4) mandatory inspections during the work, one during each phase of removal. Each inspection must be requested by the Abatement Subcontractor to be performed by the Consultant to the Consultant's satisfaction before work may begin for next phase of work, or an area accepted. Failure on the part of the Abatement Subcontractor to obtain the Consultant's approval before proceeding to the next scheduled phase is regarded as a violation of this section. In the event of this occurring, Consultant will request work be stopped and Owner will be contacted to intervene. The four (4) inspections are as follows:

1. Window and Door Barrier Completion. Abatement Subcontractor shall have all pre-abatement preparations of the work area complete, as described in Sections 3.1.

2. Post Removal Inspection. Abatement Subcontractor shall have completed abatement and final clean-up of all visible debris and perform final cleaning techniques of TSP washing and HEPA vacuuming as described in Section 3.8.

3. Daily Clean-up. Abatement Subcontractor shall have completed daily cleanup as defined in Section 3.7.

4. Final Clearance. Consultant will perform final clearance wipe testing 24 hours after final clean-up activities are completed as described in Section 3.9.

3.9.6 Air Sampling Procedure

Air sampling shall be conducted by the Consultant. Samples shall be collected and analyzed for total airborne lead. Air sampling will be collected during, but not limited to, the pre-abatement and post-abatement periods.

A. Sampling Apparatus. Air Sampling shall be collected utilizing a closed-face, 37 millimeter cassette. A mixed cellulose ester filter with 0.8 micrometer pore size with a cellulose support pad shall be placed in the cassette. Air sampling pumps shall be calibrated at 2.0 liters per minute prior to sampling. All pumps shall be post calibrated.

B. Analytical Method. The NIOSH 7082 (AAS) procedure shall be used for sample analysis. A blank filter shall be submitted with each set of samples.

3.9.7 Data Reporting for Lead in Air

Laboratory results for air samples shall be provided in micrograms of lead per cubic meter of air.

Information specific to obtaining the air samples should be listed on a separate data form for air samples, which would include the following:

A. Location where sample was taken
B. Length of time in use
C. Approximate volume of air sampled
D. Abatement/clearance status
E. Abatement method (e.g., removal vs. enclosure)

3.9.8 Analytical Laboratory Qualifications

Analytical laboratories must be recognized by the EPA as participating in the National Lead Laboratory Accreditation Program (NLLAP). The Laboratory must show evidence that it is proficient in lead analysis under the Environmental Lead Proficiency Analytical Testing Program. If the laboratory is not currently enrolled in these programs, the laboratory will be required to enroll in the next round of ELPAT samples. The laboratory must be accredited within a one year period by an organization recognized by NLLAP that has signed a Memorandum of Understanding with EPA. Currently, the American Industrial Hygiene Association (703-849-8888) and the American Association for Laboratory Accreditation (301-670-1377) have signed such memoranda of understanding with EPA.

1. All dust, paint, and soil samples shall be analyzed for total lead, not "bioavailable" lead, as required in the HUD Guidelines for Evaluation and Control of Lead-Based Paint in Housing.

2. The following procedure (or equivalent) shall be employed for the analysis of the wipe samples:

Remove and unfold the wipe from the shipment container. Cut the wipe into small pieces and place in a 125 ml Phillips beaker. Quantitatively rinse the shipment container into the Phillips beaker. Cover the wipe with 10 ml of distilled water. Add 2 ml of concentrated HNO3 and 2 ml of HC1. Gently heat for 20-30 minutes under reflux. Cool and transfer both the liquid and the bulk material left to a 50 ml volumetric flask. If there is too much bulk material left over, rinse with distilled water and squeeze with a glass rod. Add distilled water to make up to final volume. Prior to analysis by AA or ICP, an aliquot is filtered through ashless filter paper, then centrifuged at 9K rpm for 20 minutes. The supernatant liquid is drawn off and analyzed.

3.9.9 Qualifications of Sampling Personnel

All personnel conducting environmental sampling for this project should be certified as a lead-based paint inspector, risk assessor, or inspector technician or equivalent by the Environmental Protection Agency or the appropriate state agency, or be under the supervision of such a person. Certified Industrial Hygienists are not required to have additional certification as a lead-based paint inspector.

3.10 DISPOSAL OF WASTE MATERIAL

3.10.1 Caution Note for Contractors:

All materials, whether hazardous or non-hazardous, shall be disposed of in accordance with all laws and the provisions of this Section and any or all applicable federal, state, county, or local regulations and guidelines. It shall be the sole responsibility of the Qualified Abatement Subcontractor to assure compliance with all laws and regulations relating to this disposal. Until analytical results are available, all waste materials (including water) shall be segregated and treated as hazardous.

A. Applicability. Initial TCLP results have been used to classify waste into six categories. The categories are defined by the substrate type and the amount of the six toxic metals regulated by RCRA and most commonly found in paint.

B. Waste Segregation - The Abatement Subcontractor shall be responsible for segregating waste in accordance with the previously defined six categories. Separate waste dumpsters shall be used for each of the six categories. Prior to disposal of each dumpster of waste, a representative sample will be collected by the on-site inspector, paid for by the abatement Subcontractor and analyzed by TCLP for the RCRA metals. The result of each TCLP analysis will dictate the disposal requirement for each dumpster. Unit prices listed in Section xxx shall be utilized to compensate for additional disposal cost associated with disposing of materials as hazardous waste.

C. Component Classification - The initial TCLP results have been used to establish the following waste segregation categories:For bidding purposes Categories I and IV shall be considered construction waste. Categories II, III, V, and VI shall be considered hazardous waste.

Wood Substrates

a. Category I

Residential windows without putty
Corner boards
Basement window sills
Wood Gutter
Thresholds

b. Category II

Attic Vent
Entrance door jamb
Entrance door header
Wood shingle
Entrance door casing
Canopy components
Trellis
Clapboard siding
Toeboards
Basement window with putty
Residence window with putty
Basement window without putty
Caulks and Sealant

c. Category III

Entrance door
All exterior trim
Soffit
Metal Substrates

d. Category IV

no components listed

e. Category V

Electrical Conduit
Metal flashing
Miscellaneous metals i.e., hooks, brackets

f. Category VI

Copper downspouts

D. Disposal Requirements. The Abatement Subcontractor shall contact the Regional EPA, state, local, and all other pertinent authorities to determine lead-based paint debris disposal requirements. If applicable, the requirements of the Resource Conservation and Recovery Act (RCRA) must be complied with, as well as any or all other applicable federal, state, county, or local waste requirements.

The Owner/Consultant will supply the Abatement Subcontractor with a list of some of the appropriate agencies. During or after the actual abatement, the Abatement Subcontractor shall not leave any debris in the yard or near-by property, incinerate debris, dump debris by the road, place debris in any unauthorized dumpster, or introduce lead contaminated (non-filtered) water into storm sewers (shall not be poured down yard inlet or street drain) or sanitary sewers (shall not be flushed down toilet or any other household/residential/commercial type drain system). All waste water shall be labeled "filtered" (using 5 micron filter) or "non-filtered." All non-filtered waste water containers shall be labeled "hazardous waste" and with a date the Abatement Subcontractor began to collect contaminated water in that container.

E. EPA ID Numbers. The Abatement Subcontractor shall apply for an EPA identification number from the appropriate office; if more than 100 kg of hazardous waste will be generated from the abatement process during any calendar month. If less than 100 kg is to be generated, the Abatement Subcontractor shall obtain a Small Quantity Generator RCRA Hazardous Material ID number. The Consultant will assist the chosen Abatement Subcontractor in contacting the appropriate office to secure the identification number. The Abatement Subcontractor also has the responsibility to coordinate this action through the State and secure any additional number as required.

The following testing must be performed by a laboratory properly certified by the State of State. The name of the laboratory must be supplied to the Owner/Consultant prior to the initiation of the testing.

F. TCLP Test. Testing on lead-based paint abatement waste materials by use of the Toxicity Characteristic Leaching Procedure (TCLP) will be completed and paid by the Abatement Subcontractor, and results shall be supplied to the Consultant and Owner. Testing results on most building components have been performed by the Consultant and are attached to this contract specification.

G. Testing of Materials. The testing of material shall be performed as obtained to minimize the storage of "assumed" hazardous material. In absence of written official state guidance, the Abatement Subcontractor shall take at least one (1) composite sample of the items listed below for the RCRA eight (8) heavy metals. The Abatement Subcontractor shall also determine if additional testing for other compounds, such as pH, flashpoint, etc., are required for disposal at a particular landfill. The following materials shall be tested to determine whether or not they are hazardous:

1. Waste water.
2. Dust from HEPA filters.
3. Metals that have not been previously tested.

4. Plastic sheets, duct tape, or tape used to cover floors and other services during the lead-based paint removal.
5. Solvents and caustics used during the stripping process.
6. Liquid waste, such as wash water used to decontaminate wood after solvents have been used, and liquid waste from exterior (or interior) water blasting.
7. Rags, sponges, mops, scrapers, and other materials used for testing, abatement, and clean-up.
8. Disposable work clothes and respirator filters cartridges.
9. Any other items contaminated with lead-based paint or items produced as a result of lead-based paint abatement activity, such as the water filters.

H. Storage Requirements. Any item found to be hazardous, by way of testing, shall be kept in a secured area or lockable container that is inaccessible to all persons other than abatement personnel. All hazardous waste shall be labeled "Hazardous Waste - Contains Lead" and a date that the Abatement Subcontractor began to collect waste in that container. All hazardous and non-hazardous waste shall be kept in totally and completely separate containers. Until TCLP testing proves an item to be non-hazardous, all items shall be considered hazardous and stored in a secured area or lockable container.

I. Regulations. The Abatement Subcontractor will be required to comply with the Resource Conservation and Recovery Act (RCRA) and/or any other applicable state, county law, regulation and/or guidelines, whichever is most stringent.

J. Waste Transportation. If the Abatement Subcontractor is not a RCRA/DOT/EPA certified Hazardous Waste Transporter, a contract shall be entered into with a certified transporter to move the waste. The Abatement Subcontractor shall require the certified hazardous waste transport firm to follow RCRA, DOT, EPA, and any/all other applicable regulations. Many transporters are also capable of supplying pertinent information and services applicable to necessary rules, regulations, and specifications. The certified transporter/hauler shall submit for Owner/Consultant approved their qualifications to perform the work as specified herein. The Abatement Subcontractor shall be responsible for all actions of the waste hauler as pertaining to waste removal and disposal under this Section and all EPA, DOT, and other applicable regulations.

1. The Abatement Subcontractor must supply documents that detail the site(s) to be used for ultimate waste disposal. Documents from these disposal sites must be supplied by the Abatement Subcontractor to the Owner/Consultant from the disposal facilities stating that hazardous and/or construction waste will be accepted by these facilities. In addition, the Abatement Subcontractor must submit documents from these sites proving that they are licensed/permitted to accept such waste and will accept the waste proposed by the Abatement Subcontractor for treatment or ultimate disposal.

K. Waste Containers. The Abatement Subcontractor will comply with EPA and DOT regulations for waste containers. The Abatement Subcontractor shall contact the state and local authorities to determine their criteria for containers. In the case of any conflict in regulations, the more stringent regulation shall apply.

L. Emergencies. Abatement Subcontractors shall: contact local fire, police, hospitals or local emergency response teams and inform them of the type of hazardous waste activity and ask for assistance in the event of an accident; keep and properly maintain a suitable fire extinguisher(s) on site; have an immediate means of communication with a regulatory agency in the event of an emergency; keep a list of phone numbers of regulatory agencies on site, make sure all employees know how to deal with all types of accidents; make one person who is always on site, when the site is occupied, the emergency coordinator to ensure that emergency procedures are carried out in the event an emergency arises; and keep and maintain a "right to know" manual that is in an easily accessible location and in an area that is known to all employees.

M. Disposal Packaging. The Abatement Subcontractor shall place lead-based paint fragments and debris produced as a result of any abatement activity and lead dust in six-mil polyethylene (plastic) bags that are air-tight and puncture-resistant.

1. Cleaning Materials. The Abatement Subcontractor will place all disposable cleaning materials such as sponges, mop heads, filters, disposable clothing, and brooms in six-mil plastic bags. If after testing, those materials are determined to be hazardous, the bags will be sealed, labelled, and considered hazardous waste.

2. Contaminated Debris. In particular, the Abatement Subcontractor shall separate, label, and containerize the following:

a. All paint or paint fragments removed by chemical strippers, surface preparation, or by any abatement methodology;
b. Grossly contaminated body suits;
c. HEPA vacuum contents, filters, and respirator cartridges: paint chips or other abatement debris on plastic should always be HEPA vacuumed prior to picking up the plastic.
d. All hazardous wastes or materials should be kept totally separate from non-hazardous materials.

3. Polyethylene Sheeting. The Abatement Subcontractor shall clean surfaces and equipment and containerize large debris. Prior to removing any six (6) mil polyethylene sheeting, the Abatement Subcontractor shall lightly mist the sheeting in order to keep dust down and remove and containerize any debris and fold six (6) mil polyethylene sheeting inward to contain debris and to form tight bundles to containerize for disposal. The Abatement Subcontractor shall place all plastic sheeting in six (6) mil thick polyethylene bags and seal.

N. Removing and Transporting Waste

1. Vehicles. The Abatement Subcontractor shall ensure that all non-hazardous waste is transported in covered vehicles to a landfill, or lined landfill, if required.

2. Container Handling. The Abatement Subcontractor shall carefully place the containers into the truck or dumpster used for disposal. At NO time will debris or containers be thrown or dropped.

3. <u>Dust or Debris</u>. If the Abatement Subcontractor subcontracts the removing of the non-hazardous lead-based paint abatement waste, the Contractor shall ensure that the company removing the waste material adequately covers all loads so as to assure that no dust or debris is released.

4. <u>Liquid Wastes</u>. The Abatement Subcontractor shall contain and properly dispose of all liquid waste, including lead-contaminated wash water if not filtered and drained.

5. <u>Containers</u>. The Abatement Subcontractor shall HEPA vacuum the exterior of all waste containers prior to removing the waste containers from the work area and shall wet wipe the containers to ensure that there is no residual contamination. Containers should then be moved out of the work area into the designated storage area.

6. <u>Solvents</u>. The Abatement Subcontractor shall place solvent residues and residues from strippers in drums made out of materials that cannot be dissolved or corroded by chemicals. Solvents will be tested by the Abatement Subcontractor to determine of they are hazardous. Solvents, caustic, and acid waste must be segregated and not stored in the same containers.

3.10.2 Soil Sampling Procedure

A. <u>Pre-abatement Soil Sampling</u>. In order to establish baseline lead-in-soil conditions on the site prior to the initiation of exterior lead abatement, soil samples will be collected.

3.10.3 Post-abatement Soil Sampling

A. Post-abatement soil samples, will be collected at the same building where pre-abatement soils samples were collected.

B. If pre-abatement soil samples at any of the ten building locations exceed 1,000 µg/g, the Contractor may be required to perform soil excavation and removal at additional cost as specified in Section 3.10.4.

C. If pre-abatement soil samples are at or below 1,000 µg/g, and post-abatement soil samples exceed 1,000 µg/g, the Contractor will be required to perform soil excavation and removal at no additional cost as specified in Section 3.10.4 under Section 3.11 Damages.

3.10.4 Excavation and Removal of Contaminated Soil

A. Careful excavation will begin with equipment, such as an excavator or backhoe. Work will continue with hand tools as directed by the Consultant. Careful handling of soil with hand tools shall be employed in order to avoid damaging the structure and to minimize waste generation.

B. Excavation to a depth of two (2) inches will take place within the area identified by the Consultant.

C. Excavation will be performed with care to protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by equipment, contaminated soil, and other hazards created by operations.

D. Excavated soils will be placed in a pre-designated area on six (6) mil polyethylene roll sheeting and covered with the same material.

E. Proper protective measures will be taken to prevent human exposure to excavated soils. Protective measures shall include installation of construction fencing around excavated soil and staking or weighting polyethylene sheeting to prevent wind or precipitation damage.

F. Careful removal of contaminated soil will begin with equipment, such as an excavator or pay loader. Work will continue until all contaminated soil is removed from the area outlined on the site plan to the specified depth.

G. Appropriate worker protection practices shall be followed as specified in OSHA Regulations.

3.10.5 Laboratory Testing for Lead in Soil

Pre-abatement and post-abatement soil lead analysis will be performed. EPA protocols for soil sampling will be followed

3.11 DAMAGES

The Abatement Subcontractor shall protect remaining surfaces such as drywall, paneling, plaster, glass, and the property soil, etc., from damage. Damages to non-protected remaining surfaces shall be repaired at the Abatement Subcontractor’s expense. Random background soil samples will have been obtained by the Consultant. Results will be supplied without specifying their location. The Abatement Subcontractor is responsible for damages if the property soil becomes further contaminated. Reference is made to Section 3.10.1 and 3.10.2.

3.12 REOCCUPANCY CRITERIA

During all stages of the exterior abatements, dwelling units will be reoccupied after final cleanup and visual inspection completed by the Consultant at the end of each work day. Two sets of post-abatement wipe samples analyzed by atomic absorption spectroscopy (AAS) will be collected for confirmatory purposes. A comparison will be made with pre-abatement wipe samples collected prior to abatement. If the two sets of results are not statistically different, occupancy shall be maintained. However, if a unit is cleared and re-occupied based on the Consultant’s visual inspection and it then fails to meet the clearance criteria based on the laboratory results, the cost of the cleaning of the occupants’ household furnishings will be borne by the Abatement Subcontractor. U.S. HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing will apply for lead wipe results.

Appendix 8
Example of a Risk Assessment Report

This Appendix provides examples of lead-based paint risk assessment reports in two types of settings: a single-family rental dwelling operated by a small-scale owner (Appendix 8.1) and a large multi-family housing development with many similar dwelling units (Appendix 8.2).

Appendix 8.1

Example of a Risk Assessment Report for a Single-Family Dwelling Operated by a Small-Scale Owner

(See Appendix 8.2 for a Multifamily Risk Assessment.)

Part I: Identifying Information:

Lead-Based Paint Risk Assessment Report

For The Dwelling Located at:

1234 Main St.
Anywhere, Any State 300000

Prepared For:

Mr. Joseph H. Smith, Owner
4444 Podunck Way
Anywhere, Any State 300000
400-777-7777

By:

Michael L. Hazard, Certified Assessor
5678 Snowflake St.
Anywhere, Any State 300000
400-333-3333

Any State License No. 94-567

April 19, 1994

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Summary

Part 1: Identifying Information

A lead-based paint risk assessment was conducted at 1234 Main St. in Anywhere, Any State 300000 for Mr. Joseph H. Smith, Owner, who is located at 4444 Podunck Way, Anywhere, Any State 300000 (400-777-7777) on April 1, 1994. The risk assessment was conducted by Michael L. Hazard, a Certified Risk Assessor (Any State License No. 94-567).

Part II: Results

4. List of Location and Type of Identified Lead Hazards

While the building and its paint are in reasonably good condition overall, the risk assessment showed that lead-based paint hazards (as defined in Title X of the 1992 Housing and Community Development Act) exist in the following locations:

a. Deteriorated lead-based paint on the exterior side of the windows.

b. Leaded dust on the floor of Bobby's bedroom (the southeast bedroom on the second floor).

c. Deteriorated lead-based paint on the interior door leading to Bobby's bedroom (the southeast bedroom

A few other painted surfaces that have not been tested for lead are in "fair" condition and should be repainted within the next year before further deterioration occurs. However, these surfaces are not considered to be immediate "hazards," using criteria in the 1995 *HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. Those surfaces are:

· Exterior Doors
· Exterior Railings
· All Interior Doors (except the bedroom door to the southeast bedroom, which is in poor condition and requires repair immediately)
· Interior window trim
· Stairways
· Bathroom cabinets

Since vacancies occur frequently in this property, these surfaces can be repainted at that time. Before any scraping or sanding, the paint should be tested to see if it contains lead. The paint on the porch floor is in poor condition, but since it does not contain lead-based paint, it does not require priority attention.

There has not been any previous lead-based paint testing at this dwelling, although a lead-based paint inspection of all painted surfaces is recommended so that potential lead problems can monitored before they become hazardous. Soil lead levels were all below 400 µg/g. Current EPA and HUD Guidance for soil is 400 µg/g for bare play areas and 2,000 µg/g for other areas. Using these criteria, soil is not a hazard at this property.

The owner has decided to select the following hazard control measures, which are all acceptable based on HUD's *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*:

- stabilize the paint on the exterior of all the windows
- remove the lead dust located in the child's bedroom
- replace the door leading to the southeast second floor bedroom

Mr. Smith has chosen to use interim controls for the windows until 1997, when the State of Any State is likely to begin a special loan fund for financing lead-based paint abatement that should make window replacement financially possible. Mr. Smith will also make sure that the part-time as-needed maintenance worker he uses will be trained. Certain property management practices will be adopted to ensure that the normal repair work done will not disturb those surfaces with lead-based paint.

After the cleaning and paint film stabilization work has been completed, clearance dust samples must be taken to make certain that the dwelling is lead-safe before the family moves back in to the room.

Reevaluation: Standard Reevaluation Schedule 3 contained in the HUD Guidelines applies to this property, since one of the rooms had a dust lead level greater than the standard. Therefore, the dwelling should be reevaluated in April 1995 (12 months from now). If no lead-based paint hazards are identified at that time, another reevaluation should be conducted in April 1997 (2 years later). If no lead-based paint hazards are identified at that time, no further reevaluations are needed. However, since lead-based paint may be present in the dwelling, the owner should monitor the condition of all painted surfaces at least annually or whenever other information indicates a potential problem.

Mr. Smith has agreed to share the results of this report with the Jones family, which now occupies the residence and to provide the family with the EPA brochure and a brochure from the Anywhere Childhood Lead Poisoning Prevention program as a way of educating the residents.

Form 5.0
Resident Questionnaire

Children/Children's Habits

1. (a) Do you have any children that live in your home? Yes __X___No _____
   (b) If yes, how many?__2___Ages?__1___ __3___ _____ _____ _____
   (c) Record blood lead levels, if known_____ _____ _____ _____ _____

IF NO CHILDREN, SKIP TO Q.5

2. Locate the rooms/areas where each child sleeps, eats, and plays.

Name of Child	Location of Bedroom	Location of All Rooms Where Child Eats	Primary Location Where Child Plays Indoors	Primary Location Where Child Plays Outdoors
Bobby	Southeast - Second Floor	Kitchen	Living Room	Back Yard Under Jungle Gym
Jennifer	Southwest - Second Floor	Kitchen	Living Room	Back Yard Under Jungle Gym

3. Where are toys stored/kept?____Living Room________________________________
4. Is there any visible evidence of chewed or peeling paint on the woodwork, furniture, or toys?
   Yes _____No __X___

Family Use Patterns

5. Which entrances are used most frequently?___Front Door______________
6. Which windows are opened most frequently?___Living Room______________
7. Do you use window air conditioners? If yes, where?_____No____X________
   (Condensation often causes paint deterioration)
8. (a) Do any household members engage in gardening? Yes _____No __X___
   (b) Record the location of any vegetable garden.__No garden_______________
   (c) Are you planning any landscaping activities that will remove grass or ground covering Yes______No __X___
9. (a) How often is the household cleaned?once/week________________
   (b) What cleaning methods do you use? mopping and sweeping___
10. (a) Did you recently complete any building renovations? Yes _____No __X___
    (b) If yes, where?_________________
    (c) Was building debris stored in the yard? If Yes, Where?________________
11. Are you planning any building renovations? Where?_______No__________
12. (a) Do any household members work in a lead-related industry? Yes _____No __X___
    (b) If yes, where are dirty work clothes placed and cleaned?_________________

Form 5.6
Management Data For Rental Dwellings

Part 1: Identifying Information

Identifying Information:

Name of Building or Development Not Applicable
Number of Buildings ____1_____
Number of Individual Dwelling Units/Building: ____1___
Number of Total Dwelling Units: ___1____
Date of Construction 1937(If between 1960 - 1978, consider a Screen Risk Assessment)
Date of Substantial Rehab, if any None

List of Addresses of Dwellings (attach list if more than 10 dwellings are present)

Dwelling No.	Address	No. Children Aged 0 - 6 Years Old	Recent Code Violation Reported by Owner?	Chronic Maintenance Problem?
1	1234 Main St. Anywhere,Any State	2	No	No

Record number and locations of common child play areas (on-site playground, backyards, etc.)

Number 1 Play Structure In Back Yard

Part 2: Management Information

1. List names of individuals who have responsibility for lead-based paint. Include owner, property manager (if applicable), maintenance supervisor and staff (if applicable) and others. Include any training in lead hazard control work (inspector, supervisor, worker, etc.) that has been completed. Use additional pages, if necessary.

   This information will be needed to devise the risk management plan contained in the risk assessor's report.

Name	Position	Training Completed (if none, enter "None")
Joseph Smith	Owner	None
Not Applicable	Property Manager	
Joe Sweat	Maintenance Worker	None

2. Has there been previous lead-based paint evaluations?
   ____ Yes ___X____ No (If yes, attach the report)

3. Has there been previous lead hazard control activity?
   ______ Yes ___X___ No (If yes, attach the report)

4. Maintenance usually conducted at time of dwelling turnover:
   Repainting:______Where needed_______
   Cleaning:_______Where needed________
   Repair: ______Where needed________

5. Employee and Worker Safety Plan

   a. Is there an occupational safety and health plan for maintenance workers?
      ______ Yes ___X___ No (If yes, attach plan)

   b. Are workers trained in lead hazard recognition?
      ______ Yes ___X___ No If yes, who performed the training?
      ____

   c. Are workers involved in a hazard communication program?
      ______ Yes ___X___ No

   d. Are workers trained in proper use of respirators?
      ______ Yes ___X___ No

e. Is there a medical surveillance program
______ Yes ___X___ No

6. Is there a HEPA Vacuum available?
______ Yes ___X___ No

7. Are there any on-site licensed or unlicensed day-care facilities.
______ Yes ___X___ No If yes, give location ___________________________

8. Planning for Resident Children with Elevated Blood Levels

a. Who would respond for the owner if a resident children with an elevated blood lead level was identified?
The owner

b. Is there a plan to relocate such children?
______ Yes ___X___ No If Yes, Where? __________________________________

c. Do you (the owner) know if there ever has been a resident child with an elevated blood lead level?
______ Yes ______ No ___X___Unknown

9. Owner Inspections

a. Are there periodic inspections of all dwellings by the owner?
___X___ Yes ______ No If Yes, how often? Every year or whenever the unit is vacant

b. Is the paint condition assessed during these inspections?
___X___ Yes ______ No

11. Have any of the dwellings have ever received a housing code violation notice?
______ Yes __X____ No ______ Unknown If yes, describe code violation
____
_____

12. If previously detected, unabated lead-based paint exists in the dwelling, have the residents been informed? ______ Yes ______ No ___X__Not Applicable

Form 5.7
Maintenance Data for Rental Dwellings

Recorded during onsite investigation

1. Condition of Paint on Selected Surfaces

Building Component	Paint Condition (Intact, Fair, Poor, or Not Present) To Be Completed by Risk Assessor	Deterioration Due to Friction or Impact?	Deterioration Due to Moisture?	Location of Painted Component with Visible Bite Marks
Building Siding	Intact			
Exterior Trim	Intact			
Window Troughs	Poor	No	No	
Exterior Doors	Fair	Yes	No	
Railings	Fair	Yes	No	
Porch Floors	Poor	Yes	No	
Other Porch Surfaces	Intact			
Interior Doors	Fair (Door to Southeast Bedroom is Poor)	Yes	No	
Ceilings	Fair		No	
Walls	Intact			
Interior Windows	Fair	Yes	No	
Interior Floors	Fair	Yes	No	
Interior Trim	Intact			
Stairways	Fair	Yes	No	
Radiator (Or Radiator Cover)	Intact			
Kitchen cabinets	Intact			
Bathroom cabinets	Fair	Yes	No	
Other surfaces				

If the overall condition of a component is similar throughout a dwelling, that condition should be recorded. If a component in a couple of locations is in poor condition, but the overall condition is good or fair, the specific sites of the badly deteriorated paint should be noted. The specific locations of any component with bite marks should be recorded.

Form 5.7 (continued)

2. Painting Frequency and Methods

   a. How often is painting completed? every ____5_____ years

   b. Is painting completed upon vacancy, if necessary?
   __X____ Yes ______ No

   c. Who does the painting? ___X____Property Owner _______Residents
   IF Residents, SKIP to Q.2

   d. Is painting accompanied by scraping, sanding, or paint removal?
   ___X___ Yes ______ No

   e. How are paint dust/chips cleaned up? (check one)
   __X____ Sweeping ______ Vacuum ______ Mopping ______ HEPA/TSP/HEPA

   f. Is the work area sealed off during painting?
   ______ Yes __X____ No

   g. Is furniture removed from the work area?
   ______ Yes ___X___ No

   h. If no, is furniture covered during work with plastic?
   ______ Yes ___X___ No

3. Is there a preventive maintenance program?
   ______ Yes ___X___ No

4. Describe work order system (if applicable, attach copy of work order form)

   There is no formal work order system.

5. How are resident complaints received and addressed? How are requests prioritized? If formal work orders are issued, is the presence or potential presence of lead-based paint considered in the work instructions?

   Resident complaints are received directly by the owner, who then authorizes the maintenance employee to complete the necessary repairs. The presence of lead-based paint is not routinely considered in the repair and maintenance work.

6. Record location of dwellings recently prepared for reoccupancy.

   Not Applicable

Form 5.1
Building Condition Form

Condition	Yes	No
Roof Missing Parts of Surfaces (tiles, boards, etc.)		X
Roof Has Holes or Large Cracks		X
Gutter or Downspouts Broken	X	
Chimney Masonry cracked, bricks loose or missing, obviously out of plumb		X
Exterior or interior walls have obvious large cracks or holes, requiring more than routine painting		X
Exterior siding has missing boards or shingles		X
Water stains on interior walls or ceilings		X
Plaster walls deteriorated		X
Two or more windows or doors broken, missing, or boarded up		X
Porch or steps have major elements broken, missing, or boarded up		X
Foundation has major cracks, missing material, structural leans, or visibly unsound		X
Total	2 (1, see notes)	

If the "Yes" column has 2 or more checks, the dwelling is considered to be in poor condition for the purposes of a risk assessment. However, specific conditions and extenuating circumstances should be considered before determining final condition of the building and the appropriateness of a lead hazard screen.

Notes:

Gutter downspout reattached during visit; owner stated this was due to a recent storm

8. Dwelling Selection Process

   This section is not applicable for this property

9. Analysis of Previous XRF Testing Report

   There is no previous XRF Testing Report; this section is not applicable for this property.

Form 5.3
Field Sampling Form for Deteriorated Paint

Name of Risk Assessor Michael Hazard
Name of Property Owner Joseph Smith
Property Address 1234 Main St, Anywhere Any State 300000 Apt. No.____________
Sampling Protocol __X___All Dwellings _____Targeted _____Worst-Case _____Random
Target Dwelling Criteria (Check All That Apply)

_____ Code Violations
_____ Judged to be in Poor Condition
_____ Presence of 2 or More Children between Ages of 6 Months and 6 Years
_____ Serves as Day-Care Facility
_____ Recently Prepared for Reoccupancy
_____ Random Sampling
_____ None of the above

Sample Number	Room	Building Component	Laboratory Result (µg/g) or XRF Reading (mg/cm²)
1	Southeast Child's Bedroom (Bobby's Room)	Window Trough Frame	9.2 mg/cm² (portable XRF)
2	Front Porch	Floor	0.1 mg/cm² (portable XRF)
3	Southeast Child's Bedroom (Bobby's Room)	Interior Door	5.3 mg/cm² (portable XRF)
4	Living Room	Window Trough Frame	7.8 mg/cm² (portable XRF)
HUD Standard			5,000 µg/g or 1 mg/cm²

Sample all layers of paint, not just deteriorated paint layers
Total Number of Samples This Page___4_____
Page ____1____ of ____1_____
Date of Sample Collection_4___/_1___/_94___ Date Shipped to Lab_4___/__1__/__94__
Shipped by _____________________ Received by _______________________________
(signature)(signature)
Date Results Reported _4___/_10___/_93___
Analyzed by___Lisa Baker_____________________
Approved by___Jim Zimmerman____________________

Form 5.4
Field Sampling Form For Dust
(Single Surface)

Name of Risk Assessor _____Michael Hazard______________________
Name of Property Owner _____Joseph Smith______________________
Property Address _1234 Main St, Anywhere, Any State______ Apt. No.___________

Dwelling Selection Protocol __X___ All Dwellings _____ Targeted _____ Worst-Case _____ Random
Target Dwelling Criteria (Check All That Apply)
_____ Code Violations
_____ Judged to be in Poor Condition
_____ Presence of 2 or More Children between Ages of 6 Months and 6 Years
_____ Serves as Day-Care Facility
_____ Recently Prepared for Reoccupancy

Sample Number	Room (Record Name of Room Used by the Owner or Resident)	Surface Type	Is Surface Smooth and Cleanable?	Dimensions[1] of Sample Area (inches x inches)	Area (ft²)	Result of Lab Analysis (µg/ft²)
1	Play Room Living Room	Floor	Yes	_12_ x _12_	1	79
2	Play Room Living Room	Interior Window Sill	Yes	_3__ x _33_	0.69	150
3	Kitchen _________	Floor	Yes	_12_ x _12_	1	<25
4	Kitchen _________	Window Trough	No	_3__ x _25_	0.52	579
5	Bedroom 1 Bobby (Southeast)	Floor	No	_12_ x _12_	1	1,356
6	Bedroom 1 Bobby (Southeast)	Interior Window Sill	No	_2.5_ x _34_	0.59	400
7	Bedroom 2 Jennifer (Southwest)	Floor	Yes	_12_ x _12_	1	29
8	Bedroom Jennifer (Southwest)	Window Trough	No	_3_ x _33_	0.69	600
9	Blank					<25

[1] Measure to the nearest 1/8 inch

Total Number of Samples This Page____9____
Page ___1______ of ____1_____
Date of Sample Collection__4__/__1__/_94_ Date Shipped to Lab__4__/_4___/_94___
Shipped by _______________________________ Received by_______________________
(signature)(signature)
HUD Standards: 100 µg/ft² (floors), 500 µg/ft² (interior window sills), 800 µg/ft² (window troughs)

Form 5.5
Field Sampling Form For Soil
(Composite Sampling Only)

Name of Risk Assessor ____Michael Hazard_______________________
Name of Property Owner ___Joseph Smith________________________
Property Address _1234 Main St. Anywhere, Any State__________________________

Sample No.	Location	Bare or Covered	Lab Result (µg/g)
1	Building Perimeter	Bare	222
	Building Perimeter		
2	Play Area 1 (describe) <u>Back Yard Jungle Gym</u>	Bare	102
	Play Area 2 (describe) ____________		

Collect only the top ½" of soil

Total Number of Samples This Page____2____
Page ___1______ of ____2_____
Date of Sample Collection__4__/__1__/__94__ Date Shipped to Lab__4__/__1__/__94__

Shipped by _________________________________ Received by ________________________________
(signature)(signature)

13. Other sampling results

The owner decided not to have water sampling conducted at this property.

Part III: Lead Hazard Control Options

14. Lead-Based Paint Policy Statement

The owner indicated such a statement would be developed.

15. Name of Individual in Charge of Lead-Based Paint Hazard Control Program: Joseph Smith

16. Recommended Changes to Work Order System and Property Management

The existing work order system is an informal verbal one. If painted surfaces will be disturbed during a particular repair job, the painted surface should be tested to determine if it has lead-based paint on it. If it does (or if testing is not completed), the maintenance worker should take the necessary precautions by wetting down the surface and performing cleanup. If the surface area is large or if the work will generate a significant amount of dust, clearance testing should be completed before residents move back into the room. The table below can be used as a general guide in determining whether maintenance jobs are likely to be high risk or low risk.

When work is assigned, the owner or worker should determine whether or not the job is low or high risk and adopt protective measures as needed

Table 17.1 (Taken from HUD Guidelines)
Summary of Low- and High-Risk Job Designations for Surfaces Known or Suspected to Have Lead-Based Paint

Job Description	Low Risk	High Risk*
Repainting (includes surface preparation)		√
Plastering or wall repair		√
Window repair		√
Water or moisture damage repair (repainting and plumbing)		√
Door repair	√	
Building component replacement		√
Welding on Painted Surfaces		√
Door lock repair or replacement	√	
Electrical fixture repair	√	
Floor refinishing		√
Carpet replacement		√
Groundskeeping	√	
Radiator leak repair	√	
Baluster repair (metal)		√
Demolition		√

* High-risk jobs typically disturb more than 2 square feet per room. If these jobs disturb less than 2 square feet, then they can be considered low-risk jobs.

Table 17.2
Summary of Protective Measures For Low- and High-Risk Jobs

Protective Measure	Low Risk	High Risk
Worksite preparation with plastic sheeting (6 mil thick)	Plastic sheet no less than 5 feet by 5 feet immediately underneath work area	Whole floor, plus simple airlock at door or tape door shut
Children kept out of work area	Yes	Yes
Resident relocation during work	No	Yes
Respirators	Probably not necessary*	Recommended
Protective clothing Note: Protective shoe coverings are not to be worn on ladders, scaffolds, etc.	Probably not necessary*	Recommended
Personal hygiene (enforced hand washing after job)	Required	Required
Showers	Probably not necessary	Recommended
Work practices	Use wet methods, except near electrical circuits	Use wet methods, except near electrical circuits
Cleaning	Wet cleaning with lead-specific detergent trisodium phosphate or other suitable detergent around the work area only (2 linear feet beyond plastic)	HEPA vacuum/wet wash/ HEPA vacuum the entire work area
Clearance	Visual examination only	Dust sampling during the preliminary phase of the maintenance program and periodically thereafter (not required for every job)

* Employers must have objective data showing that worker exposures are less than the OSHA Permissible Exposure Limit of $50 \mu g/m^3$ if respirators and protective clothing will not be provided.

Paint chips are now cleaned up by sweeping. Mopping or other wet cleaning methods should be used instead.

If residents are present, the work area should be sealed off so that leaded dust does not enter the living area. Any furniture present should be moved or covered with plastic. Further details are provided in the Appendix. The possible presence of lead-based paint should be considered in all repair and maintenance work.

A lead-based paint inspection should be completed at some point in the future to determine exactly where all the lead-based paint is located so that it can be properly managed.

The Anywhere, Any State Childhood Lead Poisoning Prevention Program offers a general awareness class in lead-based paint hazards, which both the owner and the maintenance worker should attend. The program also offers the use of a HEPA vacuum and provides advice on respirators and medical surveillance and other lead-related issues (see Appendix).

The practice of examining the condition of the paint annually or upon vacancy is a good one and should be continued.

Since the paint has not yet been completely tested, it should be assumed to contain lead-based paint. The owner should tell residents to report any paint that is peeling, chipping, flaking, chalking, or otherwise deteriorating so that it can be repaired quickly and safely.

17. Interim Control Options and Estimated Costs

The costs shown below include labor, materials, worker protection, site containment and cleanup. These are only very rough estimates that may not be accurate; a precise estimate should be obtained from a certified lead-based paint abatement contractor. I would be pleased to perform clearance testing after this work has been completed at your request.

Hazard A: Window Trough Surfaces

a. Paint Film Stabilization of both frame and sash — $xx/window
b. Encapsulation of Exterior Frame with a Liquid Encapsulant Coating plus sash replacement — $xx/window

Hazard B: Leaded Dust On Bobby Jones' Bedroom (Southeast Bedroom) Floor

a. Dust removal and recoating hardwood floor with polyurethane — $xxx

Hazard C: Deteriorated Lead-Based Paint on the interior door leading to Bobby's Bedroom (Southeast Bedroom)

a. Paint Film Stabilization plus rehang door for smooth operation (paint film stabilization alone without door repair is not appropriate) — $xx

18. Acceptable Abatement Options and Estimated Costs

Hazard A Window Trough Surfaces

a. Enclosure of window frame with metal panning system plus sash replacement — $xx/window
b. Replacement of entire window assembly — $xx/window
c. Remove all lead-based paint from entire window assembly using chemical paint removers — $xx/window

Hazard B: Leaded Dust On Bobby's Bedroom (Southeast Bedroom) Floor

a. Enclosure of floor with new subflooring and tile — $xxx/room

Hazard C: Deteriorated Lead-Based Paint on the interior door leading to Bobby's Bedroom (Southeast Bedroom)

a. Replace door and door frame — $xxx

b.	Encapsulate door	$xxx
c.	Replace door and enclose door frame	$xxx
d.	Remove lead-based paint from door and door frame chemically	$xxx

19. Reevaluation and Monitoring Schedule

Each of these treatments will need to be reexamined periodically to make certain that they remain effective and to ensure that new lead-based paint hazards do not appear. The interim controls shown above are less expensive initially, but they may be more expensive in the long run since they need to be reevaluated more frequently. The replacement and paint removal methods are more expensive initially, but do not require any reevaluation.

The owner should monitor the condition of the paint at least annual annually or if there is some indication that paint might be failing. A professional reevaluation is also needed. The standard schedule for reevaluating the dwelling is shown below.

Reevaluation: Standard Reevaluation Schedule 3 contained in the HUD Guidelines applies to this property, since one of the rooms had a dust lead level greater than the standard. Therefore, the dwelling should be reevaluated in April 1995 (12 months from now). If no lead-based paint hazards are identified at that time, another reevaluation should be conducted in April 1997 (2 years later). If no lead-based paint hazards are identified at that time, no further reevaluations are needed. However, since lead-based paint may be present in the dwelling, the owner should monitor the condition of all painted surfaces at least annually or whenever other information indicates a potential problem.

Part IV: Site-Specific Lead Hazard Control Plan

20. Lead Hazard Control Option To Be Implemented in This Property

Hazard A: Window Trough Surfaces

Paint Film Stabilization of both frame and sash

Hazard B: Leaded Dust On Bobby Smith's Bedroom (Southeast Bedroom) Floor

Dust removal and recoating hardwood floor with polyurethane

Hazard C: Deteriorated Lead-Based Paint on the interior door leading to Bobby's Bedroom (Southeast Bedroom)

Replace door and door frame

21. Training Plan for Managers, Maintenance Supervisors and Workers

The part-time worker will attend the lead awareness class offered by the Anywhere Any State Childhood Lead Poisoning Prevention Program to learn how maintenance work can be conducted safely when dealing with lead-based paint. The owner has agreed to attend the same class. The Appendix to this report contains brochures with the relevant information.

22. Method of Resident Notification of Results of Risk Assessment and Lead Hazard Control Program

The summary of this report will be provided by the owner to the residents in the dwelling. The brochure in the Appendix will be provided to the residents. The owner will explain to the resident that the lead hazards at the property will be corrected within two weeks. The dwelling will be tested after the work has been completed to make certain that it was effective. After the work has been completed and clearance established, a certificate will be appended to this report.

23. Signatures (Risk Assessor and Owner), Date and Certificate of Lead-Based Paint Compliance

____

Joseph Smith, Owner
(date)

____

Michael Hazard, Certified Risk Assessor
(date)

Example of Certificate of Lead-Based Paint Compliance

I hereby certify that on May 1, 1994 the dwelling located at 1234 Main St, Anywhere, Any State meets the criteria established by the Department of Housing and Urban Development for lead safety. Either no lead-based paint hazards were identified or all lead-based paint hazards have been corrected.

____

Owner

____

Authorized Signature

Risk Assessor License # ________________________

Expiration Date: March 31, 1996

Any State
Department of Health
Division of Childhood Lead Poisoning Prevention

Appendix 8.2

Example of a Risk Assessment Report for a Large Multi-Family Housing Development

Part I: Identifying Information:

Lead-Based Paint Risk Assessment Report

For Home Sweet Home Apartment Building

5678 Main St.
Anywhere, Any State 300000

Prepared For:

Mr. Joseph H. Smith, Owner
4444 Podunck Way
Anywhere, Any State 300000
400-777-7777

By:

Michael L. Hazard, Certified Assessor
5678 Snowflake St.
Anywhere, Any State 300000
400-333-3333

Any State License No. 94-567
EPA Certificate No. 33456

April 19, 1994

Table of Contents

Summary

Part I: Identifying Information

A lead-based paint risk assessment was conducted at the Home Sweet Home Apartment Building at 5678 Main St. in Anywhere, Any State 300000 for Mr. Joseph H. Smith, Owner, who is located at 4444 Podunck Way, Anywhere, Any State 300000 (400-777-7777) on April 1, 1994. The risk assessment was conducted by Michael L. Hazard, a Certified Risk Assessor (Any State License No. 94-567).

Home Sweet Home contains 438 apartments distributed through 15 stories. All the apartments are of a similar construction and have been repainted over the years in a similar fashion (the apartment owner's maintenance crew does most of the painting). Twenty-three of the units were targeted for sampling and visual assessment for this risk assessment using the criteria established in the HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing. One of these 23 targeted dwellings had been recently prepared for reoccupancy.

Part II. Results

4. List of Location and Type of Identified Lead-Based Paint Hazards

The building and its paint are in relatively poor condition overall, with water leaks and structural deficiencies evident throughout. The risk assessment showed that lead hazards exist in the following locations:

Hazard A: Deteriorated lead-based paint on the exterior doors, window troughs, exterior trim and on the interior kitchen and bathroom walls.

Hazard B: Leaded dust on window troughs and in common hallways.

Hazard C: Contaminated soil in the play area located at the front of the building and around the building perimeter.

Paint chip sampling indicated that lead-based paint is present on exterior doors, window troughs, exterior trim, and on interior kitchen and bathroom walls. Previous lead-based paint testing at this location indicated that lead-based paint was present on <u>all</u> interior walls and kitchen cabinets, but in no other location. A review of the testing report showed that many painted surfaces had not been tested at all. For those that were tested, no attempt had been made to correct for the substrate underneath the paint. For example, the previous report indicated that lead-based paint was present on the kitchen cabinets. However, laboratory analysis of this paint indicated that the cabinets do <u>not</u> in fact contain lead-based paint and therefore do not require treatment. A more complete lead-based paint testing effort is needed if the exact locations of lead-based paint is to be determined. The previous testing report should not be relied upon to determine how maintenance and other repair work should be done.

Dust testing showed that leaded dust on window troughs in all rooms sampled averaged 30,532 $\mu g/ft^2$, more than 10 times greater than the HUD standard of 800 $\mu g/ft^2$.

Soil lead levels around the perimeter of the building and in the playground in front of the building were between 3,000 - 4,000 µg/g, well above the HUD Interim Standard of 2,000 µg/g for building perimeters and 400 µg/g for play areas.

After considering a number of options, the owner has decided to use interim controls in the immediate future, since the building is scheduled for comprehensive renovation within several years. These interim controls include:

- Stabilizing the paint on all surfaces that have deteriorated lead-based paint
- Removal of leaded dust located on window troughs and in common hallways
- Covering the bare soil with new sod and planting thorny bushes around the building perimeter to prevent children from entering this area. The play area will be covered with a suitable ground liner and then covered with sand at least 12 inches deep.

Mr. Smith has chosen to use interim controls until the building is renovated, which is scheduled to occur in 1998. A lead-based paint inspection will be performed at that time with the intent of including abatement in the renovation plans. The ten maintenance workers (some of whom work in other nearby apartment buildings owned by Mr. Smith), will all be trained in lead-based paint work practices. Certain property management practices will also be adopted to ensure that the normal repair work done will not disturb those surfaces with lead-based paint.

After the interim control work has been completed, a clearance examination, including dust sampling must be completed to make certain that the dwelling is lead-safe before the family moves back into the affected rooms.

Reevaluation:

Because the levels of leaded dust were more than 10 times greater than the HUD standard, this property should be reevaluated according to Schedule 4 in the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing.* This schedule calls for a reevaluation in September 1994 (6 months from now). If no lead-based paint hazards are identified, another reevaluation is not needed until September 1995 (1 year later). Assuming no new lead-based paint hazards are identified, a final reevaluation should be performed in September 1997, according to the HUD Guidelines. If the building passes the reevaluation, no further reevaluation is required, although the owner should still monitor the condition of the paint at least annually or whenever there is information that the paint is deteriorating.

After explaining the control measures that will be undertaken, Mr. Smith has agreed to share the results of this report with the residents in the building, and to provide each family with the EPA brochure and a brochure from the Anywhere Childhood Lead Poisoning Prevention program as a way of educating the residents.

Form 5.6
Management Data For Rental Dwellings

Part 1: Identifying Information

Identifying Information:

Name of Building or Development Home Sweet Home Apartment Building
Number of Buildings ____1_____
Number of Individual Dwelling Units/Building: ____438___
Number of Total Dwelling Units: ___438____
Date of Construction 1937
Date of Substantial Rehab, if any None

List of Addresses of Dwellings (attach list if more than 10 dwellings are present)

Dwelling Unit No.	Address	No. Children Aged 0 - 6 Years Old	Recent Code Violation Reported by Owner?	Chronic Maintenance Problem?
1	5678 Main St. Anywhere,Any State	209	No	No
2		2	No	No
3		1	No	No
4		3	No	No
5		0	No	No
6		0	No	No
7		0	No	No
8		2	No	No
9		3	Yes	Yes
10		0	No	

(**Other pages of this form would be included to list all 438 units)**
Record number and locations of common child play areas (on-site playground, backyards, etc.)

Number 1 On-Site Playground in Front of Building

Part 2: Management Information

1. List names of individuals who have responsibility for lead-based paint. Include owner, property manager (if applicable), maintenance supervisor and staff (if applicable) and others. Include any training in lead hazard control work (inspector, supervisor, worker, etc.) that has been completed. Use additional pages, if necessary.

   This information will be needed to devise the risk management plan contained in the risk assessor's report.

Name	Position	Training Completed (if none, enter "None")
Joseph Smith	Owner	None
Madeline Fairfield	Property Manager	None
Joe Sweat	Maintenance Supervisor	None

2. Has there been previous lead-based paint evaluations?
   __X__ Yes _______ No (If yes, attach the report)

3. Has there been previous lead hazard control activity?
   ______ Yes ___X___ No (If yes, attach the report)

4. Maintenance usually conducted at time of dwelling turnover:

Repainting_______X_____
Cleaning_____X_______
Repair ____As Needed___

Comments:
The dwelling has all trash removed after the resident has left. Joe Sweat inspects the dwelling and decides whether repainting is needed or other repairs to building systems are necessary. After performing any repainting or other repairs, the floors are mopped and the kitchen counters and bathrooms cleaned. All other floors are vacuumed.

5. Employee and Worker Safety Plan

   a. Is there an occupational safety and health plan for maintenance workers?
   ______ Yes ___X___ No (If yes, attach plan)

   b. Are workers trained in lead hazard recognition?
   ______ Yes ___X___ No If yes, who performed the training?
   ____

c. Are workers involved in a hazard communication program?
______ Yes ___X___ No

d. Are workers trained in proper use of respirators?
______ Yes ___X___ No

e. Is there a medical surveillance program
______ Yes ___X___ No

6. Is there a HEPA Vacuum available?
______ Yes ___X___ No

7. Are there any on-site licensed or unlicensed day-care facilities.
______ Yes ___X___ No If yes, give location __________________________

8. Planning for Resident Children with Elevated Blood Levels

a. Who responds for the owner if a resident children with elevated blood lead levels is identified?
Madeline Fairfield

b. Is there a plan to relocate such children?
______ Yes ___X___ No If Yes, Where? _________________________________

c. Do you (the owner) know if there ever has been a resident child with an elevated blood lead level?
______ Yes ______ No ___X___Unknown

9. Owner Inspections

a. Are there periodic inspections of all dwellings by the owner?
___X___ Yes ______ No If Yes, how often? Every year or whenever the unit is vacant

b. Is the paint condition assessed during these inspections?
___X___ Yes ______ No

10. Do you (the owner) know if any of the dwellings have ever received a housing code violation notice?
______ Yes __X____ No ______ Unknown If yes, describe code violation
____
____

11. If previously detected, unabated lead-based paint exists in the dwelling, have the residents been informed? ______ Yes ___X___ No

Form 5.7
Maintenance Data for Rental Dwellings

Condition of Paint on Selected Surfaces (Separate Page For Each Targeted Dwelling)

Building Component	Paint Condition (Intact, Fair, Poor, or Not Present) To Be Completed by Risk Assessor	Deterioration Due to Friction or Impact?	Deterioration Due to Moisture?	Location of Painted Component with Visible Bite Marks
Building Siding	Fair			
Exterior Trim	Poor	No	No	
Window Troughs	Poor	No	No	
Exterior Doors	Poor	Yes	No	
Railings	Fair	Yes	No	
Porch Floors	Not Applicable			
Other Porch Surfaces	Not Applicable			
Interior Doors	Fair	Yes	No	
Ceilings	Fair		No	
Walls	Intact (Kitchen and Bathroom Walls are Poor)			
Interior Windows	Fair	Yes	No	
Interior Floors	Fair	Yes	No	
Interior Trim	Intact			
Stairways	Fair	Yes	No	
Radiator (Or Radiator Cover)	Intact			
Kitchen cabinets	Poor	No	No	
Bathroom cabinets	Intact			
Other surfaces				

If the overall condition of a component is similar throughout a dwelling, that condition should be recorded. If a component in a couple of locations is in poor condition, but the overall condition is good or fair, the specific sites of the badly deteriorated paint should be noted. The specific locations of any component with bite marks should be recorded.

Form 5.7 (continued)

1. Painting Frequency and Methods

   a. How often is painting completed? every ____5_____ years

   b. Is painting completed upon vacancy, if necessary?
   __X____ Yes ______ No

   c. Who does the painting? ___X____Property Owner _______Residents
   IF Residents, SKIP to Q.2

   d. Is painting accompanied by scraping, sanding, or paint removal?
   ___X___ Yes ______ No

   e. How are paint dust/chips cleaned up? (check one)
   __X____ Sweeping ______ Vacuum ______ Mopping ______ HEPA/TSP/HEPA

   f. Is the work area sealed off during painting?
   ______ Yes __X____ No

   g. Is furniture removed from the work area?
   ______ Yes ___X___ No

   h. If no, is furniture covered during work with plastic?
   ______ Yes ___X___ No

2. Is there a preventive maintenance program?
   ______ Yes ___X___ No

3. Describe work order system (if applicable, attach copy of work order form)

   Ms. Madeline Fairfield, property manager, receives complaints from residents and prepares a written work order for Mr. Joe Sweat, maintenance supervisor, who assigns the job to one or more individual workers

4. How are resident complaints received and addressed? How are requests prioritized? If formal work orders are issued, is the presence or potential presence of lead-based paint considered in the work instructions?

   Resident complaints are received directly by the property manager, who then authorizes the maintenance supervisor to complete the necessary repairs. The presence of lead-based paint is not routinely considered in the repair and maintenance work.

5. Record location of dwellings recently prepared for reoccupancy.

   Apartment 234

Form 5.1
Building Condition Form

Condition	Yes	No
Roof Missing Parts of Surfaces (tiles, boards, etc.)		X
Roof Has Holes or Large Cracks	X	X
Gutter or Downspouts Broken	X	
Chimney Masonry cracked, bricks loose or missing, obviously out of plumb		X
Exterior or interior walls have obvious large cracks or holes, requiring more than routine painting		X
Exterior siding has missing boards or shingles	X	X
Water stains on interior walls or ceilings	X	X
Plaster walls deteriorated		X
Two or more windows or doors broken, missing, or boarded up	X	X
Porch or steps have major elements broken, missing, or boarded up		X
Foundation has major cracks, missing material, structural leans, or visibly unsound		X
Total	6	

If the "Yes" column has 4 or more checks, the dwelling is considered to be in poor condition. Less than 4 checks in the "Yes" column means that the dwelling appears to be well maintained.

8. Dwelling Selection Process

HUD Guidelines state that for buildings with 438 apartments with a similar painting history and management history, 23 of those apartments can be selected to characterize the lead-based paint risks throughout the building. These 23 apartments were selected using a targeted approach, as defined in the HUD Guidelines. Information on maintenance history, code violations, and presence of young children was used to select those apartments likely to have the highest risks. The dwellings were not selected randomly. Walkthrough surveys could not be conducted in all 438 apartments.

9. Analysis of Previous XRF Testing

A preliminary assessment of an XRF Lead-Based Paint inspection conducted 5 years ago by Joe Crook Inspections was performed using the criteria in the HUD Guidelines. The results of this assessment indicate that the earlier results are unreliable and that further testing will be needed before any substantial renovation or disturbance of surfaces with lead-based paint.

	Review of Previous Lead-Based Paint Inspections	**YES**	**NO**
1	Did the report clearly explain the entire testing program and include an executive summary in narrative form?		X
2	Did the report provide an itemized list of similar building components (testing combinations) and the percentage of each component that tested positive, negative, and inconclusive? (Percentages are not applicable for single family dwellings.)		X
3	Did the report include test results for the common areas and building exteriors as well as the interior of the dwelling units?	X	
4	Were all of the painted surfaces that are known to exist in the dwelling units, common areas, and building exteriors included in the itemized list of components that were tested?		X
5	Does the owner fully comprehend the report and completely understand their responsibilities regarding further testing or hazard control?		X
6	If confirmation testing (laboratory testing) was necessary, did the testing firm amend the final report and revise the list of surfaces that tested positive, negative, and inconclusive?		X
7	Was the unit selection process performed randomly?	X	
8	Is the name of the XRF Manufacturer, Model Number, and Serial Number of the XRF that was used in each unit recorded in the report?		X
9	Did the report record the XRF calibration checks for each day that testing was performed?	X	
10	Did the calibration checks indicate that the instrument was operating within the Quality Control Value (see chapter 7)?		X
11	Were three readings collected for each surface?	X	
12	Were substrate corrections performed (if necessary)?	X	
13	Were confirmatory paint chip samples collected if XRF readings were in the inconclusive range?		
14	Was the procedure that was used to collect the paint chip samples described?		X
15	Was the laboratory that analyzed the paint samples identified?		X

Form 5.3
Field Sampling Form for Deteriorated Paint
(Use a Separate Page for Every Unit in Multi-Family Housing)

Name of Risk Assessor Michael Hazard
Name of Property Owner Joseph Smith
Property Address 5678 Main St, Anywhere Any State 300000 Apt. No.___9________

Sampling Protocol _____All Dwellings __X___Targeted _____Worst-Case _____Random
Target Dwelling Criteria (Check All That Apply)
__X___ Code Violations
__X___ Judged to be in Poor Condition
__X___ Presence of 2 or More Children between Ages of 6 Months and 6 Years
_____ Serves as Day-Care Facility
_____ Recently Prepared for Reoccupancy
_____ Random Sampling

Sample Number	Room	Building Component	Lead (µg/g or mg/cm²)
1	Southeast Child's Bedroom (Bobby's Room)	Window Trough Frame	12,638 µg/g
2	Kitchen	Cabinets	238 µg/g
3	Kitchen	Walls	7,893 µg/g
4	Bathroom	Walls	10,487 µg/g
HUD Standard			5,000 µg/g or 1 mg/cm²

Sample all layers of paint, not just deteriorated paint layers
Total Number of Samples This Page___4_____
Page ____1_____ of ____1_____
Date of Sample Collection_4___/_1___/_94___ Date Shipped to Lab_4___/__1__/__94__
Shipped by ____________________ Received by ______________________________
(signature) (signature)
Date Results Reported _4___/_10___/_94___ Analyzed by___Lisa Baker____________________
Approved by___Jim Zimmerman___________________

Form 5.4a
Field Sampling Form for Dust
(Composite Sampling) (A separate page is used for each unit or common area)

Name of Risk Assessor ___Michael Hazard________________________
Name of Property Owner ___Joseph Smith________________________
Property Address _5678 Main St_____________ Apt. No.____9_______

Dwelling Selection Protocol _____ All Dwellings __X___ Targeted _____ Worst-Case _____ Random

Target Dwelling Criteria (Check All That Apply)
__X___ Code Violations
__X___ Judged to be in Poor Condition
__X___ Presence of 2 or More Children between Ages of 6 Months and 6 Years
_____ Serves as Day-Care Facility
_____ Recently Prepared for Reoccupancy
_____ Random Sampling

Sample Number	Record Name of Rooms Used by Owner or Resident to be Included in Sample	Dimension[1] of Surface Sampled in Each Room (inches x inches)	Total Surface Area Sampled (ft²)	Type of Surface Sampled	Is Surface Smooth and Cleanable?	Lab Result (µg/ft²)
1	_Kitchen___ _Living Room_ _Child's Bedroom__ _2nd Bedroom__	_12_ x _12_ _12_ x _12_ _12_ x _12_ _12_ x _12_	4	Smooth Floors	Yes	124
	________ ________ ________ ________	____ x ____ ____ x ____ ____ x ____ ____ x ____		Carpeted Floors		
2	_Kitchen Living Room _Child's Bedroom _2nd Bedroom	_3__ x _33.5_ _3.25_ x _33.5_ _3.25_ x _33.5_ _3.25_ x _33.5_	2.97	Interior Window Sills	Yes	336
3	_Kitchen__ _Living Room_ _Child's Bedroom_ _2nd Bedroom_	_2.4_x _33.5_ _2.5_ x _33.5_ _2.5_ x _33.5_ _2.5_ x _33.5_	2.30	Window Troughs	No	30,456

[1] Measure to the nearest 1/8 inch
Total Number of Samples This Page___3_____
Page ____1_____ of ___27______
Date of Sample Collection__4__/__1__/__94__ Date Shipped to Lab_4___/_1___/_94___
Shipped by ________________________________ Received by ________________________________
(signature) (signature)
HUD Standards: 100 µg/ft² (floors), 500 µg/ft² (interior window sills), 800 µg/ft² window troughs

Form 5.4a
Field Sampling Form for Dust
(Composite Sampling)

Name of Risk Assessor ___Michael Hazard________________________
Name of Property Owner ___Joseph Smith________________________
Property Address _5678 Main St_____________ Apt. No._COMMON AREAS__

Dwelling Selection Protocol _____ All Dwellings __X___ Targeted _____ Worst-Case _____ Random
Target Dwelling Criteria (Check All That Apply)
_____ Code Violations
_____ Judged to be in Poor Condition
_____ Presence of 2 or More Children between Ages of 6 Months and 6 Years
_____ Serves as Day-Care Facility
_____ Recently Prepared for Reoccupancy

Sample Number	Record Name of Rooms Used by Owner or Resident to be Included in Sample	Dimension[1] of Surface Sampled in Each Room (inches x inches)	Total Surface Area Sampled (ft²)	Type of Surface Sampled	Is Surface Smooth and Cleanable?	Lab Result (µg/ft²)
C-1	1st Floor Hallway_ 5th Floor Hallway_ 9th Floor Hallway_ 13th Floor Hallway	_12_ x _12_ _12_ x _12_ _12_ x _12_ _12_ x _12_	4	Smooth Floors	Yes	124
C-2	_1st Floor Hallway_ _5th Floor Hallway_ _9th Floor Hallway_ 13th Floor Hallway	_3__ x _33.5_ _3.25_ x _33.5_ _3.25_ x _33.5_ _3.25_ x _33.5_	2.97	Window Troughs	No	47,894
C-3	_1st Floor 5th Floor 9th Floor 13th Floor	8 x 12 8x12 8x12 8x12	2.67	Stair Treads	No	336
C-4	_1st Floor_ _5th Floor_ _9th Floor_ _13th Floor_	_12_x _12_ _12_ x _12_ _12_ x _12_ _12_ x _12_	4	Landings	No	16,456

[1] Measure to the nearest 1/8 inch

Total Number of Samples This Page___4_____
Page ____2_____ of ___27______
Date of Sample Collection__4__/__1__/__94__ Date Shipped to Lab_4___/_1___/_94___
Shipped by ________________________________ Received by ________________________________
(signature) (signature)
HUD Standards: 100 µg/ft² (floors), 500 µg/ft² (interior window sills), 800 µg/ft² window troughs

Form 5.5
Field Sampling Form For Soil
(Composite Sampling Only)

Name of Risk Assessor ____Michael Hazard________________________
Name of Property Owner ___Joseph Smith_________________________
Property Address _5678 Main St. Anywhere, Any State___________________________

Sample No.	Location	Bare or Covered	Lab Result (µg/g)
S-1	Building Perimeter (North & East Sides)	Bare	3,989
S-2	Building Perimeter (South & West Sides)	Bare	3,498
S-3	Play Area Front Playground	Bare	3,897
	Play Area 2 (describe) ____________		
HUD Interim Standard			400 for bare play areas, 2000 for other yard ares

Collect only the top ½" of soil

Total Number of Samples This Page____3____
Page ___3______ of ____27_____
Date of Sample Collection__4__/__1__/__94__ Date Shipped to Lab__4__/__1__/__94__

Shipped by _________________________________ Received by ________________________________
(signature) (signature)

Part III: Lead Hazard Control Options

14. Lead-Based Paint Policy Statement

Home Sweet Home has decided to adopt a lead-based paint policy statement, as follows:

Home Sweet Home Property Management Company is committed to controlling lead-based paint hazards in all its apartments. Madeline Fairfield, Property Manager, has my authority to direct all activities associated with lead hazard control, including directing training, issuing special work orders, informing residents, responding to cases of children with elevated blood lead levels, correcting lead-based paint hazards on an emergency repair basis, and any other efforts that may be appropriate. The company's plan to control such hazards is detailed in a risk assessment report and lead hazard control plan.

(Signed)_Joseph Smith________________________________ __________(Date)

(Owner)

(Signed)__Madeline Fairfield_________________________________ __________(Date)

(Lead Hazard Control Program Manager)

---

15. Name of Individual in Charge of Lead-Based Paint Hazard Control Program Madeline Fairfield

16. Recommended Changes to Work Order System and Property Management

If painted surfaces will be disturbed during a particular repair job, the painted surface should be tested to determine if it has lead-based paint on it, unless it has been tested previously by reliable testing. The results in this report indicate that lead-based paint is definitely present on exterior doors, window trough frames, exterior trim, and kitchen and bathroom walls. All other surfaces should be considered to be suspected lead-based paint until they have been tested. If lead-based paint is present (or is suspected to be present), the maintenance worker should take the necessary precautions by wetting down the surface and performing cleanup. If the surface area is large, clearance testing should be completed before residents move back in. As general guidance, the table shown below can be used. The work order should indicate whether respirators and protective clothing are needed, how extensive the cleaning should be, and any other special precautions. The Appendix to this report contains a sample of a work order form for lead-based paint work.

Paint chips are now cleaned up by sweeping. Mopping or other wet cleaning methods should be used instead.

If residents are present, the work area should be sealed off so that leaded dust does not enter the living area. Any furniture present should be moved or covered with plastic. Further details are provided in the Appendix. The possible presence of lead-based paint should be considered in all repair and maintenance work.

A lead-based paint inspection should be completed at some point in the future to determine exactly where all the lead-based paint is located so that it can be properly managed.

Table 17.1 (from HUD Guidelines)
Summary of Low- and High-Risk Job Designations for Surfaces Known or Suspected to Have Lead-Based Paint

Job Description	Low Risk	High Risk*
Repainting (includes surface preparation)		√
Plastering or wall repair		√
Window repair		√
Water or moisture damage repair (repainting and plumbing)		√
Door repair	√	
Building component replacement		√
Welding on Painted Surfaces		√
Door lock repair or replacement	√	
Electrical fixture repair	√	
Floor refinishing		√
Carpet replacement		√
Groundskeeping	√	
Radiator leak repair	√	
Baluster repair (metal)		√
Demolition		√

* High-risk jobs typically disturb more than 2 square feet per room. If these jobs disturb less than 2 square feet, then they can be considered low-risk jobs.

Table 17.2 (from HUD Guidelines)
Summary of Protective Measures For Low- and High-Risk Jobs

Protective Measure	Low Risk	High Risk
Worksite preparation with plastic sheeting (6 mil thick)	Plastic sheet no less than 5 feet by 5 feet immediately underneath work area	Whole floor, plus simple airlock at door or tape door shut
Children kept out of work area	Yes	Yes
Resident relocation during work	No	Yes
Respirators	Probably not necessary*	Recommended
Protective clothing Note: Protective shoe coverings are not to be worn on ladders, scaffolds, etc.	Probably not necessary*	Recommended
Personal hygiene (enforced hand washing after job)	Required	Required
Showers	Probably not necessary	Recommended
Work practices	Use wet methods, except near electrical circuits	Use wet methods, except near electrical circuits
Cleaning	Wet cleaning with lead-specific detergent trisodium phosphate or other suitable detergent around the work area only (2 linear feet beyond plastic)	HEPA vacuum/wet wash/ HEPA vacuum the entire work area
Clearance	Visual examination only	Dust sampling during the preliminary phase of the maintenance program and periodically thereafter (not required for every job)

* Employers must have objective data showing that worker exposures are less than the OSHA Permissible Exposure Limit of $50\mu g/m^3$ if respirators and protective clothing will not be provided.

The Appendix to this report contains a list of training providers who can train the maintenance workers to handle lead-based painted surfaces safely.

A HEPA vacuum should be purchased for routine use.

The Appendix also contains information on medical surveillance, respirator use, and other important considerations.

The practice of examining the condition of the paint annually or upon vacancy is a good one and should be continued.

Since the paint has not yet been fully and adequately tested, it should be assumed to contain lead-based paint. The owner should tell residents to report any paint that is peeling, chipping, flaking, chalking, or otherwise deteriorating so that it can be repaired quickly and safely.

17. Acceptable Interim Control Options and Estimated Costs

The costs shown below include labor, materials, worker protection, site containment and cleanup. These are only very rough estimates that may not be accurate; a precise estimate and a full lead hazard control plan should be obtained from a certified lead-based paint abatement contractor. I would be pleased to help you develop such a plan if you request.

<u>Hazard A: Deteriorated Lead-Based Paint on Exterior Doors, Exterior Side of Windows, Exterior Trim, Kitchen Walls and Bathroom Walls</u>

a. Repair of Water Leaks, followed by Paint Film Stabilization $xx
b. Repair of Water Leaks, followed by Encapsulation of Exterior Door and Window Frames with a Liquid Encapsulant Coating plus sash replacement $xx

<u>Hazard B: Leaded Dust On Window Troughs and Common Hallways</u>

a. Dust removal followed by sealing concrete stairway floors with concrete sealant and paint film paint film stabilization of window troughs.

<u>Hazard C: Contaminated Soil in the Playground and Around the Building Perimeter</u>

a. Fence off playground and building perimeter to eliminate access $xx
b. Cover soil with a suitable material such as bark, gravel, sand, astroturf and plant dense thorny bushes around building perimeter to limit access

18. Abatement Options and Estimated Costs

<u>Hazard A: Deteriorated Lead-Based Paint on Exterior Doors, Exterior Side of Windows, Exterior Trim, Kitchen Walls and Bathroom Walls</u> (all options assume repair of water leaks occurs first)

a. Replace doors $xx
b. Chemically remove paint from doors and repaint $xx
c. Replace windows and exterior trim $xx
d. Chemically remove paint from windows and trim and repaint $xx
e. Remove paint from trim using heat guns operating below 1100°F $xx
f. Enclosure of kitchen and bathroom walls $xx
g. Demolish and replace kitchen and bathroom walls $xx

<u>Hazard B: Leaded Dust On Window Troughs and Common Hallways</u>

a. Cover exterior sills with aluminum coil stock $xx
b. Replace exterior sills $xx
c. Install new tiles in common hallways $xx

<u>Hazard C: Contaminated Soil in the Playground and Around the Building Perimeter</u>

a. Remove and replace top soil around building and in playground $xx
b. Pave soil around building perimeter with asphalt or cement plus eliminate playground $xx
c. Pave soil around building perimeter and cover play area with a geotextile fabric and cover with new sand, soil, bark or other material providing adequate fall protection. Do not pave playground area. $xx

19. Reevaluation Schedule

Because the levels of leaded dust in window troughs were more than 10 times greater than the HUD standard, this property should be reevaluated according to Schedule 4 in the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing.* This schedule calls for a reevaluation in September 1994 (6 months from now). If no lead-based paint hazards are identified, another reevaluation is not needed until September 1995 (1 year later). Assuming no new lead-based paint hazards are identified, a final reevaluation should be performed in September 1997, according to the HUD Guidelines. If the building passes the reevaluation, no further reevaluation is required, although the owner should still monitor the condition of the paint at least annually or whenever there is information that the paint is deteriorating.

Part IV: Site-Specific Lead Hazard Control Plan

20. Lead Hazard Control Option To Be Implemented in This Property

<u>Hazard A: Deteriorated Lead-Based Paint on Exterior Doors, Exterior Side of Windows, Exterior Trim, Kitchen Walls and Bathroom Walls</u>

Repair of Water Leaks, followed by Paint Film Stabilization $xx

<u>Hazard B: Leaded Dust On Window Troughs and Common Hallways</u>

Dust removal followed by sealing concrete stairway floors with concrete sealant and paint film paint film stabilization of window troughs.

<u>Hazard C: Contaminated Soil in the Playground and Around the Building Perimeter</u>

Soil in the playground will be covered by a liner and sand at least 12 inches deep. Dense thorny bushes will be planted around building perimeter to limit access.

21. Training Plan for Managers, Maintenance Supervisors and Workers

Ms. Madeline Fairfield will attend the lead hazard awareness training course offered by the Anywhere Childhood Lead Poisoning Prevention Program. She will be responsible for ensuring that all maintenance workers and their supervisors are trained in lead-based paint work practices.

22. Method of Resident Notification of Results of Risk Assessment and Lead Hazard Control Program

The results of this report will be described by the owner to the residents in the dwelling through a brief summary that will be placed in each resident's mailbox. The brochure in the Appendix will be provided to the residents. The owner will explain to the resident that the lead hazards at the property will be corrected within two weeks and that all residents should report any deteriorating paint in the future to Ms. Fairfield. The dwelling will be tested after the work has been completed to make certain that it was effective.

23. Signatures (Risk Assessor and Owner), Date and Certificate of Lead-Based Paint Compliance

After the work has been completed and clearance established, a certificate will be appended to this report.

______________________________ ____________

Joseph Smith, Owner (date)

______________________________ ____________

Michael Hazard, Certified Risk Assessor (date)

Example of Certificate of Lead-Based Paint Compliance

I hereby certify that on May 1, 1994 the apartment building located at 5678 Main St, Anywhere, Any State meets the criteria established by the Department of Housing and Urban Development for lead safety. Either no lead-based paint hazards were identified or all lead-based paint hazards have been corrected.

____

Owner

____

Authorized Signature

Expiration Date: September 1, 1994

Any State
Department of Health
Division of Childhood Lead Poisoning Prevention

Appendix 9: Insurance Companies Offering Lead Abatement General and Professional Liability Coverage

Fidelity Environmental Insurance Co.
105 Campus Drive - University Square
P.O. Box 7006
Princeton, NJ 08543-7006
(800) 338-1236
GL, E&O

American Safety Risk Retention Group
c/o Environmental Mgmt Ins Services
1900 The Exchange, Suite 450
Atlanta, GA 30339
(404) 916-1908
GL, E&O

North American Specialty Insurance Co.
c/o Eric Underwriters Agency
7257 South Tucson Way
Englewood, CO 80112
(800) 388-9221
GL

United Capitol Insurance Co.
1400 Lake Hearn Drive
Atlanta, GA 30319
(404) 843-5599
GL, E&O

United Coastal Insurance Co.
233 Main Street
P.O. Box 2350
New Britain, CT 06050-2350
(203) 223-5000
GL, E&O

Commercial Casualty Insurance Co.
160 Technology Park
Norcross, GA 30092
(404) 729-8209
E&O

Homestead Insurance Company
c/o Freberg Environmental Insurance
1675 Broadway, Suite 2210
Denver, CO 80202
(303) 571-4235
E&O

Commerce & Industry Insurance Co.
70 Pine Street, 11th Floor
New York, NY 10270
(212) 770-7000
GL, E&O

Reliance National Insurance Co.
77 Water Street
New York, NY 10005
(212) 858-3641
GL, E&O

Housing Authority Risk Retention Group
(Public Housing Only)
677 South Main Street
P.O. Box 189
Cheshire, CT 06410
1-800-HES-3313
1-800-873-0242

Appendix 10: Questions and Answers on Sampling Lead-Based Paint Hazardous Waste

1. What is considered a representative sample?

   A representative sample consists of a collection of the various components of the waste in the same weight proportion as is found in the entire bulk of the waste. As such, a representative sample should contain a sample of all major items found in the entire waste stream, in an accurate weight proportion. If dealing with a large quantity of waste, a minimum of four samples should be taken at any one site. A single sample may be appropriate if there is a small quantity of waste. More samples may be necessary if the variability among samples is high. A site may be defined as a pile of debris generated in a given day or waste from a given work area.

2. How should representative sampling be conducted on abatement waste (*e.g.*, large woodwork pieces, windows)?

   Waste from abatement projects can be characterized during a pre-abatement screening step or upon generation. Pre-abatement screening facilitates hazardous waste reduction via segregation of waste such as architectural components into hazardous and nonhazardous components. As a pre-abatement step for vacant residential units, an experienced contractor may be able to identify which of the architectural components should be tested through an assessment of paint quality and knowledge of paint history. Once the assessment is made, representative samples for different types of components should be taken for determining which of the components are hazardous. This approach reduces total quantities of hazardous waste through source characterization and segregation. This approach may be preferred by abatement contractors and/or housing project owners who are concerned about the cost of hazardous waste management.

   If waste has been already generated, then follow the steps discussed next:

   Estimate the total weight or mass of the debris before it is removed from the dwelling. Collect samples so that each major component of the debris is present in approximately the correct proportion, including the entire cross-section of the substrate. Alternatively, if the waste includes different types of materials, it may be most appropriate to sample from representative areas of a waste pile or from representative containers. For example, if doors and windows are to be sampled, and the door is 20 percent of the waste and the window is 10 percent of the waste, the sample should contain 2 parts door for each window part. Take a core (plug) sample of both the door and the window and combine it in the correct proportion, including the substrate and the surface paint on both sides.

3. Should samples be analyzed as intact pieces or should the material be cut into smaller pieces or ground into small particles?

   The laboratory conducting the analysis is required to cut the representative sample of the waste into pieces that will pass through a specific sieve size (generally 9.5 mm cubes will fit). The sample should not be ground up, but rather cut into small pieces (*e.g.*, ¼ inch hole saw plugs). The contractor should work with the laboratory to develop a standard procedure for sample preparation (*e.g.*, agreement should be reached in advance regarding who will be responsible for cutting the material. The laboratory may prefer a larger piece of waste which could then be cut into smaller pieces that would pass through the specified sieve size as a sample preparation step performed in the laboratory.

4. Who can I call for more information on TCLP sampling and analysis?

   EPA maintains two hotlines equipped to answer such questions. The general RCRA hotline number is 1-800-424-9346. RCRA hotline staff can answer RCRA questions, including TCLP sampling and analysis. EPA also runs a second hotline dedicated to SW-846 sampling methods at (703) 821-4789.

5. How should I go about selecting a laboratory to conduct TCLP analysis?

   As a first step, identify a list of potential labs that perform the TCLP in your area. Such a list can be obtained from other property owners and/or contractors who have used labs for this purpose. Most states also maintain a list of accredited or registered labs. A small number of states accredit labs for TCLP testing (e.g., California). The American Industrial Hygiene Association (703) 849-8888 and the American Association of Laboratory Accreditation (301) 670-1277 can also provide lists of laboratories in your area. Below are several questions that may be helpful in interviewing potential labs.

   - Is the lab located in a state that accredits labs for TCLP testing (e.g., California)? If so, are they accredited?

   - Does the lab have written sample preparation procedures (i.e., how do they prepare the sample to undergo the leaching procedure)?

   - Does the lab have their own lab-specific written procedures for performing the TCLP (not just a copy of federal guidance)?

   - What quality control procedures are used to ensure data are accurate (e.g., multiple reviews of results)?

   - What will the final report look like? For example, will it specify detection limits and sample preparation techniques used?

   - What is the turn around time and cost of performing the TCLP? (Note that an average price for running a TCLP test for lead only is between $60 - $100.)

Appendix 10.1: State and Territorial Hazardous Waste Management Agencies

Alabama
Land Division
Alabama Dept of Environmental Mgmt
PO Box 463
Montgomery, AL 36130-1463
(205) 271-7730

Alaska
Alaska Dept of Environmental Conservation
Div of Environmental Quality
Hazardous Waste Management Program
410 Wiloughby Avenue
Juneau, AK 99801-1795
(997) 465-5150

American Samoa
Environmental Quality Commission
Government of American Samoa
Pago Pago, American Samoa 96799
011-684-633-2304

Arizona
Office of Waste and Water Quality Mgmt
Arizona Dept. of Environmental Quality
3033 North Central Avenue, Room 304
Phoenix, AZ 85012
(602) 207-2305

Arkansas
Hazardous Waste Division
Arkansas Dept. of Pollution Control & Energy
PO Box 9583-8913
Little Rock, AR 72219-8913
(501) 570-2872

California
Dept. of Toxic Substances
PO Box 806-95812-0806
400 P Street
Sacramento, CA 95814
(916) 324-1826

Colorado
Hazardous Materials & Waste Mgmt Div
Colorado Dept of Health
4300 Cherry Creek Drive, South
Denver, CO 80222
(303) 692-3300

Commonwealth of Northern Mariana Islands
Division of Environmental Quality
Dept of Public Health & Environmental Svcs
Commonwealth of the Northern Mariana Islands
Office of the Governor
Saipan, Mariana Islands 96950
011-670-234-6114

Connecticut
Waste Engineering and Enforcement Division
Dept of Environmental Protection
State Office Building
79 Elm Street
Hartford, CT 06106
(203) 566-5712

Delaware
Hazardous Waste Management Branch
Division of Air & Waste Management
Dept of Natural Resources & Environmental Control
PO Box 1401, 89 Kings Highway
Dover, DE 19903
(302) 739-3689

District of Columbia
Pesticides and Hazardous Materials Division
Dept of Consumer and Regulatory Affairs
2100 Martin Luther King Ave., SE, Rm 203
Washington, DC 20032
(202) 404-3194

Florida
Division of Waste Management (UST)
Dept of Environmental Regulations
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, FL 32399-2400
(904) 488-0190

Georgia
Hazardous Waste Management Branch
Floyd Towers East/Room 1154
205 Butler Street, SE
Atlanta, GA 30334
(404) 656-2833

Guam
Hazardous Waste Management Program
Guam Environmental Protection Agency
PO Box 2999
Agana, Guam 96910
011-671-646-5300

Hawaii
Dept of Health
Solid & Hazardous Waste Bureau
5 Waterfront Plaza, Suite 250
500 Ala Moana Boulevard
Honolulu, HI 96813
(808) 586-4225

Idaho
Dept of Environmental Quality
Dept of Health & Welfare
1410 North Hilton
Boise, ID 83706
(208) 334-5879

Illinois
Bureau of Land Pollution Control
Illinois Environmental Protection Agency
220 Churchill Road
Springfield, IL 62706
(217) 782-6760

Indiana
Indiana Dept of Environmental Management
105 G. Meridian Street
PO Box 6015
Indianapolis, IN 46206-6015
(317) 232-3210

Iowa
Air Quality and Solid Waste Protection
Dept of Water, Air & Waste Management
900 East Grand Avenue
Henry A. Wallace Building
Des Moines, IA 50319-0034
(515) 281-5145

Kansas
Bureau of Waste Management
Dept of Health & Environment
Forbes Field, Building 740
Topeka, KS 66620
(913) 296-1600

Kentucky
Division of Waste Management
Dept of Environmental Protection
Cabinet of Natural Resources & Environmental Protection
Fort Boone Plaza, Building #2
14 Riley Road
Frankfort, KY 40601
(502) 564-6716

Louisiana
Hazardous Waste Division
Office of Solid & Hazardous
Louisiana Dept of Environmental Quality
PO Box 82718-70884-2178
7290 Blue Bonnet, 5th Floor
Baton Rouge, LA 72810
(504) 765-0355

Maine
Bureau of Hazardous Material & Solid Waste Control
Dept of Environmental Protection
State House Station #17
Augusta, ME 04333
(207) 287-2651

Maryland
Waste Management Administration
Maryland Dept of the Environment
2500 Broening Highway
Baltimore, MD 21224
(410) 631-3304

Massachusetts
Division of Hazardous Waste
Massachusetts Dept of Environmental Protection
One Winter Street, 7th Floor
Boston, MA 02108
(617) 292-5853

Michigan
Waste Management Division
Environmental Protection Bureau
Dept of Natural Resources
Box 30241
Lansing, MI 48909
(517) 373-2730

Minnesota
Minnesota Pollution Control Agency
520 Lafayette Road, North
St. Paul, MN 55155
(612) 297-8503

Mississippi
Division of Hazardous Waste Management
Mississippi Dept of Environmental Quality
Office of Pollution Control
PO Box 10385
Jackson, MS 39289-0385
(601) 961-5063

Missouri
Division of Environmental Quality
Hazardous Waste Program
Dept of Natural Resources
Jefferson Building
205 Jefferson Street, 13th & 14th Floor
PO Box 176
Jefferson City, MO 65102
(314) 751-3176

Montana
Solid and Hazardous Bureau
Dept of Health and Environmental Sciences
Cogswell Building
Helena, MT 59620
(406) 444-1430

Nebraska
Hazardous Waste Management Section
Dept of Environmental Quality
PO Box 98922
Lincoln, NE 68509
(402) 471-2186

Nevada
Waste Management Program
Division of Environmental Protection
Dept of Conservation & Natural Resources
Capital Complex
333 West Nye Lane
Carson City, NV 89710
(702) 687-4670

New Hampshire
Dept of Environmental Services
Waste Management Division
Health & Human Services Building
6 Hazen Drive
Concord, NH 03301-6509
(603) 271-2900

New Jersey
Division of Waste Management
Dept of Environmental Protection
401 East State Street (CN 028)
Trenton, NJ 08625
(609) 292-8341

New Mexico
Hazardous & Radioactive Material Bureau
New Mexico Environmental Dept
PO Box 26110
Sante Fe, NM 87502
(505) 827-4358

New York
Hazardous Waste Remediation
Dept of Environmental Conservation
50 Wolfe Road, Room 209
Albany, NY 12233-7010
(518) 457-6603

North Carolina
Hazardous Waste Section
Division of Solid Waste Management
Dept of Environment Health & Natural Resources
401 Obertin Road, Suite 150
Raleigh, NC 27605
(919) 733-2178

North Dakota
Division of Waste Management
Dept of Health & Consolidated Laboratories
PO Box 5520
Bismarck, ND 58502-5520
(701) 221-5166

Ohio
Division of Hazardous Waste Management
Ohio Environmental Protection Agency
1800 Watermark Drive
PO Box 1049
Columbus, OH 43266-0149
(614) 644-2917

Oklahoma
Hazardous Waste Management Services
Oklahoma State Dept of Health
1000 NE 10th Street
Oklahoma City, OK 73117-1299
(405) 271-5338

Oregon
Hazardous & Solid Waste Division
Dept of Environmental Quality
811 SW 6th Avenue
Portland, OR 97204
(503) 229-5356

Pennsylvania
Bureau of Waste Management
Pennsylvania Dept of Environmental Resources
PO Box 8471, 14th Floor MSSOB
Harrisburg, PA 17105
(717) 787-9870

Puerto Rico
Environmental Quality Board
Santurce, PR 00910-1488
1 (809) 725-5333

Rhode Island
Division of Waste Management
Dept of Environmental Management
291 Promenade Street
Providence, RI 02908
(401) 277-2808

South Carolina
Bureau of Solid & Hazardous Waste Management
Dept of Health & Environmental Control
2600 Bull Street
Columbia, SC 29201
(803) 734-5200

South Dakota
Office of Waste Management
Dept of Environmental & Natural Resources
523 E Capitol
Foss Building, Room 416
Pierre, SD 57501
(605) 773-3153

Tennessee
Division of Solid Waste Management
Tennessee Dept of Environment & Conservation
401 Church Street, L & C Tower
Nashville, TN 37243
(615) 532-0780

Texas
Industrial Hazardous Waste Division
Texas Waster Commission
PO Box 13807
Austin, TX 78711-3087
(512) 908-2334

Utah
Division of Solid & Hazardous Waste
Dept of Environmental Quality
PO Box 144889
288 N 1460 West
Salt Lake City, UT 84114-4880
(801) 538-6170

Vermont
Hazardous Material Division
Dept of Environmental Conservation
Agency of Natural Resources
103 S Maine Street
Waterbury, VT 05676
(802) 244-8702

Virgin Islands
Dept of Planning & Natural Resources
Nisky Center, Suite 231
45A Estate Nisky
St. Thomas, VI 00802
(809) 774-6420

Virginia
Waste Division
Dept of Environmental Quality
Monroe Building, 11th Floor
101 N 14th Street
Richmond, VA 23219
(804) 527-5000
(804) 225-2667

Washington
Hazardous Waste Program
Dept of Ecology
PO Box 47600
Olympia, WA 98504-7660
(206) 459-6316

West Virginia
Office of Waste Management
Division of Environmental Protection
Dept Commerce, Labor, Environmental Resources
1356 Hansord Street
Charleston, WV 25301
(304) 558-5393

Wisconsin
Bureau of Solid & Hazardous Waste Mgmt
Dept of Natural Resources
PO Box 7921
Madison, WI 53707
(608) 266-1327

Wyoming
Solid & Hazardous Waste Division
State of Wyoming
Dept of Environmental Quality
122 W 25th Street
Herschler Building
Cheyenne, WY 82002
(307) 777-7752

Appendix 11: One Hour Waiting Period Rationale for Clearance Sampling

This Appendix describes the rationale for why it is necessary to wait no longer than one hour to conduct clearance examinations. Conservative (health protective) assumptions have been made throughout the analysis to ensure that the risk is minimal. The scenario is that no one will enter the room or work area for at least one hour to minimize air turbulence and reentrainment of small particles. The rationale shows why one hour is a safe waiting period and why additional benefits will not be gained by waiting longer.

Settling Velocities

Settling velocities for leaded dust can be estimated by making assumptions on the particle size, density, and shape, as well as the degree of air turbulence. Particles can be assumed to be roughly spherical, with a density of 2.5 g/cm³ (pure lead oxide has a density of 9.5 g/cm³, but since lead-based paint dust contains other materials, a lower density is appropriate). Mineral dust has an average density of 2.5 g/cm³, and normal urban particulate matter is likely to have a density of between 1 - 1.7 g/cm³. Turbulence is expected to be minimal since all movement through the area will have ceased, although some reentrainment of small particles can still be expected due to air currents and building leakage in the area. This is true regardless of the length of time involved. Particles can be expected to vary in size from 0.2 to 250 µm or even larger (Mamane, 1993). Some paints were manufactured with pigment particle sizes on the order of 1 µm. However, it is very unlikely that resins and binders in the paint would break down completely to particles this small. To date, there has been little research conducted on particle size distributions in lead abatement dust, although one pilot study found that 41% of the airborne dust generated during abrasive blasting operations on lead painted bridges was less than 6 µm in diameter (NIOSH, 1993a). The percentage should be much lower in residential work, where abatement methods that produce small particles are prohibited (no blasting, burning, power sanding are permitted).

Larger particles will settle more rapidly than smaller particles. The table below shows terminal settling velocities for different particle sizes with a density of 2.5 g/cm³ (Blume, 1993).

Particle Settling Velocities

Particle Diameter (µm)	Settling Velocity (cm/sec)	Settling Time for a Ceiling Height of 10 feet
0.5	0.0025	34 hours
1.0	0.0088	9 hours
5.0	0.19	26 minutes
10	0.75	7 minutes
100	75	4 seconds

If one assumes that rooms in residential structures are typically 10 feet high, that all the particles are present at the ceiling level and need to travel the full 10 feet from the ceiling to the floor, and that all the particles are about 5 µm in diameter (all health protective assumptions), it can be shown that it would take a little less than half an hour for all particles greater than 5 µm to settle out of the air, assuming that turbulence and reentrainment are low:

$$\frac{10 \text{ feet} \times 2.54 \text{ cm/inch} \times 12 \text{ inch/foot} \times 1 \text{ min/60 sec}}{0.19 \text{ cm/sec}} = 27 \text{ minutes}$$

Therefore, one can assume that by waiting one hour after all cleanup work has been completed, nearly all of the lead particulate greater than 5 µm will have settled out the air to the floor, where it is available for measurement (clearance). In fact, all particles greater than 3 µm will reach the floor in a little more than an hour (70 minutes). Of course, there will always be some ambient air movement and turbulence, even in rooms that have the doorways sealed off with plastic sheets. This is due to ordinary building leakage. Additionally, some turbulence will occur as individuals open the door and re-enter the room. However, all of this reentrainment will occur regardless of how long one waits for particles to settle. Even if these particles do become airborne, it is unlikely that they will contribute substantially to exposures, as shown below.

Contribution of Small Particles to Settled Leaded Dust Levels

For the purpose of this analysis of the impact of air lead levels on clearance status, assume that all these small particles settle out of the room air (a "worst-case" scenario). How will the remaining particulate less than 5 µm affect settled leaded dust levels? Consider the case of a room 10 feet long by 10 feet wide x 10 feet high, for a total volume of 1,000 ft^3m. Personal breathing zone airborne lead concentrations reported from the HUD Demonstration Project (NIOSH 1990) during cleaning were reported to be 16 $\mu g/m^3$, which is the 95th percentile (of the statistical distribution, not the sample distribution). There are several health-protective assumptions in using this number. First, they are personal breathing zone samples. This method of air sampling is not intended to produce a full particle size distribution. Since its purpose is to measure exposure through inhalation, the method over-samples the smaller particle sizes. Second, by selecting the 95th percentile, levels of airborne particulate should be lower in 95 out of a hundred jobs. Finally, these exposures were measured during cleanup activity, not after cleanup activity. It is reasonable to expect that airborne concentrations will decline greatly immediately following active work in the area.

For the purposes of this analysis, if we assume that all of the dust measured by the personal breathing zone samples is less than 5 µm in diameter (even though it is likely that some of it will be much larger) and that the dust is distributed across the floor surface area, it can be shown that the additional contribution to settled leaded dust from airborne leaded dust is very small. Settled leaded dust is the principal route of exposure for children and is the measure of choice for clearance determination.

Using the assumptions as stated, there would be a total of 453 µg of lead suspended in the air in the room:

$$28.3m^3 \times 16\ \mu g/m^3 = 453\ \mu g$$

If <u>all</u> of the dust settled out of the air, and if deposition is uniform across the floor surface, then it would contribute no more than an additional 6 µg/ft² to the floor of the room, which measures 10 feet x 10 feet (100 ft²):

$$453\ \mu g/100\ ft^2 = 4.53\ \mu g/ft^2$$

This additional dust loading is well below the routine limit of quantitation for the typical wipe sampling method (25 µg/ft²) and about 6% of the clearance standard of 100 µg/ft² for floors. While it could be argued that deposition is unlikely to be uniform, this would mean simply that there would be "hot spots" with higher loadings and corresponding "cold spots" where loadings would be lower. The existing clearance standards are geared toward average settled leaded dust levels; therefore, the average across the floor is the best way to characterize the contribution of the airborne dust to settled dust.

The result of this exercise shows two things:

- Most leaded dust generated during residential abatement or interim control activity is likely to settle out of the air relatively quickly if turbulence is kept reasonably low for about an hour after the work has been completed. Ambient air currents will always be present and may cause some reentrainment no matter how long one waits.

- The contribution of airborne leaded dust to settled leaded dust immediately following cleanup is likely to be very small and virtually non-detectable.

These results have important implications. It does not appear to be necessary to wait 24 hours after cleaning before collecting clearance dust samples (as previously suggested in the HUD public housing guidelines). This decreases the amount of time required for clearance testing, reducing the expense of resident relocation.

<u>Airborne Lead</u>

Finally, it is worthwhile to consider the extent of airborne dust exposure. At first glance, 16 µg/m³ appears to be well above the EPA National Ambient Air Quality Standard (NAAQS) for Lead (1.5 µg/m³). However, the NAAQS is a quarterly average designed to protect the population from long-term chronic exposure, while the HUD Demonstration air sampling data are approximately two-hour time weighted averages. The use of a quarterly average is not appropriate for a short term exposure. Furthermore, there is no evidence that air cleaning machines (so-called "negative air" machines) provide any benefit in removing particles from the air. In fact, at least one NIOSH study found no correlation at all between worker exposures and the use of these machines, although there was a significant correlation with the use of HEPA vacuums and airborne lead (NIOSH 1992b). Finally, it should be evident that air lead levels will drop greatly as the doors and windows are opened. The 453 µg in the room should rapidly dissipate to negligible levels. Again, this dilution process will occur regardless of how long one waits to enter the area, whether it be one hour or 24 hours.

The results of this analysis should be validated through field research at on-going abatement jobs and through pilot testing.

Appendix 12: Statistical Rationale for Sample Sizes and Percentages Used in Guidance for Inspecting in Multifamily Housing

This appendix presents the statistical rationale and calculations used to develop sample sizes (number of units to be tested) in multifamily housing. The samples sizes apply both to inspections for lead-based paint and to post-abatement dust clearance testing in multifamily housing. The appendix also presents the detection capability of the sampling scheme, that is, the probability that the scheme will successfully detect various levels of contamination in the housing development tested.

A12.1 Sample Size Calculations

To determine the applicable sample size using the methods of this appendix, the housing units must first be properly grouped. For lead-based paint inspections, similar units and buildings should be grouped based on common construction, floor plans, and painting history. This type of grouping will make it less likely that lead-based paint will be missed in the testing. Likewise, for dust clearance testing, units and buildings that have similar construction and were cleaned in the same manner, should be grouped for sampling purposes.

Because the sampling scheme applies to both testing for lead-based paint inspections and dust clearance testing, the term "the HUD standard" will be used to mean either 1.0 mg/cm² for lead-based paint inspections or the applicable clearance standard for dust testing. The term "component" means a floor, window sill or window well for dust clearance testing, and means any painted building component for lead-based paint inspections.

The basic specification for the sampling scheme is that it achieve 95% confidence that at least 95% of the units meet the HUD standard. This means that, if all units sampled meet the HUD standard for all components tested, there is 95% confidence that fewer than 5% of the units in the development have one or more components in violation of the HUD standard, assuming no within unit sampling error and no measurement error. An alternate interpretation is that up to a 5% chance of missing some lead in up to 5% of the units is allowed. In a large development, 5% of the units might be a large absolute number, however, so the total number of leaded units which might escape detection has been limited to 50. This leads to the following quantitative prescription for the sampling plan:

TEST THE SMALLEST NUMBER OF UNITS WITH THE PROPERTY THAT, IF ALL TESTED UNITS ARE AT OR BELOW THE HUD STANDARD FOR ALL COMPONENTS, THERE IS 95% CONFIDENCE THAT THE NUMBER OF UNITS WITH AT LEAST ONE COMPONENT AT OR ABOVE THE HUD STANDARD IS LESS THAN 50 UNITS OR 5%, WHICHEVER IS SMALLER.

As an example, 56 units should be tested in a 600 unit development. Sample sizes where taken from Table 7.3 of Chapter 7 (or Table IV in this appendix). If no lead (above the HUD standard) is found in any of the 56 tested units, the owner of the development can be 95% confident that less than 30 units (the lesser of 50 and 5% of 600) have lead above the HUD standard. As a second example, 232 units should be tested in a 4000 unit development. If all are below the dust clearance HUD standard for all tested floors, window sills and window troughs, there is 95% confidence that less than 50 of the 4000 units (the lesser of 50 and 5% of 4000) have any lead dust levels at or above the applicable HUD standard. Note that developments with 20 or fewer units, all units should be tested and the classification rules for single-family housing apply.

The statistical calculations required to determine the number of units to be tested, based on the criterion above, are fairly straightforward. For the sake of brevity, call a unit with one or more components with lead-based paint (or dust lead, as the case may be) at or above the HUD standard a "leaded unit". Make the following definitions:

N = Total number of units in the development;

k = Maximum allowable number of leaded units;

n = Smallest number of units which must be tested to provide 95% confidence that the total number of leaded units is "k" or less, based on finding no leaded units in the sample tested.

For example, if 95% confidence is required that less than 5% of 300 units have lead, then k = 14. If fewer than 50 out of 4000 with lead is required, then k = 49.

In the usual statistical convention, "n" is defined as the smallest integer for which the probability of obtaining no positive results in a simple random sample of size "n" from a population of size "N", of which k+1[1] are positive, is less than 0.05. When k+1 of "N" total are positive, the probability of observing <u>no</u> positive results in a simple random sample of size "n" is given by the hypergeometric formula[1]:

$$[(N-k-1)...(N-k-n)]/[(N)(N-1)...(N-n+1)].$$

The required value of "n" is obtained by successively evaluating this expression for n = 1, 2, 3,..., until its value first drops below 0.05. The calculations were performed in SAS[2], using the hypergeometric distribution function[1]. Table I shows the exact values of "k" and "n" for selected values of "N".

In developing the sample sizes for Table 7.3 of Chapter 7 (Table 7.3 has been reproduced as Table IV in this appendix), two refinements to the calculations were made. First, because of the discrete nature of the problem, it is possible for the sample size to <u>decrease</u> when the total number of units <u>increases</u>. To see how this happens, suppose that a building has 40 units. Since 5% of 40 is two, the maximum number of leaded units allowed is 1. However, if the building

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1 k+1 is used to determine the probability for at most k positive values. This assures that the occurrence of k positive values will have probability <u>less than</u> 0.05.

has 41 units, 5% of 41 is 2.05, so the maximum number of leaded units is 2. Since it is obviously easier to detect 2 units out of 41 than 1 out of 40, the minimum sample size for a building with 41 units is smaller than the minimum sample size for a building with 40 units. Specifically, the exact sample size for 40 units is 31, while the exact sample size for 41 units is 26. The same problem occurs every time the number of units is a multiple of 20. Since it is extremely counter-intuitive for the sample size to decrease when the number of units increases, the additional requirement that the sample size never decrease was imposed. The result of this requirement, which can be observed clearly in Table 7.3, is that the sample size remains constant for some time beginning at each multiple of 20.

The second refinement to the calculation was to calculate a percentage of units to be sampled when the total number of units is very large. When the total number of units is 1,000 or greater, the maximum acceptable number of leaded units is 49. Suppose that a proportion "P" of the N units is to be tested when N is large. Then, when the number of leaded units is 50, the minimum unacceptable number, the probability that zero leaded units will be found in the sample can be approximated by $(1\text{-}P)^{50} = 0.05$ if P=0.058. (The ratio of n to N in Table I is approximately 0.058 for N greater than 1000). Thus, the limiting percentage for the sample size is 5.8%. In Table 7.3, the sample size is taken as 5.8% of the number of units, rounded to the nearest whole number, when N is 1,040 or larger.

A12.2 Detection Capability of the Sampling Scheme

By the detection capability of the sampling scheme is meant the probability that the sample contains at least one leaded unit when leaded units are present. Thus, the detection capability is the probability that a problem (lead-based paint or dust above the applicable HUD standard) will be detected in the development, in the sense of showing up in at least one of the units in the sample.

The detection capability of the sampling scheme depends on the total number of leaded units in the development as a whole. Clearly, the more leaded units there are, the better the chance that they will appear in the sample. When the number of leaded units is k+1 (in Table I), the detection capability is, by definition, (slightly) greater than 95%. In general, when the number of leaded units is "L", the detection capability is calculated from the formula

$$1 - [(N-L)(N-L-1)...(N-L-n+1)]/[(N)(N-1)...(N-n+1)]$$

where "N" and "n" are, respectively, the total number of units in the development, and the sample size. Table II shows the number of leaded units which must be present in the development as a whole for the detection capability to be 50%, 75%, 90%, 95%, 97.5%, or 99%.

As an example, the detection capability of the scheme in a 600-unit development is 99% when the development contains 45 leaded units. This means that the sample of 56 units in a 600-unit development is 99% certain to include at least one of the 45 leaded units. Notice that the numbers are almost exactly the same for all developments with 1,000 units or more. This reflects the design decision that the number of leaded units which may be missed completely (with 5% probability) must be less than 50. Of course, the fixed numbers in the table reflect a decreasing percentage of the total number of units in the development. Table III shows the percentage of leaded units which must be present to achieve the various detection capabilities.

For example, in a 1,000-unit development, the detection capability of the scheme is 75% when 2.4% of the units are leaded. That is, the sample of 57 units tested is 75% sure to contain at least one of the 2.4% of units which are leaded. Put another way, although 97.6% of the units have no lead above the HUD standard, a random sample of only 5.7% of the units has a 75% chance of finding one of the leaded units. The percentages in Table III are fixed (except for roundoff) for developments with 200 - 1,000 units, and then decline for larger developments. Again, this is the result of the design decision to fix the percentage of leaded units which may be missed (with 5% probability), for developments with 1,000 units or less. For larger developments, the number of such units is fixed, but the percentage is declining.

Tables II and III give probabilities of finding at least one leaded unit in the tested sample. This does not mean that all, or even most, of the leaded units will be sampled. To achieve this would require virtually 100% sampling. The expected percentage of the leaded units which will be sampled is equivalent to the sampling percentage, i.e., the sample size as a percentage of the number of units in the development. For example, in a 100-unit development, 45 units are sampled. Thus, 45% of the leaded units would also be expected to be sampled, on average. In a 1,000-unit development, an average of 5.7% of the leaded units would be sampled.

TABLE I

Calculation of the Number of Units to be Tested		
N[a]	k[b]	n[c]
20	0	20
40	1	31
60	2	38
80	3	42
100	4	45
200	9	51
300	14	54
400	19	55
600	29	56
1,000	49	57
1,500	49	86
2,000	49	115
2,500	49	144
3,000	49	174
3,500	49	203
4,000	49	232

Calculation of the Number of Units to be Tested		
N[a]	k[b]	n[c]
4,500	49	261
5,000	49	290

[a]N = Number of Units in the Development
[b]k = Maximum Allowable Number of Leaded Units
[c]n = Number of Units to be Tested

TABLE II

N[a]	n[b]	Number of Leaded Units in Development Needed for Detection Capability to be:					
		50%	75%	90%	95%	97.5%	99%
20	20	1	1	1	1	1	1
40	31	1	1	2	2	3	3
60	38	1	2	3	3	4	5
80	42	1	2	3	4	5	6
100	45	2	3	4	5	6	8
200	51	3	5	8	10	12	15
300	54	4	7	12	15	18	23
400	55	5	10	16	20	25	30
600	56	7	14	23	30	37	45
1,000	57	12	24	39	50	61	75
1,500	86	12	24	39	50	61	76
2,000	115	12	24	39	50	61	76
2,500	144	12	24	39	50	62	76
3,000	174	12	24	39	50	62	76
3,500	203	12	24	39	50	62	76
4,000	232	12	24	39	50	62	76
4,500	261	12	24	39	50	62	76
5,000	290	12	24	39	50	62	76

[a]N = Number of Units in the Development
[b]n = Number of Units Tested

TABLE III

N[a]	n[b]	Percentage of Leaded Units in Development Needed for Detection Capability to be:					
		50%	**75%**	**90%**	**95%**	**97.5%**	**99%**
20	20	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
40	31	2.5%	2.5%	5.0%	5.0%	7.5%	7.5%
60	38	1.7%	3.3%	5.0%	5.0%	6.7%	8.3%
80	42	1.3%	2.5%	3.8%	5.0%	6.3%	7.5%
100	45	2.0%	3.0%	4.0%	5.0%	6.0%	8.0%
200	51	1.5%	2.5%	4.0%	5.0%	6.0%	7.5%
300	54	1.3%	2.3%	4.0%	5.0%	6.0%	7.7%
400	55	1.3%	2.5%	4.0%	5.0%	6.3%	7.5%
600	56	1.2%	2.3%	3.8%	5.0%	6.2%	7.5%
1,000	57	1.2%	2.4%	3.9%	5.0%	6.1%	7.5%
1,500	86	0.8%	1.6%	2.6%	3.3%	4.1%	5.1%
2,000	115	0.6%	1.2%	2.0%	2.5%	3.1%	3.8%
2,500	144	0.5%	1.0%	1.6%	2.0%	2.5%	3%
3,000	174	0.4%	0.8%	1.3%	1.7%	2.1%	2.5%
3,500	203	0.3%	0.7%	1.1%	1.4%	1.8%	2.2%
4,000	232	0.3%	0.6%	1.0%	1.3%	1.6%	1.9%
4,500	261	0.3%	0.5%	0.9%	1.1%	1.4%	1.7%
5,000	290	0.2%	0.5%	0.8%	1.0%	1.2%	1.5%

[a]N = Number of Units in the Development
[b]n = Number of Units Tested

TABLE IV
Number of Units to Be Tested in Multifamily Developments

Number of Units in Building or Group of Similar Buildings	Number of Units to Be Tested
21–26	20
27	21
28	22
29–30	23
31	24
32	25
33–34	26
35	27
36	28
37	29
38–39	30
40–50	31
51	32
52–53	33
54	34
55–56	35
57–58	36
59	37
60–73	38
74–75	39
76–77	40
78–79	41
80–95	42
96–97	43
98–99	44
100–117	45
118–119	46
120–138	47
139–157	48
158—177	49
178–197	50
198–218	51
219–258	52
259–299	53
300–379	54
380–499	55
500–776	56
777–1004	57
1005-1022	58
1023-1039	59

For buildings or groups of similar buildings with 1,040 units or more, test 5.8 percent of the number of units, rounded to the nearest unit. EXAMPLE: If there are 2,170 units, 5.8 percent

A12.3 Sample Size and Decision Percentages in the Multifamily Decision Flowchart

To obtain 99% confidence on conclusions made about a component type using the multifamily decision flowchart in Chapter 7, XRF readings must be taken on at least 40 components of the given type. A sample size of 40 was chosen as a minimum sample size that could be achieved in almost all cases given that at least 20 units would be tested in a multifamily housing development.

For simplicity, a single percentage was desired for declaring a component type either positive or negative in multifamily housing. The decision rule in the flowchart to declare a component type positive is based on the percentage of XRF readings classified as positive relative to the HUD standard and the decision rule to declare a component type negative is based on the percentage of XRF readings less than the HUD 1.0 mg/cm² standard, assuming a 5% false positive rate and a sample size of at least 40. Parameters provided in the *XRF Performance Characteristics Sheet* for each specific XRF instrument were developed so that the false positive rate would be 5%. Thus, for sample sizes of 40 or greater and when operating an XRF instrument as specified in the *XRF Performance Characteristics Sheet*, 99% confidence may be obtained for the following:

- At least one component of a given type has lead in paint equal or greater than the HUD standard if 15% of the components are classified as positive relative to the HUD standard.
- None of the components of a given type have lead in paint greater than the HUD standard if 100% of the XRF readings taken on the components of a given type are less than 1.0 mg/cm².

The statistical rationale for the percentages used in the decision rules of the flowchart are given below.

Positive Percentage in Multifamily Decision Flowchart

The Multifamily Decision Flowchart (Figure 7.11 of Chapter 7) gives the following rule: based on XRF readings, if 15% or more components of a given type are classified as positive relative to the HUD standard, then the inspector concludes that lead is present at 1.0 mg/cm² or greater on at least one of the components of the type tested. Assuming a true false positive rate of 5%, the 99th percentiles of the observed number and percentage of false positive classifications for several sample sizes are shown below in Table V.

TABLE V

Sample Size	Number of False Positive Results	Percentage of False Positive Results
20	4	20
40	**6**	**15**
60	7	12
80	9	11
100	11	11

With a sample size of at least 40 for a component type and if the components all have true lead levels less than the HUD standard (1.0 mg/cm²), there is only a 1% probability of observing 15% or more positive results. In other words, if 15% or more results are actually observed on a component type, one can be

99% confident that lead is present on at least one of the components of a given type. Since 15% is the percentage that corresponds with a sample size of 40, 15% was adopted as the cutoff percentage for declaring a component type positive relative to the HUD standard in Chapter 7.

<u>Negative Percentage in Multifamily Decision Flowchart</u>

The flowchart specifies that if 100% of the XRF readings taken on components of a given type are less than 1.0 mg/cm², the conclusion is that no lead is present at or above the 1.0 mg/cm² HUD standard on the component type.

Given that the sample size must be at least 40 (as described above), suppose that exactly 1 of the 40 components tested has true lead level of 1.0 mg/cm² or greater. Then, the probability of obtaining an XRF reading less than 1.0 mg/cm² on all (100%) of the components of the given type is:

$$
\begin{aligned}
&\Pr(\text{All XRF readings} < 1.0\ \text{mg/cm}^2) = \\
&\quad \Pr(1\ \text{true lead level} \geq 1.0\ \text{mg/cm}^2\ \text{has XRF reading} < 1.0\ \text{mg/cm}^2) \\
&\quad * \Pr(39\ \text{true lead levels} < 1.0\ \text{mg/cm}^2\ \text{have XRF readings} < 1.0\ \text{mg/cm}^2) \\
&\quad = p_1 \text{ x } p_2^{39},
\end{aligned}
$$

where

p_1 = probability a true lead ≥ 1.0 mg/cm² has XRF reading < 1.0 mg/cm²
p_2 = probability a true lead < 1.0 mg/cm² has XRF reading < 1.0 mg/cm²

The maximum value of this expression using results from XRF instruments examined by EPA in a large field study[3] was 0.017. Thus, if one or more of the 40 components is truly positive (lead level 1.0 mg/cm² or greater) relative to the HUD standard, there is less than a 2% chance of obtaining XRF readings less than 1.0 mg/cm² on all (100%) components of the component types. This means that, whenever all XRF readings on a component of a given type are less than 1.0 mg/cm², there is at least 98% confidence that none of the 40 components have true lead above 1.0 mg/cm².

With the application of the flowchart and with a sample size of 40, there is a very high probability (at least 98 percent) that a tested component type will be correctly classified. Combined with the 95 percent probability that at least one leaded component will be selected for inspection by the sampling scheme described above when 5 percent or more of the components have lead-based paint at or above 1.0 mg/cm², the procedure provides an overall confidence level of between 93 percent and 95 percent.

A12.4 <u>References</u>

[1] W. Feller (1968), *An Introduction to Probability Theory and its Applications, Volume I*, Third Edition, Wiley, New York.

[2] SAS Institute Inc., Cary NC 27512-8000.

[3] Lead-Based Paint Testing: Field Study Technical Report, U.S. Environmental Protection Agency report, in press.

Appendix 13.1: Wipe Sampling for Settled Lead-Contaminated Dust

Wipe samples for settled leaded dust can be collected from floors (both carpeted and uncarpeted), interior and sash/sill contact areas, and other reasonably smooth surfaces. Wherever possible, hard surfaces should be sampled. Wipe media should be sufficiently durable so that it is not easily torn, but can be easily digested in the laboratory. Recovery rates of between 80-120% of the true value should be obtained for all media used for wipe sampling. Blank media should contain no more than 25 µg/wipe (the detection limit using Flame Atomic Absorption). Additional standards for wipe sampling can be found by consulting ASTM ES 30-94.

1. Wipe Sampling Materials and Supplies

a. Type of disposable wipe: Any wipe material that meets the following criteria may be used:

(i) Contains low background lead levels (less than 5 µg/wipe)
(ii) Is a single thickness
(iii) Is durable and does not tear easily (do not use Whatman™ filters)
(iv) Does not contain aloe
(v) Can be digested in the laboratory
(vi) Has been shown to yield 80-120% recovery rates from samples spiked with leaded dust (not lead in solution)
(vii) Must remain moist during the wipe sampling process (wipes containing alcohol may be used as long as they do not dry out)

Examples of acceptable wipe media include: "Little Ones Baby Wash Cloths™," "Little Ones Baby Wipes Natural Formula™," or "Little Ones Baby Wipes Lightly Scented™," available at K-Mart Stores. This product is also available under the brand names "Pure and Gentle Baby Wipes™" and "Fame Baby Wipes™." Individually-packaged "Wash'n Dri Wipes" are also acceptable. "Wet Wipes," which are available at Walgreens and other stores, may also be used. Other brands are also acceptable if equivalence in both lead contamination (analysis of blanks) and laboratory digestion recoveries (analysis of wipes spiked with known amounts of leaded dust, not lead in solution) can be established. The wipes listed above have proven to be sufficiently durable under field use and to have acceptable recovery rates. Do not use "Little Ones Diaper Wipes," also available at K-Mart stores, or any other brand of wipes for which recovery data have not been established. Do not use wipes that contain aloe. Wipes that contain alcohol may be used as long as they do not dry out during the wipe process.

b. Non-sterilized non-powdered disposable gloves. Disposable gloves are required to prevent cross-sample contamination from hands.

c. Non-sterilized polyethylene centrifuge tubes (50 ml size) or equivalent hard-shell container that can be rinsed quantitatively in the laboratory.

d. Dust sample collection forms contained in these Guidelines

e. Camera & Film to document exact locations (Optional)

f. Template Options

   i. Masking tape. Masking tape is used on-site to define the area to be wiped. Masking tape is required when wiping window sills and window wells in order to avoid contact with window jambs and channel edges. Masking tape on floors is used to outline the exact area to be wiped.

   ii. Hard, smooth, reusable templates made of laminated paper, metal, or plastic. Note: Periodic wipe samples should be taken from the templates to determine if the template is contaminated. Disposable templates are also permitted so long as they are not used for more than a single surface. Templates must be larger than 0.1 ft^2, but smaller than 2 ft^2. Templates for floors are typically 1 ft^2. Templates are usually not used for windows due to the variability in size and shape (use masking tape instead).

g. Container labels or permanent marker.

h. Trash bag or other receptacle (do not use pockets or trash containers at the residence).

i. Rack, bag, or box to carry tubes (optional)

j. Measuring tape

k. Disposable shoe coverings (optional)

2. Single Surface Wipe Sampling Procedure

a. Outline Wipe Area:

Floors: Identify the area to be wiped. Do not walk on or touch the surface to be sampled (the wipe area). Apply adhesive tape to perimeter of the wipe area to form a square or rectangle of about one square foot. No measurement is required at this time. The tape should be positioned in a straight line and corners should be nominally perpendicular. When putting down any template, do not touch the interior wipe area.

Window sills and other rectangular surfaces: Identify the area to be wiped. Do not touch the wipe area. Apply two strips of adhesive tape across the sill to define a wipe area at least 0.1 square foot in size (approx. 4 inches x 4 inches).

When using tape, do not cross the boundary tape or floor markings, but be sure to wipe the entire sampling area. It is permissible to touch the <u>tape</u> with the wipe, but not the surface <u>beyond</u> the tape.

b. Preliminary inspection of the disposable wipes:

Inspect the wipes to determine if they are moist. If they have dried out, do not use them. When using a container that dispenses wipes through a "pop-up" lid, the first wipe in the dispenser at the beginning of the day should be thrown away. The first wipe may be contaminated by the lid and is likely to have dried to some extent. Rotate the container before starting to ensure liquid inside the container contacts the wipes.

c. Preparation of centrifuge tubes:

Examine the centrifuge tubes and make sure that the tubes match the tubes containing the blind spiked wipe samples. Partially unscrew the cap on the centrifuge tube to be sure that it can be opened. Do not use plastic baggies to transport or temporarily hold wipe samples. The laboratory cannot measure lead left on the interior surface of the baggie.

d. Gloves

Don a disposable glove on one hand; use a new glove for each sample collected. If two hands are necessary to handle the sample, use two new gloves, one for each hand. It is not necessary to wipe the gloved hand before sampling. Use a new glove for each sample collected.

e. Initial placement of wipe:

Place the wipe at one corner of the surface to be wiped with wipe fully opened and flat on the surface.

f. First wipe pass - (side-to-side):

With the fingers together, grasp the wipe between the thumb and the palm. Press down firmly, but not excessively with both the palm and fingers (do not use the heel of the hand). Do not touch the surface with the thumb. If the wipe area is a square, proceed to wipe side-to-side with as many "S"-like motions as are necessary to completely cover the entire wipe area. (See step h for non- square areas.) Exerting excessive pressure on the wipe will cause it to curl. Exerting too little pressure will result in poor collection of dust. Do not use only the fingertips to hold down the wipe, because there will not be complete contact with the surface and some dust may be missed. Attempt to remove all visible dust from the wipe area.

g. Second wipe pass - (top-to-bottom):

Fold the wipe in half with the contaminated side facing inward. (The wipe can be straightened out by laying it on the wipe area, contaminated side up, and folding it over.) Once folded, place in the top corner of the wipe area and press down firmly with the palm and fingers. Repeat wiping the area with "S"-like motions, but on the second pass, move in a top-to-bottom direction. Attempt to remove all visible dust. Do not touch the contaminated side of the wipe with the hand or fingers. Do not shake the wipe in an attempt to straighten it out, since dust may be lost during shaking.

h. Rectangular areas (e.g. window sills):

If the surface is a rectangle (such as a window sill), two side-to-side passes must be made over half of this surface, the second pass with the wipe folded so that the contaminated side faces inward. For a window sill, do not attempt to wipe the irregular edges presented by the contour of the window channel. Avoid touching other portions of the window with the wipe. If there are paint chips or gross debris in the window sill, attempt to include as much of it as possible on the wipe. If all of the material cannot be picked up with one wipe, field personnel may use a second wipe at their discretion and insert it in the same container. Consult with the analytical laboratory to determine if they can perform analysis of two wipes as a single sample. When performing single-surface sampling, do not use more than two single surface wipes for each container. If heavily dust-laden, a smaller area should be wiped. It is not necessary to wipe the entire window well but do not wipe less than 0.10 ft^2 (approx 4" x 4").

i. Packaging the Wipe:

After wiping, fold the wipe with the contaminated side facing inward again, and insert aseptically (without touching anything else) into the centrifuge tube or other hard-shelled container. If gross debris is present, such as paint chips in a window well, make every attempt to include as much of the debris as possible in the wipe.

j. Labelling the Centrifuge tube:

Seal the tube and label with the appropriate identifier. Record the laboratory submittal sample number on the field sampling form (see Chapters 5 and 14).

k. Area Measurement:

After sampling, measure the surface area wiped to the nearest eighth of an inch using a tape measure or a ruler. The size of the area wiped must be at least 0.10 ft^2 in order to obtain an adequate limit of quantitation (25 µg/wipe is the typical detection limit with flame AA; 25 µg/0.10 square feet = 250 µg/ft^2, which is half of the HUD clearance criterion for interior window sills). No more than 2 square feet should be wiped with the same wipe or else the wipe may fall apart. Record specific measurements for each area wiped on the field sampling form.

l. Form Completion

Fill out the appropriate field sampling forms (see Form 5.4 or Form 14.2 in these Guidelines) completely. Collect and maintain any field notes regarding type of wipe used, lot number, collection protocol, etc.

m. Trash Disposal:

After sampling, remove the masking tape and throw it away in a trash bag. Remove the glove; put all contaminated gloves and sampling debris used for the sampling period into a trash bag. Remove the trash bag when leaving the dwelling. Do not throw away gloves or wipes inside the dwelling unit where they could be accessible to young children, resulting in a suffocation hazard.

Repeat steps a. through m. for additional samples in the same dwelling unit.

3. Composite Wipe Sampling

Whenever composite sampling is contemplated, consult with the analytical laboratory to determine if the laboratory is capable of analyzing composite samples. When conducting composite wipe sampling, the procedure stated above should be used with the following modifications:

When outlining the wipe areas (step a), set up all of the areas to be wiped before sampling. The size of these areas should be roughly equivalent, so that one room is not over-sampled.

After preparing the centrifuge tube, put on the glove(s) and complete the wiping procedures for all subsamples (steps e-i). A separate wipe must be used for each area sampled. After wiping each area, carefully insert the wipe sample into the same centrifuge tube (no more than 4 wipes per tube).

Once all subsamples are in the tube, label the tube. Record a separate measurement for each area that is subsampled on the field collection form (see Form 5.4a or Form 14.2a for a sample form). Finally, complete trash disposal (step m), making sure that no masking tape is left behind.

Risk assessors and inspector technicians do not have to remove their gloves between subsample wipes for the same composite sample as long as their gloved hands do not touch an area outside of the wipe areas. If a glove is contaminated, the glove should be immediately replaced with a clean glove.

In addition to these procedural modifications, the following rules for compositing should be observed:

· Separate composite samples are required from carpeted and hard surfaces (*e.g.*, a single composite sample should not be collected from both carpeted and bare floors).

· Separate composite samples are required from each different component sampled (*e.g.*, a composite sample should not be collected from both floors and window sills).

· Separate composite samples are required for each dwelling

4. Blank Preparation

After sampling the final dwelling unit of the day, but before decontamination, field blank samples should be obtained. Analysis of the field blank samples determines if the sample media is contaminated. Each field blank should be labeled with a unique identifier similar to the others so that the laboratory does not know which sample is the blank (i.e., the laboratory should be "blind" to the blank sample).

Blank wipes are collected by removing a wipe from the container with a new glove, shaking the wipe open, refolding as it occurs during the actual sampling procedure, and then inserting it into the centrifuge tube without touching any surface or other object. One blank wipe is collected for each dwelling unit sampled or, if more than one dwelling unit is sampled per day, one blank for every 50 field samples, whichever is less. Also, collect one blank for every lot used. Record the lot number.

5. Inspector Decontamination:

After sampling, wash hands thoroughly with plenty of soap and water <u>before getting into car.</u> A bathroom in the dwelling unit may be used for this purpose, with the owner's or resident's permission. If there is no running water in the dwelling unit, use wet wipes to clean the hands. During sampling, inspectors must not eat, drink, smoke, or otherwise cause hand to mouth contact.

6. Spike Sample Submission

Samples spiked with a known amount of leaded dust should be inserted into the sample stream randomly by the person conducting field sampling to determine if there is adequate quality control of the digestion process at the laboratory. Dust-spiked wipe samples should be submitted blindly to the laboratory by the individual performing field sampling at the rate of no less than one for every fifty field samples. Any laboratory can spike wipe samples using the procedure in Appendix 14.3. The laboratory performing the analysis of the field samples can also prepare the spike sample as long as the person performing the field sampling makes the spike sample indistinguishable from the field samples. The person conducting the field sampling should take the spike sample prepared in the laboratory and relabel the container with an identifier similar to the other field samples. The spike sample wipe should not be put into another container. Spike samples should be made using the same lot as that used in the field.

A dust-spiked sample is defined as a wipe or filter containing a known weight of lead-based paint dust, measured to the nearest 0.1 µg of leaded dust. A dust-spiked sample is prepared in a laboratory with the amount of lead-based dust present being between 50 - 1000 µg. For wipe samples, labs should use NIST Standard Lead Paint Dust (Standard 1578) or an equivalent secondary standard. See Appendix 14.3 for further details.

7. Field Qualifications of Dust Sampling Technicians

All individuals performing dust sampling should have state-certified training. Where possible, field experience in environmental sampling is preferable.

8. Quality Assurance/Quality Control

Blind analysis of spiked samples must fall within 80% - 120% of the true value. If the laboratory fails to obtain readings within the QA/QC error limits:

a. Two more spikes should be sent immediately to the lab for analysis.

b. If the two additional spike samples fail, the sample batch should be considered invalid. A full review of laboratory procedures may be necessary. Additional samples may need to be collected from the dwelling units from locations near the locations previously sampled.

If more than 50 µg/wipe is detected in a blank sample, the samples should be collected again since the media is contaminated. Blank correction of wipe samples is not recommended.

9. Other Information

See Chapter 5 and Chapter 14 for additional information on dust wipe sampling. Also see "Residential Sampling for Lead: Protocols for Leaded Dust and Soil Sampling" from EPA and ASTM ES 30-94 for further information.

Appendix 13.2
Paint Chip Sampling

Dust sampling must always be done **before** paint chip sampling in order to minimize the prospect of cross-sample contamination. Paint chip sampling is a destructive method that may release a small quantity of lead dust. Although paint chip samples are to be collected from inconspicuous areas, the occupant must always be notified that paint chip sampling may be necessary.

1. Paint Chip Sampling Tools and Materials

a. Sharp stainless steel paint scraper (such as Proprep™ Scraper, $7.50, 1-800-255-4535) available at many paint stores.

b. Disposable wipes for cleaning paint scraper.

c. Non-sterilized non-powdered disposable gloves.

d. Hard-shelled containers (such as non-sterilized 50-ml polypropylene centrifuge tubes) that can be rinsed quantitatively for paint chip samples if results are to be reported in mg/cm². Ziplock baggies can be used only if results are to be reported in µg/g or percent by weight.

e. Collection device (clean creased piece of paper or cleanable tray).

f. Field sampling and laboratory submittal forms.

g. Tape measure or ruler (if results are reported in mg/cm²).

h. Ladder.

i. Plastic trash bags.

j. Flashlight.

k. Adhesive tape.

l. Heat Gun or other heat source operating below 1100°F to soften the paint before removal.

2. Containment

a. Method One: Plastic Sheeting Underneath Sampling Area

A clean sheet of plastic measuring four feet by four feet should be placed under the area to be sampled to capture any paint chips that are not captured by the collection device or creased piece of paper. Any visible paint chips falling to the plastic should be included in the sample. Dispose of the plastic after each sample is collected by placing the sheeting in a trash bag. Do not throw away the plastic at the dwelling. Wet wipes may be used to clean the area.

b. Method Two: "Glovebag" Approach

If further containment is deemed necessary, a "glovebag" approach may be used. A durable sheet of plastic is loosely taped to the surface to be sampled, with a paint scraper, collection device, and shipment container housed inside the plastic. There should be enough "play" in the plastic to permit a scraping motion without dislodging the tape holding the plastic to the surface. Large plastic baggies can be used in lieu of the sheet of plastic if paint chips are to be shipped to the lab in plastic baggies. Properly conducted, this method completely seals the surface during the actual scraping operation. A four by four foot sheet of plastic is still required under the glove bag to capture any debris that falls to the ground during the glove bag removal. The tape should be slowly removed from the surface to avoid lifting any additional paint off of the surface.

3. Paint Sample Collection

The paint chip sample need not be more than 2-4 square inches in size (consult with the laboratory for the optional size). Persons collecting paint chips should wear new disposable gloves for each sample.

The most common paint sampling method is to scrape paint directly off the substrate. The goal is to remove all layers of paint equally, but none of the substrate. A heat gun should be used to soften the paint before removal to reduce the chances of including substrate with the sample and to help prevent sample loss. Including substrate in the sample will dilute the lead content if results are reported in µg/g or weight percent. Hold the heat gun no closer than six inches from the surface. Do not scorch the paint. Discontinue heating as soon as softening or blistering is observed.

Use a razor-sharp scraper to remove paint from the substrate. Paint samples collected in this fashion are usually reported in µg/g or % lead only. The sample may be placed in a baggie for shipment to the laboratory.

If the area sampled is measured exactly, and all the paint within that area can be removed and collected, it is possible to also report the results in mg/cm^2. All of the sample must be placed in a hard-shelled container for shipment to the laboratory. The hard-shelled container is used since the laboratory will analyze the entire sample submitted. The exact dimensions of the area sampled must be recorded on the field sampling form. For mg/cm^2, including a small amount of substrate in the sample is permitted.

4. Composite Paint Chip Sample Collection

Paint chip samples may be composited by collecting individual subsamples from different surfaces. If results are reported in mg/cm^2, each subsample should be exactly the same size in surface area. If results are reported in weight percent or µg/g, each subsample should have about the same weight (weighing is done in a laboratory). The result is then compared to the standard for lead-based paint divided by the number of sub-samples (the composite standard). If the result is above this number, one or more of the samples may be above the standard. Each sub-sample should be reanalyzed individually in this case. If the result is below this number, none of the sub-samples can contain lead above the standard. No more than 5 subsamples should be included in the same sample container or ziplock baggie. If both single-surface and composite samples are collected side-by-side, the individual samples can be submitted for analysis without returning to the dwelling if the composite result is above the composite standard. If the laboratory does not analyze the entire composite sample, it must use a validated homogenizing technique to ensure that all sub-samples are completely mixed together.

5. Cleanup and Repair

a. All settled dust generated must be cleaned up using wet wipes.

b. The surface can be resealed with new paint if necessary. If desired, apply spackling and/or new paint to repair the area where paint was removed.

c. Personnel conducting paint sampling should avoid hand-to-mouth contact (specifically, smoking, eating, drinking, and applying cosmetics) and should wash their hands with running water immediately after sampling. The inspector should ask to use the resident's bathroom for this purpose. Wet wipes may be used if no running water is available or if the bathroom is not available.

6. Laboratory Submittal

The samples should be submitted to a laboratory recognized by the EPA National Lead Laboratory Accreditation Program. Appropriate sample submittal forms should be used. The field sample number should appear on the field sampling form, the laboratory submittal form, and the container label. The name of the laboratory, the date the samples were sent to the lab, and all personnel handling the sample from the time of collection to the time of arrival at the laboratory should be recorded on a chain of custody form, if appropriate.

See Appendix 14 for the laboratory analytical procedures to be used.

7. Qualifications of Paint Sampling Technicians

All individuals performing paint sampling should be certified. Where possible, field experience in environmental sampling is preferable.

8. Other Information

See ASTM ES 28-94 and ES 37-94 for additional information

Appendix 13.3: Soil Sampling Protocol For Housing

A. Collection Technique General Description

Bare soil samples are typically collected with a coring device or a scooping technique. The device may be used in either of two ways. Most coring devices come equipped with a "T" handle which can be attached to the top of the coring tool or probe. This allows the operator to push the tool into the ground. The coring tool can be twisted with the "T" handle as it is pushed into the ground in order to allow the cutting edge of the soil probe to cut through roots and packed earth. In softer soils, a disposable new plastic syringe at least ½ inch diameter can be used for each composite sample

The other method for using the coring tool is to attach a hammer device to the top of the coring tool. To utilize the coring tool in this manner, the hammer device is first attached to the top of the coring tool and the tip of the probe is placed on the ground where the sample is to be collected. The hammer is then raised and allowed to fall while it is guided by the operator’s hands. The hammer attachment may be the most appropriate tool when the nature of the soils is hard and compacted. Otherwise the "T" handle is easier to use.

The soil samples are collected by driving or pushing the coring tool into the ground, usually about ½ inch deep. The tool is then moved gently from side to side to loosen a plug of soil. The tool is then pulled from the ground and the soil sample is pushed so that the upper part of the soil plug lies between one inch marks made on the coring device. The top one half inch of the soil sample is then cut from the core with a stainless steel knife or cutting tool provided for that purpose. This top one half inch section of the soil core is then transferred to a sample container. All sub-samples are collected in this manner. The collection of subsamples from the sampling line is referred to as a "composite" sample.

After collecting a composite sample, the soil probe should be decontaminated or discarded if disposable core liners are used. This process consists of wiping the end of the probe with wet wipes until no more visible dirt is removed from the probe. Similar cores are then collected from the bottom inch of the six-inch core.

B. Materials and Supplies

1. Core sampling device: Standard soil coring device. Other similar core sampling devices may be used, such as disposable plastic syringes with the end cut off. The plunger is used to remove the soil from the syringe body.

2. Disposable wipes.

3. Non-sterilized 5" x 8" plastic ziplock baggies: Unless baggies are 4 mil industrial strength, they must be double bagged

4. Non-sterilized non-powdered disposable gloves: For example, Action Scientific (800-678-1033) No. A-105

5. Floor Plan & Property Sketch

6. Soil Sample Collection Form

7. Laboratory submittal form

8. Pre-printed labels or permanent ink pen

9. Trash bag or other receptacle (do not use pockets or trash containers at the residence)

C. Bare Soil Sampling Procedures

1. Soil sampling is not recommended when the ground is frozen.
2. The location of soil samples should be recorded on the exterior site plan sketch.
3. Perimeter Sampling Locations: One composite soil sample should be collected so that at least 5 and no more than 10 different aliquots of surface soil are collected from the building perimeter. The aliquots should be collected from all sides of the building where bare soil is present. Each spot should be at least 2 feet distant from each other and 2 feet away from the foundation, unless the bare soil is closer than 2 feet.

4. Play Area Sampling Locations: A second composite sample should consist of at least 5 and no more than 10 aliquots collected along an X-shaped grid in the child's principle play area. Each spot should be at least 1 foot distant from each other. The soil where the aliquots are collected must be bare.

5. The core sampling device should be used to deliver the top ½ inch of soil from each spot to the baggie. No special effort should be made to collect visible paint chips. If paint chips are present, they should not be avoided and should be included in the sample. When sampling play areas, the inspector should make an effort to avoid including grass, twigs, stones, and other gross debris in the sample.

6. When all aliquots of the composite sample have been placed in the baggie, the baggie should be ziplocked. If the baggie is not 4 mil industrial weight, the sample should be double bagged. A label with the sample number should be affixed to the baggie. The number should be recorded on the soil plat form showing the approximate location of each sample and the soil collection field data form.

7. The core sampler should be cleaned with a disposable wipe after each composite sample is collected. If a disposable core sampler is used, it can be used for all sub-samples, but not new composite samples unless it is cleaned thoroughly.

D. Laboratory Submittal

1. Submittal Form Preparation

The sample numbers on the sample container must be the same as those on the field sampling form and must also be used on the laboratory submittal form. Confirm that all samples recorded on are in fact present on the laboratory submittal form.

Chain of custody requirements should be followed if applicable.

E. Laboratory Analytical Procedure

1. Laboratories analyzing soil samples must participate in the Environmental Lead Laboratory Proficiency Testing Program or equivalent and be an EPA-NLLAP Accredited Laboratory.

2. Soil samples are received, logged in, opened and placed on drying plates, dried, and mixed thoroughly.

3. Sample sieving: Samples are to be sieved once with a number 10 sieve with a mesh size of 2 millimeters. Visible paint chips are disaggregated by forcing the paint chips and other large particles through the sieve by a rubbing motion. Sieving is always done under a laboratory hood.

4. Samples are oven dried to a constant weight and analyzed by EPA Method SW-846 or equivalent.

F. See ASTM ES <u>29-94</u> for further information.

Appendix 13.4: Sampling Airborne Particulate for Lead (NIOSH Method 7082)

Editor's Note: See also ASTM Standard E 1553-93 and ES 33-94

LEAD

Formula: Pb
M.W.: 207.19 (Pb); 223.19 (PbO)

METHOD: 7082
ISSUED: 2/15/84

OSHA: 0.05 mg/m^3
NIOSH: 0.05 mg/m^3 [1]
ACGIH: 0.15 mg/m^3; STEL 0.45 mg/m^3

PROPERTIES: soft metal; d 11.3 g/cm^3; MP 327.5°C; valences +2, +4 in salts

SYNONYMS: vary depending on the chemical form (elemental lead and lead compounds except alkyl lead); CAS #1317-36-8 (PbO); CAS #7439-92-1 (Pb). Editor's Note: This method has not been validated for lead paint chip samples. It is typically used to analyze lead <u>air</u> samples.

SAMPLING

SAMPLE: FILTER
(0.8 µm cellulose ester membrane)

FLOW RATE: 1 to 4 L/min

VOL-MIN: 200 L@ 0.05 mg/m^3
-MAX: 1200L

SHIPMENT: routine

SAMPLE STABILITY: stable

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIES: 0.13 to 0.4 mg/m^3 [2]; 0.15 to 1.7 mg/m^3 (fume) [3]

BIAS: not significant [2]
OVERALL PRECISION (s_r): 0.072 [2]; 0.068 (fume) [3]

MEASUREMENT

TECHNIQUE: ATOMIC ABSORPTION, FLAME

ANALYTE: lead

ASHING: conc. HNO_3, 6 ml; 140° C

FINAL SOLUTION: 10% HNO_3, 10 ml

FLAME: air-acetylene, oxidizing

WAVELENGTH: 283.3 nm

BACKGROUND CORRECTION: D_2 or H_2 lamp

CALIBRATION: Pb++ in 10% HNO_3

RANGE: 10 to 200 µg per sample [3, 8]

ESTIMATED LOD: 2.6 µg per sample [9]

PRECISION (s_r): 0.03 [2]

APPLICABILITY: The working range is 0.025 to 0.5 mg/m^3 for a 400 L air sample. The method is applicable to elemental lead, including Pb fume, and all other aerosols containing lead. This is an elemental analysis, not compound specific. Aliquots of the samples can be analyzed separately for additional elements.

INTERFERENCES: Use D_2 or H_2 continuum background correction to control flame or molecular absorption. High concentrations of calcium, sulfate, carbonate, phosphate, iodide, fluoride, or acetate can be corrected.

OTHER METHODS: This method combines and replaces P&CAM 173 [8] and S341 [7,9] for lead. Method 7300 (ICP-AES) is an alternate analytical method. Method 7505 is specific for lead sulfide. The following have not been revised: the dithizone method, which appears in P&CAM 102 [4] and the lead criteria document [1]; P&CAM 191 (ASV) [5]; and P&CAM 214 (graphite furnace-AAS) [6].

REAGENTS:

1. Nitric acid, conc.
2. Nitric acid, 10% (w/v). Add 100 ml conc. HNO_3 to 500 ml water; dilute to 1 l.
3. Hydrogen peroxide, 30% H_2O_2 (w/w), reagent grade.
4. Calibration stock solution, 1000 µg Pb/ml. Commercial standard or dissolve 1.00 g Pb metal in minimum volume of (1+1) HCl and dilute to 1 l with 1% (v/v) HCl. Store in a polyethylene bottle. Stable ≥ one year.
5. Air compressed, filtered.
6. Acetylene.
7. Distilled or deionized water.

EQUIPMENT:

1. Sampler: Cellulose ester filter, 0.8 µm pore size, 37 mm diameter; in cassette filter holder.
2. Personal sampling pump, 1 to 4 l/min, with flexible connecting tubing.
3. Atomic Absorption Spectrophotometer with an air-acetylene burner head.
4. Lead hollow cathode lamp or electrode dischargeless lamp.
5. Regulators, two-stage, for air and acetylene.
6. Beakers, Phillips, 125 ml, or Griffin, 50 ml with watchglass covers.*
7. Volumetric flasks, 10 and 100 ml.*
8. Assorted volumetric pipets as needed.*

REAGENTS:

EQUIPMENT:

9. Hotplate, surface temperature 140°C.

10. Bottles, polyethylene, 100 ml.

* Clean all glassware with conc. nitric acid and rinse thoroughly with distilled or deionized water before use.

SPECIAL PRECAUTIONS: Perform all acid digestions in a fume hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.

2. Sample at an accurately known flow rate between 1 and 4 l/min for up to 8 hrs for TWA measurements.[1] Do not exceed a filter loading of ca. 2 mg total dust.

SAMPLE PREPARATION:

NOTE: The following sample preparation gave quantitative recovery (see EVALUATION OF METHOD) [9]. Steps 4 through 9 of Method 7300 or other quantitative ashing techniques may be substituted, especially if several metals are to be determined on a single filter.

3. Open the cassette filter holders and transfer the samples and blanks to clean beakers.

4. Add 3 ml conc. HNO_3, and 1 ml 30% H_2O_2 and cover with a watchglass. Start reagent blanks at this step.

NOTE: If PbO_2 is not present in the sample, the 30% H_2O_2 need not be added [3,9].

5. Heat on hotplate (140°C) until most of the acid has evaporated.

6. Repeat two more times using 2 ml conc. HNO_3 and 1 ml 30% H_2O_2 each time.

7. Heat on 140°C hotplate until a white ash appears.

8. When sample is dry, rinse the watchglass and walls of the beaker with 3 to 5 ml 10% HNO_3. Allow the solution to evaporate to dryness.

9. Cool each beaker and dissolve the residues in 1 ml conc. HNO_3.

[1] Editor's Note: Use a flow rate of 2 liters/minute and a closed-face 37 mm cassette.

10. Transfer the solution quantitatively to a 10 ml volumetric flask and dilute to volume with distilled water.

NOTE: If the concentration (M) of any of the following is expected to exceed the lead concentration (M) by 10 fold or more, add 1 ml 1 M Na_2EDTA to each flask before dilution to volume: CO, PO_3, I^-, F^-, $CH_3COO^=$. If Ca^{++} or SO are present in 10-fold excess, make all standards and samples 1% (w/w) in La^{++} [8].

CALIBRATION AND QUALITY CONTROL:

11. Prepare a series of working standards covering the range 1 to 20 µg Pb/ml (1 to 200 µg Pb per sample) by adding aliquots of calibration stock solution to 100 ml volumetric flasks. Dilute to volume with 10% HNO_3. Store the working standards in polyethylene bottles and prepare fresh weekly.

12. Analyze the working standards together with the blanks and samples (steps 17 and 18).

13. Prepare a calibration graph of absorbance vs. solution concentration (µg/ml).

14. Aspirate a standard for every 10 samples to check for instrument drift.

15. Check recoveries with at least one spiked media blank per 10 samples.

16. Use method of additions occasionally to check for interferences.

MEASUREMENT:

17. Set spectrophotometer as specified by the manufacturer and to conditions on page 13.6-1.

NOTE: An alternative wavelength is 217.0 nm [10]. Analyses at 217.0 nm have slightly greater sensitivity, but poorer signal-to-noise ratio compared to 283.3 nm. Also, non-atomic absorption is significantly greater at 217.0 nm, making the use of D_2 or H_2 continuum correction mandatory at that wavelength.

18. Aspirate standards, samples and blanks. Record absorbance readings.

NOTE: If the absorbance values for the samples are above the linear range of the standards, dilute with 10% HNO_3, reanalyze and apply the appropriate dilution factor in the calculations.

CALCULATIONS:

19. Using the measured absorbances, calculate the corresponding concentrations (µg/ml) of lead in the sample, C_s, and average media blank, C_b, from the calibration graph.

20. Using the solution volumes (ml) of the sample, V_s, and media blanks, V_b, calculate the concentration, C (mg/m_3), of lead in the air volume sampled, V (L):

$$C = \frac{C_s V_s - C_b V_b}{V}, \text{ mg/m}^3$$

EVALUATION OF METHOD:

Method S241 [7] was issued on October 24, 1975, and validated over the range 0.13 to 0.4 mg/m^3 for a 180 l air sample, using generated atmospheres of lead nitrate [2]. Recovery in the range 18 to 72 µg Pb per sample was 98%, and collection efficiency of 0.8 µm mixed cellulose ester filters (Millipore Type AA) was 100% for the aerosols. Subsequent studies on analytical recovery of 200 µg Pb per sample gave the results [3,9]:

Species	Digestion Method	Analytical Recovery, %
Pb metal	HNO_3 only	92 ± 4
Pb metal	$HNO_3 + H_2O_2$	103 ± 3
PbO	HNO_3 only	93 ± 4
PbS	HNO_3 only	93 ± 5
PbO_2	HNO_3 only	82 ± 3
PbO_2	$HNO_3 + H_2O_2$	100 ± 1
Pb in paint*	HNO_3 only	95 ± 6
Pb in paint*	$HNO_3 + H_2O_2$	95 ± 6

* Standard Reference Material #1579, U.S. National Bureau of Standards.

Additional collection efficiency studies were also done using Gelman GN-4 filters for the collection of Pb fume, which had geometric mean diameter of 0.1 µm [3]. Mean collection efficiency for 24 sampling runs at flow rates between 0.15 and 4.0 l/min was > 97 ± 2%. Overall precision, s_r, was 0.072 for lead nitrate aerosol [2,7] and 0.068 for Pb fume [3,9].

REFERENCES:

[1] Criteria for a Recommended Standard...Occupational Exposure to Inorganic Lead (Revised Criteria), U.S. Department of Health, Education and Welfare, Publ. (NIOSH) 78-158 (1978).

[2] Documentation of the NIOSH Validation Tests, U.S. Department of Health, Education and Welfare, Publ. (NIOSH) 77-185 (1977).

[3] Heavy Metal Aerosols: Collection and Dissolution Efficiencies, Final Report of NIOSH Contract 210-79-0058, W.F. Gutknecht, M.H. Ranade, P.M. Grohse, A. Damle, and D. O'Neal, Research Triangle Institute; available as Order No. PB 83-106740 from NTIS, Springfield, VA 22161 (1981).

[4] NIOSH Manual of Analytical Methods, 2nd ed., V. 1, P&CAM 102, U.S. Department of Health, Education and Welfare, Publ. (NIOSH) 77-157-A (1977).

[5] Ibid, P&CAM 191.

[6] Ibid, P&CAM 214.

[7] Ibid, V. 3, S341, U.S. Department of Health, Education and Welfare, Publ. (NIOSH) 77-157-C (1977).

[8] Ibid, V. 5, P&CAM 173, U.S. Department of Health, Education and Welfare, Publ. (NIOSH) 77-157-A (1979).

[9] Ibid, V. 7, (revised 3/25/81), U.S. Department of Health, Education and Welfare, Publ. (NIOSH) 82-100 (1982).

[10] Analytical Methods for Atomic Absorption Spectrophotometry, Perkin-Elmer (1976).

METHOD REVISED BY: Mark Millson and R. DeLon Hull, NIOSH/DPSE; S341 originally validated under NIOSH Contract CDC-94-74-45; additional studies under NIOSH Contract 210-79-0058.

EPA
United States
Environmental Protection
Agency

Office of Water
(WH-550)

EPA/810-F-93-001
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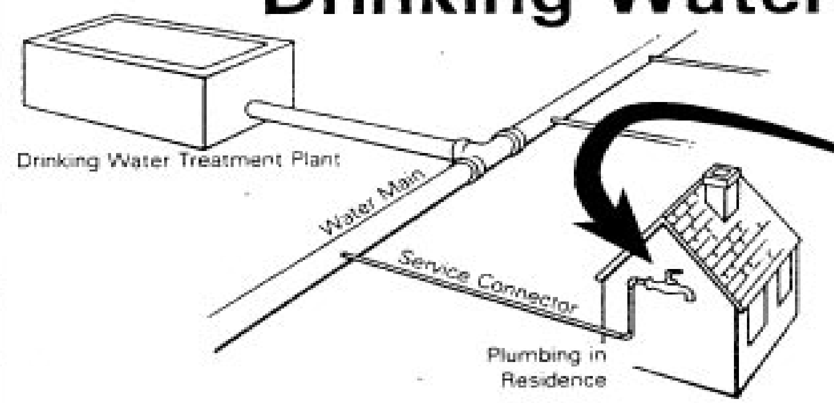
LEAD In Your Drinking Water



Health Threats From Lead

Too much lead in the human body can cause serious damage to the brain, kidneys, nervous system, and red blood cells.

You have the greatest risk, even with short-term exposure, if:

- you are a young child, or
- you are pregnant.

Sources of Lead in Drinking Water

Lead levels in your drinking water are likely to be highest if:

- your home has faucets or fittings made of brass which contains some lead, **or**
- your home or water system has lead pipes, **or**
- your home has copper pipes with lead solder, **and**
  - the home is less than five years old, or
  - you have natually soft water, or
  - water often sits in the pipes for several hours.

Actions You Can Take To Reduce Lead In Drinking Water

Flush Your Pipes Before Drinking

Anytime the water in a particular faucet has not been used for six hours or longer, “flush” your cold-water pipes by running the water until it becomes as cold as it will get. (This could take as little as five to thirty seconds if there has been recent heavy water use such as showering or toilet flushing. Otherwise, it could take two minutes or longer.) The more time water has been sitting in your home's pipes, the more lead it may contain.

Only Use Cold Water for Consumption

Use *only* water from the cold-water tap for drinking, cooking, and **especially for making baby formula**. Hot water is likely to contain higher levels of lead.

The two actions recommended above are very important to the health of your family. They will probably be effective in reducing lead levels because most of the lead in household water usually comes from the plumbing in your house, not from the local water supply.

Have Your Water Tested

After you have taken the two precautions above for reducing the lead in water used for drinking or cooking, **have your water tested.** The only way to be sure of the amount of lead in your household water is to have it tested by a competent laboratory. Your water supplier may be able to offer information or assistance with testing. Testing is especially important for apartment dwellers, because flushing may not be effective in high-rise buildings with lead-soldered central piping.

For more details on the problem of lead in drinking water and what you can do about it, read the following questions and answers.

Your local or state department of health or environment might be able to provide additional information.

Q Why is lead a problem?

A Although it has been used in numerous consumer products, lead is a toxic metal now know to be harmful to human health if inhaled or ingested. Important sources of lead exposure include: ambient air, soil, and dust (both inside and outside the home), food (which can be contaminated by lead in the air or in food containers), and water (from the corrosion of plumbing). On average, it is estimated that lead in drinking water contributes between 10 and 20 percent of total lead exposure in young children. In the last few years, federal controls on lead in gasoline have significantly reduced people's exposure to lead.

The degree of harm depends upon the level of exposure (from all sources). Known effects of exposure to lead range from subtle biochemical changes at low levels of exposure, to severe neurological and toxic effects or even death at extremely high levels.

Q Does lead affect everyone equally?

A Young children, infants and fetuses appear to be particularly vulnerable to lead poisoning. A dose of lead that would have little effect on an adult can have a big effect on a small body. Also, growing children will more rapidly absorb any lead they consume. A child's mental and physical development can be irreversibly stunted by over-exposure to lead. In infants, whose diet consists of liquids made with water - such as baby formula - lead in drinking water makes up an even greater proportion of total lead exposure (40 to 60 percent).

Q How could lead get into my drinking water?

A Typically, lead gets into your water after the water leaves your local treatment plant or your well. That is, the source of lead in your home's water is most likely pipe or solder in your home's own plumbing.

The most common cause is corrosion, a reaction between the water and the lead pipes or solder. Dissolved oxygen, low pH (acidity) and low mineral content in water are common causes of corrosion. All kinds of water, however, may have high levels of lead.

One factor that increases corrosion is the practice of grounding electrical equipment (such as telephones) to water pipes. Any electric current traveling through the ground wire will accelerate the corrosion of lead in the pipes. (Nevertheless, wires **should not be removed** from pipes unless a qualified electrician installs an adequate alternative grounding system.)

Q Does my home's age make a difference?

A Lead-contaminated drinking water is most often a problem in houses that are either very old or very new.

Up through the early 1900's, it was common practice, in some areas of the country, to use lead pipes for interior plumbing. Also, lead piping was often used for the service connections that join residences to public water supplies. (This practice ended only recently in some localities.) Plumbing installed before 1930 is most likely to contain lead.

Copper pipes have replaced lead pipes in most residential plumbing. However, the use of lead solder with copper pipes is widespread. Experts regard this lead solder as the major cause of lead contamination of household water in U.S. homes today. New brass faucets and fittings can also leach lead, even though they are “lead-free”.

Scientific data indicate that the newer the home, the greater the risk of lead contamination. Lead levels decrease as a building ages. This is because, as time passes, mineral deposits form a coating on the inside of the pipes (if the water is not corrosive). This coating insulates the water from the solder. But, during the first five years (before the coating forms) water is in direct contact with the lead. More likely than not, **water in buildings less than five years old has high levels of lead contamination**.

Q How can I tell if my water contains too much lead?

A You should have your water tested for lead. Testing costs between $20 and $100. Since you cannot see, taste, or smell lead dissolved in water, testing is the only sure way of telling whether or not there are harmful quantities of lead in your drinking water.

You should be particularly suspicious if your home has lead pipes (lead is a dull gray metal that is soft enough to be easily scratched with a house key), if you see signs of corrosion (frequent leaks, rust-colored water, stained dishes or laundry), or if your non-plastic plumbing is less than five years old. You water supplier may have useful information, including whether or not the service connector used in your home or area is made of lead.

Testing is especially important in high-rise buildings where flushing might not work.

Q How do I have my water tested?

A Water samples from the tap will have to be collected and sent to a qualified laboratory for analysis. Contact your local water utility or your local health department for information and assistance. In some instances, these authorities will test your tap water for you, or they can refer you to a qualified laboratory. You may find a qualified testing company under “Laboratories” in the yellow pages of your telephone directory.

You should be sure that the lab you use has been approved by your state or by EPA as being able to analyze drinking water samples for lead contamination. To find out which labs are qualified, contact your state or local department of the environment or health.

Q What are the testing procedures?

A Arrangements for sample collection will vary. A few laboratories will send a trained technician to take the samples; but in most cases, the lab will provide sample containers along with instructions as to how you should draw your own tap-water samples. If you collect the samples yourself, make sure you follow the lab's instructions exactly. Otherwise, the results might not be reliable.

Make sure that the laboratory is following EPA's water sampling and analysis procedures. Be certain to take a “first draw” and a “fully flushed” sample. (The first-draw sample - taken after at least six hours of no water use from the tap tested - will have the highest level of lead, while the fully flushed sample will indicate the effectiveness of flushing the tap before using the water.)

Q How much lead is too much?

A Federal standards initially limited the amount of lead in water to 50 parts per billion (ppb). In light of new health and exposure data, EPA has set an action level of 15 ppb. If tests show that the level of lead in your household water is in the area of 15 ppb or higher, it is advisable - especially if there are young children in the home - to reduce the lead level in your tap water as much as possible. (EPA estimates that more than 40 million U.S. residents use water that can contain lead in excess of 15 ppb.)

Note: One ppb is equal to 1.0 microgram per liter (ug/l) or 0.001 milligram per liter (mg/l).

Q How can I reduce my exposure?

A If your drinking water is contaminated with lead - or until you find out for sure - there are several things you can do to minimize your exposure. Two of these actions should be taken right away by everyone who has, or suspects, a problem. The advisability of other actions listed here will depend upon your particular circumstances.

Immediate Steps

- The first step is to refrain from consuming water that has been in contact with your home's plumbing for more than six hours, such as overnight or during your work day. Before using water for drinking or cooking, “flush” the cold water faucet by allowing the water to run until you can feel that the water has become as cold as it will get. You must do this for each drinking water faucet - taking a shower will not flush your kitchen tap. Buildings built prior to about 1930 may have service connectors made of lead. Letting the water run for an extra 15 seconds after it cools should also flush this service connector. Flushing is important because the longer water is exposed to lead pipes or lead solder, the greater the possible lead contamination. (The water that comes out after flushing will not have been in extended contact with lead pipes or solder.) Once you have flushed a tap, you might fill one or more bottles with water and put them in the refrigerator for later use that day. (The water that was flushed - usually one to two gallons - can be used for non-consumption purposes such as washing dishes or clothes; it needn't be wasted.)

Note: Flushing may prove ineffective in high-rise buildings that have large-diameter supply pipes joined with lead solder.

- The second step is to never cook with or consume water from the hot-water tap. Hot water dissolves more lead more quickly than cold water. So, do not use water taken from the hot tap for cooking or drinking, and **especially not for making baby formula**. (If you need hot water, draw water from the cold tap and heat it on the stove.) Use only thoroughly flushed water from the cold tap for any consumption.

Definitions

Corrosion: A dissolving and wearing away of metal caused by a chemical reaction (in this case, between water and metal pipes, or between two different metals).

First Draw: The water that immediately comes out when a tap is first opened.

Flush: To open a cold-water tap to clear out all the water which may have been sitting for a long time in the pipes. In new home, to flush a system means to send large volumes of water gushing through the unused pipes to remove loose particles of solder and flux. (Sometimes this is not done correctly or at all.)

Flux: A substance applied during soldering to facilitate the flow of solder. Flux often contains lead and ca, itself, be a source of contamination.

Naturally soft water: Any water with low mineral content, lacking the hardness minerals calcium and magnesium.

Public Water System: Any system that supplies water to 25 or more people or has 15 or more service connections (buildings or customers).

Service Connector: The pipe that carries tap water from the public water main to a building. In the past these were often made of lead.

Soft water: Any water that is not “hard” Water is considered to be hard when it contains a large amount of dissolved minerals, such as salts containing calcium or magnesium. You may be familiar with hard water that interferes with the lathering action of soap.

Solder: A metallic compound used to seal joints in plumbing. Until recently, most solder contained about 50 percent lead.

Other Actions

- If you are served by a public water system (more than 219 million people are) contact your supplier and ask whether or not the supply system contains lead piping, and whether your water is corrosive. If either answer is yes, ask what steps the supplier is taking to deal with the problem of lead contamination.

Drinking water can be treated at the plant to make it less corrosive. Cities such as Boston and Seattle have successfully done this for an annual cost of less than one dollar per person. (Treatment to reduce corrosion will also save you and the water supplier money by reducing damage to plumbing.)

Water mains containing lead pipes can be replaced, as well as those portions of lead service connections that are under the jurisdiction of the supplier.

- If you own a well or another water source, you can treat the water to make it less corrosive. Corrosion control devices for individual households include calcite filters and other devices. Calcite filters should be installed in the line between the water source and any lead service connections or lead-soldered pipe. You might ask your health or water department for assistance in finding these commercially available products.

- Recently a number of cartridge type filtering devices became available on the market. These devices use various types of filtering media, including carbon, ion exchange resins, activated alumina and other privately marketed products. Unless they have been certified as described below, the effectiveness of these devices to reduce lead exposure at the tap can vary greatly. It is highly recommended that before purchasing a filter, you verify the claims made by the vendor. If you have bought a filter, you should replace the filter periodically as specified by the manufacturer. Failure to do so may result in exposure to high lead levels.

Two organizations can help you decide which type of filter is best for you. The National Sanitation Foundation, International (NSF), an independent testing agency, evaluates and certifies the performance of filtering devices to remove lead from drinking water. Generally, their seal of approval appears on the device and product packaging. The Water Quality Association (WQA) is an independent, not-for-profit organization that represents firms and individuals who produce and sell equipment and services which improves the quality of drinking water. WQA's water quality specialists can provide advice on treatment units for specific uses at home or business.

For additional information regarding the certification program, contact NSF at (313) 769-8010, or WQA at (708) 505-0161, ext. 270.

- You can purchase bottled water for home and office consumption. (Bottled water sold in interstate commerce is regulated by the Food and Drug Administration. Water that is bottled and sold within a state is under state regulation. EPA does not regulate bottled water.)

- When repairing or installing new plumbing in old homes, instruct, in writing, any plumber you hire to use only lead-free materials.

- When building a new home, be sure lead-free materials are used. Before you move into a newly built home, remove all strainers from faucets and flush the water for at least 15 minutes to remove loose solder or flux debris from the plumbing. Occasionally, check the strainers and remove any later accumulation of loose solder or flux debris from the plumbing. Occasionally, check the strainers and remove any later accumulation of loose material.

Q What about lead in sources other than drinking water?

A As mentioned above, drinking water is estimated to contribute only 10 to 20 percent of the total lead exposure in young children. Ask your local health department or call EPA for more information on other sources of exposure to lead. A few general precautions can help prevent contact with lead in and around your home:

❖ Avoid removing paint in the home unless you are sure it contains no lead. Lead paint should only be removed by someone who knows how to protect you from lead paint dust. However, by washing floors, window sills, carpets, upholstery and any objects children put in their mouths, you can get rid of this source of lead.

❖ Make sure children wash their hands after playing outside in the dirt or snow.

❖ Never store food in open cans. Keep it in glass plastic or stainless steel containers. Use glazed pottery only for display if you don't know whether it contains lead.

❖ If you work around lead, don't bring it home. Shower and change clothes at work and wash your work clothes separately.

Q Aren't there a lot of types of treatment devices that would work?

A There are many devices which are certified for effective lead reduction, but devices that are not designed to remove lead will not work. It is suggested that you follow the recommendations below before purchasing any device:

- Avoid being misled by false claims and scare tactics. Be wary of "free" water testing that is provided by the salesperson to determine your water quality; many tests are inaccurate or misleading. Research the reputation and legitimacy of the company or sales representative.

- Avoid signing contracts or binding agreements for “one-time” offers or for those that place a lien on your home. Be very careful about giving credit card information over the phone. Check into any offers that involve prizes or sweepstakes winnings.

- As suggested above, verify the claims of manufacturers by contacting the National Sanitation Foundation International or the Water Quality Association.

Q What is the government doing about the problem of lead in household water?

A There are two major governmental actions to reduce your exposure to lead:

- Under the authority of the Safe Drinking Water Act, EPA set the action level for lead in drinking water at 15 ppb. This means utilities must ensure that water from the customer's tap does not exceed this level in at least 90 percent of the homes sampled. If water from the tap does exceed this limit, then the utility must take certain steps to correct the problem. Utilities must also notify citizens of all violations of the standard.

- In June 1986, President Reagan signed amendments to the Safe Drinking Water Act. These amendments require the use of “lead-free” pipe, solder, and flux in the installation or repair of any public water system, or any plumbing in a residential or non-residential facility connected to a public water system.

Under the provisions of these amendments, solders and flux will be considered “lead-free” when they contain not more than 0.2 percent lead. (In the past, solder normally contained about 50 percent lead.) Pipes and fittings will be considered “lead free” when they contain not more than 8.0 percent lead.

These requirements went into effect in June 1986. The law gave state governments until June 1988 to implement and enforce these new limitations. Although the states have banned all use of lead materials in drinking water systems, such bans do not eliminate lead contamination within existing plumbing. Also, in enforcing the ban, some states have continued to find illegally used lead solder in new plumbing installations. While responsible plumbers always observe the ban, this suggests that some plumbing installations or repairs using lead solder may be escaping detection by the limited number of enforcement personnel.

Where can I get more information?

First contact your county or state department of health or environment for information on local water quality.

For more general information on lead, there are now two toll-free telephone services:

EPA Safe Drinking Water Hotline

1-800-426-4791

National Lead Information Center

1-800-LEAD-FYI

Appendix 14.1: Laboratory Analytical Procedures

Methods used for analysis of samples for lead should be the methods used by the EPA Recognized Laboratory to analyze Environmental Lead Proficiency Analytical Testing (ELPAT) Program samples. ELPAT samples are distributed by the American Industrial Hygiene Association (703-849-8888). These methods are part of the laboratory accreditation process, and are standard operating procedures for analysis of samples.

Further information is available from the EPA Document Residential Sampling for Lead: Protocols for Lead Dust and Soil Sampling. Also see ASTM ES 36-94, ASTM ES 37-94, and ES 35-94

The following are methods which can potentially be used to analyze some types of lead samples. None of the methods listed below have been developed to analyze paint chips specifically. It is the laboratory's responsibility to demonstrate the use of any specific technique or reference materials of the same matrix and mass range of the samples being submitted for analysis. Only laboratories accredited through EPA's National Lead Laboratory Accreditation program should be used.

1. Standard Operating Procedures for Lead in Paint by Hotplate- or Microwave-Based Acid Digestions and Atomic Absorption or Inductively Coupled Plasma Emission Spectrometry, September 1991, NTIS Publication PB92-114172 (EPA 600/8-91/231)

2. NIOSH Methods 7082 and 7300 (<u>NIOSH Manual of Analytical Methods</u>, Third Edition, 1984, Revised 8/15/90, DHHS SN-917-011-00000-1)

3. EPA Methods 200.7, 200.8, 200.9 and 239.2 (<u>Methods for the Chemical Analysis of Water and Wastes</u>, March 1983, NTIS Publication PB84-128677 and <u>Methods for the Determination of Metals in Environmental Samples</u>, June 1991, NTIS Publication 91-231498)

4. EPA Methods 6010, 6020, 7420 and 7421 (<u>Test Methods for Evaluating Solid Waste, Physical/Chemical Methods</u>, EPA SW-846, Third Edition, revised November 1986, EPA Publications PB88-239223 and PB89-148076)

5. Standard Method 3500-Pb (<u>Standard Methods for the Examination of Water and Wastewater</u>, 17th Edition, 1989, APHA/AWWA/WPCF/American Public Health Association)

6. ASTM Methods D3335 and D3618 (<u>Annual Book of ASTM Standards</u>, American Society of Testing and Materials, Philadelphia, PA published annually)

7. EPA Reference Method for the Determination of Lead in Suspended Particulate Matter Collected from Ambient Air (40 CFR Part 50, Appendix G)

8. EPA Method 3015, Microwave Assisted Acid Digestion of Aqueous Samples and Extracts

9. EPA Method 3051, Microwave Assisted Digestion of Sediments, Sludges, Soils, and Oils

10. EPA Method 3050, Acid Digestion of Sediments, Sludges, and Soils

The EPA Office of Pollution Prevention and Toxics has established and oversees the National Lead Laboratory Accreditation Program.

The EPA recognizes a laboratory accrediting organization for the National Lead Laboratory Accreditation Program based on the requirements and conditions set forth in a memorandum of understanding on collaboration between the organization and the National Lead Laboratory Accreditation Program. Laboratories accredited by the organization for the National Lead Laboratory Accreditation Program are recognized by EPA as capable of analyzing lead in dry paint, dust, or soil samples during the period of their accreditation.

A list of recognized laboratories is available from:

1. EPA Lead Hotline: 1-800-424-LEAD

2. National Institute for Occupational Safety and Health (NIOSH)
   1-800-35-NIOSH

Lists of recognized laboratories are also available from the accrediting organizations. Organizations currently offering recognized laboratory accreditation programs are:

- American Association for Laboratory Accreditation (A2LA)
  656 Quince Orchard Road #300
  Gaithersburg, MD 20878
  (301) 670-1377

- American Industrial Hygiene Association (AIHA)
  2700 Prosperity Ave., Suite 250
  Fairfax, VA 22031
  (703) 849-8888

Additional organizations may be added at a later date.

All NLLAP accredited laboratories must participate successfully int he Environmental Lead Proficiency Analytical Testing (ELPAT) program, administered by the American Industrial Hygiene Association under a cooperative research and development agreement with the National Institute for Occupational Safety and Health.

Appendix 14.2: Procedure for the Digestion of Wipe Samples Using Diaper Wipes

Note: Other digestion methods may also produce suitable recovery rates (80%-120% of the "true value" for spiked wipe samples using a known amount of leaded dust).

I. Digestion of Single Surface Samples

Remove and unfold the wipe from the shipment container. Cut the wipe into small pieces and place in a 125 ml Phillips beaker. Quantitatively rinse the shipment container into the Phillips beaker. Cover the wipe with 10 ml of distilled water. Add 2 ml of concentrated HNO_3 and 2 ml of HCl. Gently heat for 20-30 minutes under reflux. Cool and transfer both the liquid and the bulk material left to a 50 ml volumetric flask. If there is too much bulk material left over, rinse with distilled water and squeeze with a glass rod. Add distilled water to make up to final volume. Prior to analysis by AA or ICP, an aliquot is filtered through ashless filter paper, then centrifuged at 9K rpm for 20 minutes. The supernatant liquid is drawn off and analyzed by AA, ICP, or other equivalent method.

II. Digestion of Composite Wipe Samples

The following method can be used to analyze composite dust wipe samples for lead when no more than four single surface samples are combined into a single surface composite sample (i.e., each sample container holds no more than four wipes).

The four wipe samples from each container are cut into smaller pieces and placed into a 250 ml Phillips beaker. Following the addition of 40 mL water, 8 mL concentrated HNO_3, and 8 mL concentrated HCl, the entire sample is refluxed at approximately 100°C for 50 minutes. Upon cooling, the contents in the flask are transferred quantitatively into a 100 mL volumetric flask and brought up to volume using distilled water. To ensure quantitative transfer, the wipes should be squeezed using a glass rod. Prior to analysis, an anliquot is filtered through ashless filter paper, then centrifuged at 9k rpm for 20 minutes. The supernatant liquid is drawn off and analyzed by AA, ICP, or other equivalent method.

Appendix 14.3: Procedure for the Preparation of Field Spiked Wipe Samples

There is currently no analytical grade wipe media suitable for wipe sampling in residences. A variety of commercial media are being used instead (see Appendix 13.1). Because laboratory accreditation programs do not currently provide spiked wipe samples using wipe sampling media commonly used in the field, it is necessary to prepare spiked wipe samples using the specific brand of wet wipes that will actually be used in order to determine if the laboratory digestion procedure is capable of achieving recovery rates between 80 - 120% for the specific brand of diaper wipe used in the field. Some reports indicate that recovery rates can be as low as 40% using certain types of wipes.

These field spiked samples are in addition to those the laboratory prepares for its own internal QA/QC program. The samples are not actually prepared in the field, but are manufactured under laboratory conditions. They are then relabelled in the field and inserted into the sample stream in a random and blind fashion. The spikes should be prepared using the same lot as that used in the field, since recoveries can vary by lot. The lot should be analyzed before use to ensure that there is not background contamination.

The following procedure may be used to prepare spiked wipe samples.

1. Obtain a Standard Reference Material containing a certified concentration of lead, such as NIST Standard 1579a (Powdered Lead-Based Paint) or Standard 1648 (Urban Particulate), or a traceable secondary standard with a known amount of lead.

2. Weigh out between 50 - 500 µg of lead (not total dust) to the nearest microgram.

3. Don a new disposable glove to handle each new wipe sample.

4. If tared weighing boats are used, quantitatively transfer all of the material from the boat to the wipe by wiping the boat thoroughly.

5. If glassine paper is used, be certain that the dust transfer was complete.

6. Do not let the wipe touch any other surface. Fold the wipe with the spiked side inward and carefully insert it into a non-sterilized 50 ml centrifuge tube or other hard-shelled container that is identical to the containers that will hold the field samples. The containers holding the spiked samples should be indistinguishable from those holding the field samples so that the analysis can be performed blindly. This means the same container or tube should be used to hold field samples and wipe samples.

7. Have the spiked sample inserted into the sample stream randomly, with at least one spiked sample for each 50 field samples analyzed and one blank for each sample batch.

OSHA INTERIM FINAL
LEAD IN CONSTRUCTION STANDARD
FACT SHEET

The OSHA Interim Final Lead in Construction Standard (1926.62) went into effect June 3, 1993. It applies to all workers doing construction work who may be exposed to lead on the job.

OSHA has developed a compliance document that will clarify the standard. You can order the compliance document by using the OSHA order form. Contact your state or regional OSHA office for an interpretation of the Construction Standard if necessary. (See the Resources Section for a listing.)

The sections of the standard which apply to the different parts of this fact sheet are listed in parentheses ().

1. Airborne lead exposure

How much lead am I allowed to breathe?

There are 2 legal limits for the amount of lead you are allowed to breathe:

Action Level—If you work in an area at or above 30 micrograms per cubic meter of air, your employer must give you medical surveillance and training in the hazards of working with lead. The limit of 30 ug/m^3 is called the Action Level (AL).

Permissible Exposure Limit—Your employer is not allowed to let you breathe in more than 50 micrograms of lead per cubic meter of air. This limit is for the average amount of lead in the air over an 8-hour day. It is called the Permissible Exposure Limit (PEL). If you work in an area with more lead in the air than the PEL, your employer must reduce your exposure.

If you are exposed to lead for more than 8 hours a day, the PEL must be adjusted. Divide 400 by the hours worked to get the new exposure limit .

How does my employer know how much lead is in the air?

Your employer must do an exposure assessment to determine the amount of lead in the air you are breathing. Exposure assessment can be **"air sampling,"** past exposure data from the same job or a similar job, or objective data (Section (d)(3) Basis of initial determination). Examples of objective data are product information and insurance information. Objective data are not often used. Conditions for each job, each day, and even each hour, are constantly changing. When conditions change, you cannot rely on objective data.

Your employer must determine how much lead is in the air for each job type. For example, your employer may do exposure assessment on one scraper, one cleaner, and one person using a heat gun. When your employer does air sampling, your employer must do air sampling on each shift or the shift with the highest exposure. Your employer must also sample the air if any of the employees on the job think they are getting sick because of exposure to lead on the job.

How often does my employer need to sample the air?

Your employer must determine if you are breathing air at or above the Action Level (30 ug/m^3). If your exposure to lead is below the Action Level, your employer does not need to sample again unless the conditions of your job change. If your exposure to lead is at or above the Action Level but below the PEL (50 ug/m^3), then sampling must be done every 6 months. If the amount is above the PEL, then sampling must be done every 3 months.

Your employer must also sample every time the conditions of your job change. For example, your employer needs to sample each time you do an abatement job on a different type of building (Section (d)(6) Frequency and (d)(7) Additional exposure assessments).

How can I find out the results of air sampling?

Your employer is required to give you the results of air sampling within 5 working days after receiving the results. (Section (d)(8) Employee notification)

Am I protected before air sampling is done?

YES! Certain tasks on construction jobs where lead-based paint is present are known to cause large amounts of lead in the air. These tasks are called **"lead related tasks."** The OSHA Standard splits these lead-related task into three different classes . (Section (d)(2) Protection of employees during exposure assessment)

Class 1 tasks

- Manual demolition of structures (for example, dry wall)
- Manual scraping (includes chemical stripping) or sanding
- Using a heat gun
- Power tool cleaning with dust collection systems
- Spray painting with lead-based paint

Your employer must protect you when you do Class 1 tasks as if your lead exposure is above the PEL (50 ug/m^3). Your employer must give you this protection until exposure assessment shows the exposure is less than the PEL. Even when the exposure is lower than 50 ug/m^3, you can request a respirator. Your employer must give you one.

Class 2 tasks

- Using lead-based mortar
- Burning lead
- Rivet busting
- Power tool cleaning without dust collection systems
- Cleanup activities where dry expendable abrasives are used
- Moving or tearing down the enclosure used for abrasive blasting

Your employer must protect you when you do Class 2 tasks as if your lead exposure is above 10 times the PEL (500 ug/m^3). He or she must give you higher protection until exposure assessment shows that your exposure is less than 500 ug/m^3. Even if your exposure is lower, you must still be protected. You can use the chart on the next page and the exposure assessment to find the right respirator for the job.

Class 3 tasks

- Abrasive blasting
- Welding
- Cutting
- Torch burning

Your employer must protect you when you do Class 3 tasks as if your lead exposure is above 50 times the PEL (2,500 ug/m^3). Your employer must give you this higher protection until exposure assessment show that your exposure is below this level. Even if your exposure is lower, you must still be protected. You can use the chart below to find the right respirator for the job.

SOME RESPIRATORS LEGAL FOR LEAD WORK

Task Class	MUL	Respirator Types
Class 1	500 ug/m^3	• Half-mask, air-purifying
Class 2	1250 ug/m^3	• Loose-fitting hood or helmet PAPR • Hood or helmet with supplied air continuous flow • Type CE continuous flow
Class 2	2500 ug/m^3	• Full-face, air-purifying • Tight-fitting PAPR • Full-face, supplied air, pressure demand • Half-mask or full-face, supplied air, continuous flow
Class 3	50,000 ug/m^3	• Half-mask, supplied air, pressure demand
Class 3	100,000 ug/m^3	• Full-face, supplied air, pressure demand • Type CE pressure demand
Class 3	100,000+ ug/m^3	• Full-face, SCBA, pressure demand

What does my employer have to do?

If you will be exposed above the PEL or you will do any of the lead-related tasks in Classes 1, 2, or 3, your employer must provide the following for workers. (Section (d)(2)(v)(A)-(F))

- Right respirator (See the table on page 13- 8.)
- Personal protective clothing and equipment
- Area to change into and out of your work clothes
- Facilities for hand and face washing
- Place where you can shower at the end of the day, if feasible
- Blood tests reviewed by a doctor
- Training on the hazards of working with lead
- A lead-safe area for eating and drinking
- Warning signs around the work area

Does my employer have to reduce my exposure to the lead in the air?

YES! Your employer must do everything possible to reduce your exposure.

- Use materials or tools which make less lead dust or fumes.
- Change the way you do a job so you create less dust and fumes.
- Rotate schedules so worker exposure to lead is less than a few hours a day.
- Provide you with a respirator.

Your employer must list in writing all the ways he or she is trying to reduce your exposure to lead. This is called a compliance program (Section (e)(2) Compliance Program).

2. Respirators and protective clothing

When must I wear a respirator?

According to the OSHA Standard, you are only required to wear a respirator if you are doing a Class 1, 2, or 3 task or air sampling shows you are exposed above the PEL (50 ug/m^3). But if you are exposed to any amount of lead, the regulations say you can request a respirator from your employer and your employer is required to give you a respirator. This means you can still get a respirator even if you are not exposed to lead above the PEL or doing any of the lead-related tasks.

Your employer must provide a respirator for any employee exposed to lead who asks for one. You may want to have this extra protection, especially if you are planning to have children. To prevent reproductive hazards, OSHA recommends that you not be exposed to lead air levels 35 ug/m^3 or higher without a respirator.

Whenever you are exposed above the PEL, you can always ask your employer for a Powered Air Purifying Respirator (PAPR). If you are exposed above the PEL, by law, your employer must provide you with a PAPR — **if you ask for it** and **if it protects you enough.** If a PAPR is not protective enough for the job — for example, abrasive blasting — then your employer must provide you with a better respirator that is suitable for this type of work. (Section (f)(1)(iv) Respiratory protection)

What type of respirator can I use?

The respirator you use will depend on the amount of lead in the air and the job you are doing. The standard says you must have a respirator at least as protective as those listed in the table on the next page. You can always ask your employer for a Powered Air Purifying Respirator (PAPR). By law, your employer must give you a PAPR if you are exposed above the PEL and you ask for one—and it provides enough protection. Sometimes a PAPR will not protect you enough—for example, if you were doing abrasive blasting. In that case, your employer must give you a better respirator. Any respirator you use must have a stamp of approval by National Institute of Occupational Safety and Health (NIOSH) or the Mine Safety and Health Administration (MSHA). (Table 1 Respiratory Protection for Lead Aerosols)

What do I need to do before I wear a respirator?

You need to have a medical exam by a doctor to make sure that you can use a respirator safely. Your employer should pay for this exam. You also need fit testing and training about your respirator.

What personal protective equipment do I need other than a respirator?

If you are working in an area with lead above the PEL or if you are doing any of the tasks listed under Class 1, 2, or 3, your employer must give you protective work clothing. (Section (g) Protective work clothing and equipment) This clothing should include:

- Coveralls with a hood
- Booties
- Hard hat
- Gloves
- Face shields or vented goggles

Who has what responsibilities for my protective clothing ?

If you are exposed at or below the PEL (50 ug/m^3), your employer is not required to provide you with protective clothing. If you are exposed above the PEL but below 200 ug/m^3 — or you are doing a Class 1 task — your employer must wash and dry protective clothing or give you new clothing **every week.** If you are exposed at or above 200 ug/m^3, your employer must provide clean or new protective clothing **every day.** If you are doing a Class 2 or 3 task, and an exposure assessment for the task has not been completed, your employer must assume that you are being exposed at the higher levels associated with these tasks. The employer must provide clean or new protective clothing **every day until the assessment determines** that your exposure is less than 200 ug/m^3.

Many employers provide **disposable suits.** These suits are easily torn. You should inspect your protective clothing regularly for tears or rips. If your suit tears or rips and you cannot repair it, you must get a new protective suit.

Some employers provide **reusable, non-disposable protective clothing.** This clothing is usually more durable than the disposable suits, but if it does rip or tear, have it repaired immediately to minimize your chances of being contaminated. If you are given non-disposable protective clothing, your employer is responsible for cleaning, drying, and repairing it. (Section (g)(2) Cleaning and replacement)

Where should I put my used protective clothing?

Your employer must have a closed container in the change area for used protective clothing. The container must be labeled as follows:

CAUTION: Clothing contaminated with lead.
DO NOT REMOVE DUST BY BLOWING OR SHAKING.
Dispose of lead-contaminated wash water in accordance with applicable local, state, or federal regulations.

This helps to prevent your family and other people living in the community from being exposed to lead. The standard says your employer can not let you leave the work area with protective clothing on.

3. Your workplace

How clean do we keep our job site?

The standard says you must keep all surfaces as free of lead as possible. You must clean-up floors and other surfaces with a vacuum. This vacuum must have a High Efficiency Particulate Air (HEPA) filter. Only use shoveling, dry-sweeping, wet-sweeping, or brushing if your employer shows that vacuuming does not work to pick up the dust on your job site.

Compressed air is allowed on steel structure jobs. Compressed air is not prohibited for some cleaning purposes—if you have proper ventilation and air filtration. You may use compressed air when cleaning the containment on a steel structure job. (Section (h) Housekeeping)

Can we eat or drink on the job?

NO! Your employer must **not** allow you to eat, drink, smoke, chew tobacco, or apply cosmetics in the work area where your exposure to lead is above the PEL. Your employer must have a place where anyone exposed above the PEL can eat and drink safely, away from lead. (Section (i) Hygiene facilities and practices)

Where can we change our clothes and wash?

Whenever you work with lead, your employer must have a place for you to wash your hands and face. Your employer must make sure that you wash your hands and face at the end of each work-shift.

The standard says your employer must have places where anyone exposed above the PEL or doing any of the lead related tasks (Class 1, 2, or 3) can change in and out of their work clothes. Your employer must have a place where anyone exposed above the PEL can shower, if feasible. OSHA officials have said that if your employer decides having a shower is not feasible, he or she must be able to explain their reasoning to any OSHA inspector who comes on the site. (Section (i)(2) Change areas)

Does my employer have to post warning signs in the work area?

Your employer must post warning signs in the work area where employees are exposed above the PEL. (Section (m) Signs) They must say:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

4. Training

How can workers find out about the hazards of lead?

OSHA standard says that employers must provide training to anyone:

- Working with lead at or above the Action Level (30 ug/m^3)
- Doing any of the tasks listed under Class 1, 2, or 3
- Using any lead compounds which cause eye or skin irritation

(Section (l) Employee information and training)

What does the training about lead have to include?

- OSHA Interim Final Lead in Construction Standard
- Jobs that expose workers to lead above the Action Level
- Information on respirators: their use, the different types, and the importance of a proper fit
- Medical exams required for everyone working with lead
- Ways your employer can reduce your exposure to lead
- What your employer is doing to reduce your exposure to lead

5. Recordkeeping

What records does my employer have to keep?

Your employer must keep records of:

- All exposure assessments done on your job site
- The types of respiratory protection worn on your job site
- Names and social security numbers of all employees
- All medical surveillance done on employees
- All training done for employees
- All cases of medical removal of employees

All records must be kept for at least 30 years. (Section (n) Recordkeeping).

Do I have the right to see any of these records?

YES! You have the right to see any of the air sampling results or any other types of exposure assessments done on your job site. You have the right to have a copy of your medical exam and blood test results. You can get copies of either of these types of records. Your employer is required to send a copy of your medical records to anyone you choose. Any requests to send your medical records to someone else should be in writing.

6. Medical surveillance

Special medical exams are required when you work with lead. (Section (j) Medical surveillance) These exams are called medical surveillance. There are two types:

- **Initial medical surveillance**
- **Medical surveillance program**

Initial medical surveillance

Initial medical surveillance is blood tests that check the amount of lead in your blood. It is also called **biological monitoring.** The two blood tests used in the biological monitoring are the blood lead level test and the zinc protoporphyrin (ZPP) test. You need medical surveillance if you do any of the tasks in class 1, 2 or 3 listed in this standard or if you are exposed to lead on the job any one day at or above the Action Level.

On-going medical surveillance program

You need a medical surveillance program if you are or may be exposed to lead on the job at or above the Action Level for **more than 30 days** in any continuous 12 month period. If you are a lead abatement worker, you can be exposed to lead above the Action Level for 30 or more days in a year. When you expect to do lead abatement work for at least 30 days, you should take part in a medical surveillance program.

Who must provide medical surveillance?

Medical surveillance must be provided by your employer.

Your employer must provide medical surveillance for you at no cost to you, the worker — and at a reasonable time and place.

All medical examinations and procedures must be supervised or performed by a licensed physician. Your employer must notify you of the results of the exam within 5 working days. This is called **"notification."** You may have another doctor review the findings and provide a second exam. The employer must pay for the second review. This is called **"multiple physician review."**

What does multiple physician review mean?

If you are not comfortable with the available doctor or do not agree with the doctor's findings, you can request a second medical exam with a doctor of your choice. This request must be made within 15 days after you receive your copy of the initial medical exam results. Your employer must pay for the second exam.

If the doctors do not agree, they are asked to talk with each other. If there is still no agreement, then a third doctor selected by the two previous doctors will review the findings and conduct any necessary exams. The third doctor gives a written recommendation to the employer. The third opinion is followed unless you and your employer jointly agree to follow the recommendation of either of the previous doctors. (Section (j)(3)(iii) Multiple physician review mechanism)

8. Medical treatment

What is the treatment for lead poisoning?

Chelation is the medical treatment for severe lead poisoning. It is a risky treatment. Chelation can get rid of some of the lead in your body, but it can be harmful to your health. Chelation is a serious medical treatment. When possible, you want to know that at least two doctors think it is necessary for you to have it. The second doctor should be a doctor that you know and trust. This second opinion is paid for by your employer, when you request it. This is when the multiple physician review is most helpful.

Prophylactic chelation means giving chelating drugs to someone to try and prevent lead poisoning.. Chelating drugs will not protect anyone from lead poisoning. Chelating drugs will only help remove lead from your body after you have been poisoned. It is illegal for your employer or anyone employed by your employer to give you chelating drugs.

Prophylactic chelation is prohibited. It is illegal.

Chelating drugs are dangerous to your health. They can hide lead poisoning that may be happening to you. The chelating drugs may also make your body take in lead more easily (Section (j)(4) Chelation).

Whenever possible, get a second medical opinion to determine whether you need chelation treatment.

7. Medical removal

What is medical removal?

Medical removal means that you are removed from the lead exposure on your job. The standard states you must be removed if your blood lead levels get too high. Medical removal can prevent you from getting severe lead poisoning. Removing you from the lead exposure gives your body time to get rid of the lead. Sometimes this is enough to bring the blood lead level down. Medical removal is a way to protect you from becoming lead poisoned. There are two times that you may be medically removed:

Elevated blood lead level

If your blood lead level reaches 50 ug/dl, for the periodic blood test and the follow-up blood test, you must be removed from exposure to lead. It is dangerous for you to work with lead when your blood lead level is so high. **You cannot wear a respirator to lower your exposure when your blood lead level is so high.** If you get more lead into your body, you could become lead poisoned. Your employer must provide you with a job with no lead exposure. If your employer cannot, he/she must pay you your normal wages until your blood lead level is at 40 ug/dl on two separate tests. You then return to your former job. If your blood lead level remains above 40 ug/dl, your wages must be paid as long as the job exists or up to 18 months. **This is called medical removal protection.**

Final medical determination

Final medical determination means the doctor has given a written medical opinion to remove you from lead exposure. The doctor believes that you have a medical problem that will be affected by lead exposure. The doctor believes that the risk to your health is high. **The doctor must inform the employer of the medical recommendation regarding working with lead.**

The doctor does not tell the employer what the medical problem is, but states that you are at high risk of ill health with lead exposure.

2. Complete physical exam to look at your:
    a. Blood
    b. Teeth and gums
    c. Stomach and intestines
    d. Kidneys
    e. Nerves
    f. Brain
    g. Heart
    h. Lungs
3. Blood pressure check
4. Blood tests which will show
    a. Blood lead level
    b. ZPP
    c. Hemoglobin & hematocrit (anemia test)
    d. Blood urea nitrogen
    e. Serum creatinine (kidney test)
5. Routine urinalysis (kidney and protein check)
6. Any additional test that the doctor needs to do to determine how lead has or could affect you. Pregnancy testing and male fertility must be provided if you request them.

Medical exam and consultation

You have the right to a medical exam and consultation whenever you will be working with lead at or above the Action Level for 30 days or more and

- Anytime you are working with lead and you feel sick with any of the signs and symptoms of lead poisoning.
- Yearly when you have a blood lead level at or above 40 ug/dl.
- Whenever you are concerned about having a healthy baby.
- If you have difficulty breathing while wearing a respirator.

You need to notify your employer that you want the medical exam and consultation. The content of this medical exam and consultation is determined by the doctor. (Section (j)(3) Medical exam and consultation)

The on-going medical surveillance program has three types of exams. The doctor must follow the standard and provide:

- **Blood tests for biological monitoring**
- **Six-part medical exam**
- **Medical exam and consultation**

Blood tests for biological monitoring
The blood lead level and ZPP tests are required:

1. When you begin working with lead and every 2 months for the first 6 months and then every 6 months as long as you are working with lead at or above the Action Level for 30 or more days within a year's time period.

2. When your blood lead level results are at or above 40 ug/dl, you must be tested at least every 2 months until two consecutive blood lead level results are below 40 ug/dl.

3. When your blood lead level results are at or above 50 ug/dl, you must be tested again within 2 weeks. If the second test result is at or above 50 ug/dl, you must be medically removed and tested at least every month until you reach a blood lead level of 40 ug/dl or less on two separate testing dates. The tests must be taken at least 30 days apart.

Six-part medical exam
Your employer must make the required 6-part medical exam in the medical surveillance program available to you whenever you will be working with lead at or above the Action Level for 30 or more days and your blood lead level results are 40 ug/dl or above. (Section (j)(3)(ii) Content)

1. Interview about your work and medical history:
   a. Past lead exposures
   b. Personal habits like smoking and hygiene
   c. Previous medical problems with the kidneys, heart, nerves, blood, stomach, intestines, and reproductive organs

You may return to work with lead when the doctor determines that you no longer have a medical problem that puts you at high risk of ill health with lead exposure. The doctor must put the medical opinion in writing. You then return to your former job. While you are unable to work with lead, your employer must provide you with another job where your lead exposure is not above the action level. If another job is not available, your employer must pay your wages for as long as the job exists or up to 18 months.

A doctor may use a final medical determination if you say you want to have children and your blood lead level is 30 ug/dl. You will then be placed on medical removal protection. OSHA recommends that a Maximum Permissible blood lead level of 30 ug/dl should not be exceeded in males and females who wish to have children. (Section (k)(1) Temporary medical removal and return of an employee)

What is medical removal protection?

Medical removal protection means that your job will be protected if you must be medically removed from your lead abatement job. Under the OSHA Lead Standard, your employer must pay your salary and benefits and maintain your seniority while you are medically removed. This medical removal protection will last as long as the job exists or up to 18 months. (Section (k)(2) Medical removal protection benefits)

Title X Fact Sheet

The "Residential Lead-Based Paint Hazard Reduction Act of 1992" is also known as Title X. Title X requires different government agencies to help reduce the amount of lead poisoning in this country. This fact sheet lists some of the important parts of Title X.

Why was Title X passed?

The United State Congress received information that:

- Three million American children under the age of 6 have at least low-level lead poisoning.
- Lead poisoning in children can cause reading and learning disabilities, hyperactivity, and behavior problems.
- Ingesting lead dust from deteriorating lead-based paint is the most common cause of lead poisoning.
- Homes built before 1980 contain more than 3 million tons of lead in the form of lead-based paint.
- As many as 3,800,000 American homes have chipping or peeling lead-based paint.
- The dangers of lead-based paint hazards can be reduced by abating lead-based paint or by using interim controls to prevent paint deterioration.
- Even though laws were passed in the early 1970's, until now the government has actually done very little to reduce lead-based paint hazards.

Title X is designed to eliminate lead-based paint hazards before they poison children. In the past, many agencies only got rid of lead-based paint after a child had been poisoned.

What is the law designed to do?

- Develop a system of trained people to evaluate and reduce lead hazards.
- Reduce childhood lead poisoning.
- Use government funds in the most cost-effective way to eliminate lead-based paint hazards.
- Educate the public concerning the hazards and sources of lead poisoning.
- Remove lead-based paint hazards first from federal housing.

The Federal Government to be a "model landlord."

- **Project-based, federally-assisted housing built before 1960** must have a risk assessment by January 1, 1996.
- **Project-based, federally-assisted housing built from 1960 to 1978** must have a risk assessment done by 2002.
- **Pre-1978 federally assisted housing** must be inspected before any rehabilitation work is done which might disturb lead-based paint.
- **Lead-based paint hazards must be abated or reduced** during rehabilitation of federally-assisted housing projects depending on funding. Anyone purchasing or renting a housing unit built before 1978 must be given an EPA Lead Hazard Information Pamphlet. This does not apply to tenant-based assistance such as Section 8.

Who has to be trained?

Title X requires EPA to issue specific requirements for how contractors, workers, supervisors, inspectors and risk assessors will be trained in lead-based paint hazards. EPA must issue these regulations by April 1994. These requirements will also say how contractors, workers, supervisors, inspectors and risk assessors will be certified. EPA has in place university-based national network of Regional Lead Training Centers. (See the listing in the For More Information section at the end of the manual.) As part of the EPA program, lead training programs will need to be accredited. Only this training will qualify as certification.

Will each state have its own certification program?

Each state may have its own program which is approved by EPA. EPA will run the certification program in states that do not have their own programs. EPA will issue a model-state certification program to help states set up their own programs. Because all state programs must be based on EPA's model plan, each state's program should be the same or very similar.

Will workers doing lead abatement jobs be protected?

The OSHA Interim Final Lead in Construction Standard became law on June 3, 1993. This standard includes specific requirements for protecting workers doing lead abatement jobs.

When does lead-based paint become a hazard?

EPA must issue standards on how much:

- Lead dust is allowed on the floors, windows, or air before abatement must be done.
- Lead is allowed in soil before it must be removed.

How does the government plan to educate the public?

Title X requires EPA and HUD to issue regulations which will require property owners to give each person buying or renting a property built before 1978:

- An EPA Lead Hazard Information Pamphlet.
- Any information about lead-based paint hazards in the property.
- At least 10 days to conduct an inspection of the property for lead-based paint hazards.

In addition, the sales contract for homes built before 1978 must include a statement warning about the hazards of lead-based paint.

How will people know what are the best products to use?

EPA must develop performance standards by April 1995 for all products and devices used to evaluate, reduce and abate lead-based paint hazards.

Who will make sure the laws really help solve the problem?

Title X requires the HUD Secretary and the EPA Administrator to set up a task force of federal agencies and other organizations with knowledge about lead-based paint activities. The task force will make recommendations to EPA and HUD on developing standards and dealing with the concerns of property owners.

Laws

YOUR STATE LAWS

Appendix 16: Summary of CDC Lead Poisoning Statement

Chapter 1 of the Centers for Disease Control and Prevention (CDC) statement on Preventing Childhood Lead Poisoning

Introduction

Summary

New data indicate significant adverse effects of lead exposure in children at blood lead levels previously believed to be safe. Some adverse health effects have been documented at blood lead levels at least as low as 10 micrograms per deciliter of whole blood (µg/dL).

The 1985 intervention level of 25 µg/dL is, therefore, being revised downwards to 10 µg/dL.

A multitier approach to follow-up has been adopted.

Primary prevention efforts (that is, elimination of lead hazards before children are poisoned) must receive more emphasis as the blood lead levels of concern are lowered.

The goal of all lead poisoning prevention activities should be to reduce children's blood lead levels below 10 µg/dL. If many children in the community have blood lead levels of ≥10 µg/dL, communitywide interventions (primary prevention activities) should be considered by appropriate agencies. Interventions for individual children should begin at blood lead levels of 15 µg/dL.

Childhood lead poisoning is one of the most common pediatric health problems in the United States today, and it is entirely preventable. Enough is now known about the sources and pathways of lead exposure and about ways of preventing this exposure to being the efforts to eradicate permanently this disease. The persistence of lead poisoning in the United States, in light of all that is know, presents a singular and direct challenge to public health authorities, clinicians, regulatory agencies, and society.

> Lead poisoning is one of the most common and preventable pediatric health problems today.

Lead is ubiquitous in the human environment as a result of industrialization. It has no known physiologic value. Children are particularly susceptible to lead's toxic effects. Lead poisoning, for the most part, is silent: most poisoned children have no symptoms. The vast majority of cases, therefore, go undiagnosed and untreated. Lead poisoning is widespread. It is not solely a problem of inner city or minority children. No socioeconomic group, geographic area, or racial or ethnic population is spared.

Previous lead statements issued by the Centers for Disease Control and Prevention (CDC) have acknowledged the adverse effects of lead at lower and lower levels. In the most recent previous CDC lead statement, published in 1985, the threshold for action was set at a blood lead level of 25 µg/dL, although it was acknowledged that adverse effects occur below that level. In the past several years, however, the scientific evidence showing that some adverse effects occur at blood lead levels at least as low as 10 µg/dL in children has become so overwhelming and compelling that it must be a major force in determining how we approach childhood lead exposure.

This document provides guidelines on childhood lead poisoning prevention for diverse groups. Public health programs that screen children for lead poisoning look to this document for guidance on screening regimens and public health actions. Pediatricians and other health-care practitioners look to this document for information on screening and guidance on the medical treatment of poisoned children. Government agencies, elected officials, and private citizens seek guidance about what constitutes a harmful level of lead in blood - what the current definition of lead poisoning is and what blood lead levels should trigger environmental and other interventions.

It is not possible to select a single number to define lead poisoning for the various purposes of all of these groups. Epidemiologic studies have identified harmful effects of lead in children at blood lead levels at least as low as 10 µg/dL. Some studies have suggested harmful effects at even lower levels, but the body of information accumulated so far is not adequate for effects below about 10 µg/dL to be evaluated definitively. As yet, no threshold has been identified for the harmful effects of lead.

Because 10 µg/dL is the lower level of the range at which effects are now identified, primary prevention activities - community-wide environmental interventions and nutritional and educational campaigns - should be directed at reducing children's blood lead levels at least to below 10 µg/dL. Blood lead levels between 10 and 14 µg/dL are in a border zone. While the overall goal is to reduce children's blood lead levels below 10 µg/dL, there are several reasons for not attempting to do interventions directed at individual children to lower blood lead levels of 10-14 µg/dL. First, particularly at low blood lead levels, laboratory measurements may have some inaccuracy and imprecision, so a blood lead level in this range may, in fact, be below 10 µg/dL. Secondly, effective environmental and medical interventions for children with blood lead levels in this range have not yet been identified and evaluated. Finally, the sheer numbers of children in this range would preclude effective case management and would detract from the individualized follow-up required by children who have higher blood lead levels.

The single, all-purpose definition of childhood lead poisoning has been replaced with a multitier approach, described in Table 1-1. Community prevention activities should be triggered by blood lead levels ≥ 10 µg/dL. Medical evaluation and environmental investigation and remediation should be done for all children with blood lead levels ≥ 20 µg/dL. All children with blood lead levels ≥ 15 µg/dL should receive individual case management, including nutritional and educational interventions and more frequent screening. Furthermore, depending on the availability of resources, environmental investigation (including a home inspection) and remediation should be done for children with blood lead levels of 15-19 µg/dL, if such levels persist. The highest priority should continue to be the children with the highest blood lead levels.

Other differences between the 1985 and 1991 statements are as follows:

Screening test of choice. Because the erythrocyte protoporphyrin level is not sensitive enough to identify children with elevated blood lead levels below about 25 µg/dL, the screening test of choice is now blood lead measurement.

Universal screening. Since virtually all children are at risk for lead poisoning, a phase in of universal screening is recommended, except in communities where large numbers or percentages of children have been screened and found not to have lead poisoning. The full implementation of this will require the ability to measure blood lead levels of capillary samples and the availability of cheaper and easier-to-use methods of blood lead measurement.

Table 1-1. Interpretation of blood lead test results and follow-up activities: class of child based on blood lead concentration

Class	Blood lead concentration (µg/dL)	Comment
I	≤ 9	A child in Class I is not considered to be lead-poisoned.
IIA	10-14	Many children (or a large proportion of children) with blood lead levels in this range should trigger community-wide childhood lead poisoning prevention activities (chapter 9). Children in this range may need to be rescreened more frequently.
IIB	15-19	A child in Class IIB should receive nutritional and educational interventions and more frequent screening. If the blood lead level persists in this range, environmental investigation and intervention should be done (Chapter 8).
III	20-44	A child in Class III should receive environmental evaluation and remediation (Chapter 8) and a medical evaluation (Chapter 7). Such a child may need pharmacologic treatment of lead poisoning (Chapter 7).
IV	45-69	A child in Class IV will need both medical and environmental interventions, including chelation therapy (Chapters 7 and 8).
V	≥70	A child with Class V lead poisoning is a medical emergency. Medical and environmental management must begin immediately (Chapters 7 and 8).

Primary prevention. Efforts need to be increasingly focused on preventing lead poisoning before it occurs. This will require community-wide environmental interventions, as well as educational and nutritional campaigns.

> **Succimer**. In January, 1991, the US Food and Drug Administration approved succimer, an oral chelating agent, for chelation of children with blood lead levels over 45 µg/dL.

Childhood lead poisoning prevention programs have had a tremendous impact on reducing the occurrence of lead poisoning in the United States. Because of these programs, deaths from lead poisoning and lead encephalopathy are now rare. These programs have targeted high-risk children for periodic screening; provided education to caretakers about the causes, effects, symptoms, and treatments for lead poisoning; and ensured medical treatment and environmental remediation for poisoned children. Screening and medical treatment of poisoned children will remain critically important until the environmental sources most likely to poison children are eliminated.

Federal regulatory and other actions have results in substantial progress in reducing blood lead levels in the entire US population. In the last two decades, the virtual elimination of lead from gasoline has been reflected in reductions in blood lead levels in children and adults. Lead levels in food have also decreased since most manufacturers stopped using leaded solder in cans and since atmospheric deposition of lead on food crops declined as a result of reductions of lead in gasoline. In 1978, the Consumer Product Safety Commission banned the addition of lead to new residential paint.

Nevertheless, important environmental sources and pathways of lead remain. Lead-based paint and lead-contaminated dusts and soils remain the primary sources and pathways of lead exposure for children. In addition, children continue to be exposed to lead through air, water, and food, as well as occupations and hobbies of parents and caretakers. The focus of prevention efforts, therefore, must expand from merely identifying and treating individual children to include primary prevention - preventing exposure to lead before children become poisoned. This will require a shared responsibility among many public and private agencies. Public agencies will have to work with pediatric health-care providers to identify communities with childhood lead-poisoning prevention problems and unusual sources of lead and to ensure environmental follow-up of poisoned children. Public housing and economic development agencies will have to integrate lead paint abatement into housing rehabilitation policies and programs. Health-care providers will need to phase in virtually universal screening of children. Public and private organizations must continue to develop economical and widely-available blood lead tests to make such screening possible. Public and private housing owners must bear a portion of the financial burden for abatement.

The changes in this statement are not meant to create an enormous burden on primary pediatric health-care providers. These changes will only be useful if public health and other agencies effectively complement health-care providers' activities. Several efforts have begun to increase federal support of childhood lead poisoning prevention programs and of follow-up activities. On-going efforts to develop infrastructure and technology by the public and private sectors include 1) the development of inexpensive, easy-to-use portable methods for measuring blood lead levels; 2) the development of training and certification programs for lead paint inspectors and abatement contractors; and 3) the development and testing of new abatement methods, including encapsulants. The changes in this statement are also not meant to increase the emphasis on screening of children; the long-term goal of this statement is **prevention**. Until primary prevention of childhood lead poisoning can be achieved, however, increased screening and follow-up of poisoned children is essential.

Elimination of Childhood Lead Poisoning
Will require efforts from both the private and public sectors. Will require a shift in emphasis to primary prevention. Will take time and resources. Should proceed in a rational manner, with the highest risk children being made the highest priority. Can be achieved.

In February 1991, the US Department of Health and Human Services released a *Strategic Plan for the Elimination of Childhood Lead Poisoning* (HHS, 1991). This plan describes the first 5 years of a 20-year society-wide effort to eliminate this disease. It places highest priority on first addressing the children at greatest risk for lead poisoning. The US Department of Housing and Urban Development (HUD, 1990) and the Environmental Protection Agency (EPA, 1991) have both released plans dealing with the elimination of lead hazards. To eliminate this disease will require a tremendous effort from all levels of government as well as the private sector, but we believe that the benefits to society will be well worth it. We look forward to the day when childhood lead poisoning is no longer a public health problem.

References

CDC (Centers for Disease Control and Prevention). Preventing lead poisoning in young children: a statement by the Centers for Disease Control and Prevention. Atlanta: CDC, 1985; CDC report no. 99-2230.

EPA (Environmental Protection Agency). Strategy for reducing lead exposures: report to Congress. Washington (DC): EPA, 1991.

HHS (US Department of Health and Human Services). Strategic plan for the elimination of childhood lead poisoning. Atlanta: CDC, 1991.

HUD (US Department of Housing and Urban Development). Comprehensive and workable plan for the abatement of lead-based paint in privately owned housing: report to Congress. Washington (DC): HUD, 1990.

Single-Family Housing LBP Testing Data Sheet

Address/Unit No. ______________________________ Date ______________

Room Equivalent ____

XRF Serial No. ______________ Inspector Name ______________ Signature ______________

Sample ID#	Substrate	Component	Color	Test Locations	XRF Reading	Correction Value	Result	Classification (pos, neg, inc)	Laboratory Result	UNITS	Final Classification
										mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
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										mg/cm^2 %	
										mg/cm^2 %	

Single-Family Housing LBP Testing Data Sheet

Page 2 of 5

Address/Unit No. 918 Fenway Drive Date August 15, 1997

Room Equivalent Bedroom (room5)

XRF Serial No. RS-1967 Inspector Name Mo Smith Signature

Sample ID#	Substrate	Component	Color	Test Location	XRF Reading	Correction Value	Corrected Reading	Classification (pos, neg, inc)	Laboratory Result	UNIT?	Laboratory Classification
815.1	Plaster	Wall	White	Wall A, center	1.12 mg/cm^2	N/A	1.12 mg/cm^2			mg/cm^2 %	
815.2	Plaster	Wall	White	Wall B, left	0.92 mg/cm^2	N/A	0.92 mg/cm^2			mg/cm^2 %	
815.3	Plaster	Wall	White	Wall C, right	1.31 mg/cm^2	N/A	1.31 mg/cm^2			mg/cm^2 %	
815.4	Plaster	Wall	White	Wall D, right	1.12 mg/cm^2	N/A	1.12 mg/cm^2			mg/cm^2 %	
815.5	Drywall	Walk-in closet	Blue	Wall A, bottom left	1.81 mg/cm^2	N/A	1.81 mg/cm^2	POS		mg/cm^2 %	
815.6	Drywall	Walk-in closet	Blue	Wall B, center	1.62 mg/cm^2	N/A	1.62 mg/cm^2	POS		mg/cm^2 %	
815.7	Drywall	Walk-in closet	Blue	Wall C, top right	2.11 mg/cm^2	N/A	2.11 mg/cm^2	POS		mg/cm^2 %	
815.8	Drywall	Walk-in closet	Blue	Wall D, top right	1.85 mg/cm^2	N/A	1.85 mg/cm^2	POS		mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
815.9	Wood	Window sill	Brown	Center	2.23 mg/cm^2	0.12	2.11 mg/cm^2	POS		mg/cm^2 %	
815.10	Metal	Door frame	Black	Top	2.40 mg/cm^2	0.10	2.30 mg/cm^2	POS		mg/cm^2 %	
815.11	Wood	Shelf	White	Center	4.20 mg/cm^2	N/A*	4.20 mg/cm^2	POS		mg/cm^2 %	
815.12	Wood	Baseboard	Grey	Wall B, center	5.50 mg/cm^2	N/A	5.50 mg/cm^2	POS		mg/cm^2 %	
815.13	Wood	Crown molding	Grey	Wall D, left	5.70 mg/cm^2	N/A	5.70 mg/cm^2	POS		mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	
										mg/cm^2 %	

Note: Because there were more than 4 walls in the bedroom, and because the additional walls had the same painting history as the 4 walls tested, the average was calculated for the purpose of classifying this component:
(1.12 + 0.92 + 1.31 + 1.12) / 4=1.12 mg/cm^2=POS

*Substrate correction not required on wood for readings above 4.0 mg/cm^2 per XRF Performance Characteristic Sheet.

Single Family Housing: Component Type Report

Page ______ of ______

Address/Unit No. ____

____

Date ______________________ XRF Serial No.______________________________

Inspector Name ______________________ Signature ______________________

Component Type Description	Number of Readings	Number of Positives*	Number of Negatives*	Component Type Classification

*Classify all components as positive or negative before filling out this sheet. If any components in a component type are positive, classify the component type as positive.

Single Family Housing: Component Type Report

Address/Unit No. 918 Fenway Drive Bedroom

Date August 15, 1997 XRF Serial No. RS-1967

Inspector Name Mo Smith Signature

Component Type Description	Number of Readings	Number of Positives*	Number of Negatives*	Component Type Classification
Window Sill (Wood)	15	11	4	Positive

1997 Revision

Completed Form 7.1A

*Classify all components as positive or negative before filling out this sheet. If any components in a component type are positive, classify the component type as positive.

Calibration Check Test Results

Address/Unit No. ____

____

Device ____

Date ______________________ XRF Serial No. ______________________

Contractor ____

Inspector Name ____________________ Signature ____________________

NIST SRM Used ______________ mg/cm^2 Calibration Check Tolerance Used ______________ mg/cm^2

First Calibration Check

NIST SRM			First Average	Difference Between First Average and NIST SRM*
First Reading	Second Reading	Third Reading		

Second Calibration Check

NIST SRM			Second Average	Difference Between Second Average and NIST SRM*
First Reading	Second Reading	Third Reading		

Third Calibration Check *(if required)*

NIST SRM			Third Average	Difference Between Third Average and NIST SRM*
First Reading	Second Reading	Third Reading		

Fourth Calibration Check *(if required)*

NIST SRM			Fourth Average	Difference Between Fourth Average and NIST SRM*
First Reading	Second Reading	Third Reading		

* If the difference of the Calibration Check Average from the NIST SRM film value is greater than the specified Calibration Check Tolerance for this device, consult the manufacturer's recommendations to bring the instrument back into control. Retest all testing combinations tested since the last successful Calibration Check test.

Calibration Check Test Results

Address/Unit No. Fenway Gardens Housing Complex
Oldtown, Maryland 21334

Device WXY Company, Inc. XRF 2.1

Date August 16, 1997 XRF Serial No. RS-1967

Contractor RIGAH PG Testing, Inc.

Inspector Name Mo Smith Signature

NIST SRM Used 1.02 mg/cm^2 Calibration Check Tolerance Used 0.3 mg/cm^2

First Calibration Check

NIST SRM			First Average	Difference Between First Average and NIST SRM*
First Reading	Second Reading	Third Reading		
1.12	1.00	1.08	1.07	0.05

Second Calibration Check End of Shift

NIST SRM			Second Average	Difference Between Second Average and NIST SRM*
First Reading	Second Reading	Third Reading		
0.86	1.07	0.89	0.94	-0.08

Third Calibration Check *(if required)*

NIST SRM			Third Average	Difference Between Third Average and NIST SRM*
First Reading	Second Reading	Third Reading		

Fourth Calibration Check *(if required)*

NIST SRM			Fourth Average	Difference Between Fourth Average and NIST SRM*
First Reading	Second Reading	Third Reading		

* If the difference of the Calibration Check Average from the NIST SRM film value is greater than the specified Calibration Check Tolerance for this device, consult the manufacturer's recommendations to bring the instrument back into control. Retest all testing combinations tested since the last successful Calibration Check test.

Calibration Check Test Results

Address/Unit No. 918 Fenway Drive
Oldtown, Maryland 21334

Device WXY Company, Inc. XRF 2.1

Date August 15, 1997 XRF Serial No. RS-1967

Contractor RIGAH PG Testing, Inc.

Inspector Name Mo Smith Signature

NIST SRM Used 1.02 mg/cm² Calibration Check Tolerance Used 0.2 mg/cm²

First Calibration Check

NIST SRM			First Average	Difference Between First Average and NIST SRM*
First Reading	Second Reading	Third Reading		
1.18	0.99	1.07	1.08	0.06

Second Calibration Check

NIST SRM			Second Average	Difference Between Second Average and NIST SRM*
First Reading	Second Reading	Third Reading		
1.45	1.21	1.10	1.25	0.22

Failed Calibration Check

Third Calibration Check *(if required)*

NIST SRM			Third Average	Difference Between Third Average and NIST SRM*
First Reading	Second Reading	Third Reading		

Fourth Calibration Check *(if required)*

NIST SRM			Fourth Average	Difference Between Fourth Average and NIST SRM*
First Reading	Second Reading	Third Reading		

* If the difference of the Calibration Check Average from the NIST SRM film value is greater than the specified Calibration Check Tolerance for this device, consult the manufacturer's recommendations to bring the instrument back into control. Retest all testing combinations tested since the last successful Calibration Check test.

Substrate Correction Values

Address/Unit No. ________________________________

____

Date ________________ XRF Serial No. ________________

Inspector Name ________________ Signature ________________

Use this form when the *XRF Performance Characteristics Sheet* indicates that correction for substrate bias is needed.

____

____

Substrate			Brick	Concrete	Drywall	Metal	Plaster	Wood
Location	1	First Reading						
		Second Reading						
		Third Reading						
	2	First Reading						
		Second Reading						
		Third Reading						
Correction Value (Average of the Six Readings)								

Transfer Correction Value for each substrate to the 'Correction Value' column of the LBP Testing Data Sheet.

Notes:

Substrate Correction Values

Address/Unit No. 918 Fenway Drive
Oldtown, Maryland 21334

Date August 15, 1997 XRF Serial No. RS-1967

Inspector Name Mo Smith Signature

Use this form when the *XRF Performance Characteristics Sheet* indicates that correction for substrate bias is needed.

Substrate			Brick	Concrete	Drywall	Metal	Plaster	Wood
Location	1	First Reading				0.10		0.14
		Second Reading				0.09		0.13
		Third Reading				0.09		0.12
	2	First Reading				0.10		0.11
		Second Reading				0.09		0.12
		Third Reading				0.11		0.12
Correction Value (Average of the Six Readings)						0.10		0.12

Transfer Correction Value for each substrate to the 'Correction Value' column of the LBP Testing Data Sheet.

Notes:

Metal: Location 1 – Door frame, Side B, Room 2
Location 2 – Door frame, Side C, Room 3

Wood: Location 1 – Window Sill, Side A, Room 1
Location 2 – Window Sill, Side B, Room 2

Selection of Housing Units

Page ______ of ______

Testing Site ____ Date ______________

Inspector Name ______________ Signature ______________ Number of Distinct Units to be Sampled [ ]

Total Number of Units	Random Number*	Random Number times Total Number of Units #	Round up for Unit Number to be Sampled	Distinct Unit Number

* Obtained from a hand-held calculator

Record to one decimal place (e.g., 25.4)

Selection of Housing Units

Page 1 of 6

Testing Site Fenway Gardens Housing Complex

Date August 16, 1997

Inspector Name Mo Smith

Signature

Number of Distinct Units to be Sampled 35

Total Number of Units	Random Number*	Random Number times Total Number of Units #	Round up for Unit Number to be Sampled	Distinct Unit Number
55	0.583	32.1	33	1
55	0.107	5.9	6	2
55	0.873	48.0	49	3
55	0.085	4.7	5	4
55	0.961	52.9	53	5
55	0.111	6.1	7	6
55	0.575	31.6	32	7
55	0.241	13.3	14	8
55	0.560	30.8	31	9
55	0.884	48.6	~~49~~	DUP
55	0.341	18.8	19	10
55	0.851	46.8	47	11
55	0.574	31.6	~~32~~	DUP
55	0.221	12.2	13	12
55	0.103	5.7	~~6~~	DUP
55	0.375	20.6	21	13
55	0.625	34.4	35	14
55	0.395	21.7	22	15
55	0.095	5.2	~~6~~	DUP
55	0.772	42.5	43	16
55	0.761	41.9	42	17
55	0.515	28.3	29	18
55	0.855	47.0	48	19
55	0.679	37.3	38	20
55	0.635	34.9	~~35~~	DUP
55	0.622	34.2	~~35~~	DUP
55	0.323	17.8	18	21
55	0.431	23.7	24	22
55	0.921	50.7	51	23
55	0.189	10.4	11	24
55	0.349	19.2	20	25
55	0.031	1.7	2	26

* Obtained from a hand-held calculator

Completed Form 7.4

\# Record to one decimal place (e.g., 25.4)

Selection of Housing Units

Page 2 of 6

Testing Site Fenway Gardens Housing Complex

Date August 16, 1997

Inspector Name Mo Smith

Signature

Number of Distinct Units to be Sampled: 35

Total Number of Units	Random Number*	Random Number times Total Number of Units #	Round up for Unit Number to be Sampled	Distinct Unit Number
55	0.735	40.4	41	27
55	0.929	51.1	52	28
55	0.229	12.6	~~13~~	DUP
55	0.267	14.7	15	29
55	0.155	8.5	9	30
55	0.284	15.6	16	31
55	0.447	24.6	25	32
55	0.487	26.8	27	33
55	0.721	39.7	40	34
55	0.603	33.2	34	35

* Obtained from a hand-held calculator

Completed Form 7.4

\# Record to one decimal place (e.g., 25.4)

Multifamily Housing LBP Testing Data Sheet

Page ______ of ______

Address/Unit No. ____ Date ____________________

Room Equivalent ____

XRF Serial No. ____________________ Inspector Name ____________________ Signature ____________________

Sample ID#	Substrate	Component	Color	Replication Number	Test Location	XRF Reading	Correction Value	Corrected Reading	Classification (pos, neg, inc)	Laboratory Result	UNITS	Laboratory Classification
											mg/cm^2 %	
											mg/cm^2 %	
											mg/cm^2 %	
											mg/cm^2 %	
											mg/cm^2 %	
											mg/cm^2 %	
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											mg/cm^2 %	

Multifamily Housing LBP Testing Data Sheet

Address/Unit No. Fenway Gardens Housing Complex Date August 16, 1997

Room Equivalent Unit #9, Bedroom

XRF Serial No. RS-1967 Inspector Mo Smith Signature

Sample ID#	Substrate	Component	Color	Replication Number	Test Location	XRF Reading	Correction Value	Corrected Reading	Classification (pos, neg, inc)	Laboratory Result	UNITS	Laboratory Classification
816.1	Concrete	Ceiling beam	White	1	Wall A	1.57	N/A	N/A	Pos		mg/cm² %	
816.2	Wood	Door	Brown	2	Closet door	0.52	N/A	N/A	Inc		mg/cm² %	
816.3	Plaster	Walls	White	4	Wall A	0.22	N/A	N/A	Neg		mg/cm² %	
816.4	Wood	Window casing	Brown	1	Wall B	0.95	N/A	N/A	Inc		mg/cm² %	
816.5	Wood	Door	Green	2	Wall C	0.90	N/A	N/A	Inc	0.13	mg/cm² %	Neg
816.6	Wood	Baseboard	Green	3	Wall D	0.40	N/A	N/A	Neg		mg/cm² %	
816.7	Concrete	Support column	White	2	Corner of walls D and A	2.50	N/A	N/A	Pos		mg/cm² %	
816.8	Metal	Radiator	Brown	1	Wall D, right side	0.41	N/A	N/A	Inc		mg/cm² %	
											mg/cm² %	
											mg/cm² %	
											mg/cm² %	
											mg/cm² %	
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											mg/cm² %	
											mg/cm² %	

Multifamily Housing: Component Type Report

Page ______ of ______

Address/Unit No. ____

____

Date ______________________ XRF Serial No.______________________________

Inspector Name ______________________ Signature ______________________

Description	Number of Readings	POSITIVE		INCONCLUSIVE*				NEGATIVE		Comp. Type Classif.
				Low		High				
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	

1997 Revision

Form 7.6

* Lower Boundary: ________ Upper Boundary: ________ Midpoint:________

Multifamily Housing: Component Type Report

Page 3 of 6

Address/Unit No. Fenway Gardens Housing Complex/Unit #9

Date August 16, 1997 XRF Serial No. RS-1967

Inspector Name Mo Smith Signature

Description	Total Number	POSITIVE		INCONCLUSIVE				NEGATIVE		Final Class.
				Low		High				
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	
Wood Shelves	83	4	4.8	5	6.0	9	10.8	65	78.3	NEG
Wood Doors	110	40	36.4	12	10.9	8	7.3	50	45.5	POS
~~Wood Door Casings~~	~~34~~	~~6~~	~~17.6~~	~~5~~	~~14.7~~	~~5~~	~~14.7~~	~~18~~	~~52.9~~	
Wood Hall Cabinets	60	5	8.3	8	13.3	12	20.0	35	58.3	POS
Wood Window Stools	110	60	54.5	30	27.3	10	9.1	10	9.1	POS
Wood Window Casings	63	0	0.0	0	0.0	0.0	0.0	63	100	NEG
Plaster Walls	110	0	0.0	10	9.1	9	8.2	91	82.7	NEG
Concrete Support Columns	40	40	100	0	0.0	0	0.0	0	0.0	POS
Concrete Ceiling Beams	40	40	100	0	0.0	0	0.0	0	0.0	POS
Metal Baseboards	45	0	0.0	0	0.0	0	0.0	45	100	NEG
Metal Gutters	50	20	40.0	8	16.0	2	4.0	20	40.0	POS
Brick Stairway	50	10	20.0	4	8.0	6	12.0	30	60.0	POS
Metal Radiators*	55	0	0.0	11	20.0	13	23.6	31	56.4	POS
Wood Door Casings	40	12	30.0	5	12.5	5	12.5	18	45.0	POS
* Metal Radiators:										
(retest of high inconclusives)	13	9	69.2					4	30.7	POS

* **Lower Boundary:** 0.41 mg/cm² **Upper Boundary:** 1.39 mg/cm² **Midpoint:** 0.90 mg/cm²

Performance Characteristic Sheet

EFFECTIVE DATE: October 7, 1996 **EDITION NO.: 3**

MANUFACTURER AND MODEL:

Make: *Advanced Detectors, Inc.*
Model: *LeadStar*
Source: ^{57}Co
Note: This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS

Nominal Reading Time is 15 seconds Fixed mode; or Brief mode.

XRF CALIBRATION CHECK LIMITS

For this instrument, calibration check readings should be taken in *Fixed Mode*.

Instruments with software versions 4.1 to 4.30*
0.83 to 1.02 mg/cm² (inclusive)
* This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30

Instruments with software versions earlier than version 4.1
0.83 to 1.12 mg/cm² (inclusive)

(Operators may choose to use limits in the manufacturer's operations manual for this calibration check. The rate of an incorrect result if the limits in the manufacturer's operations manual are followed may be different from the rate of an incorrect result stated here.)

SUBSTRATE CORRECTION:

Substrate correction recommended for XRF results below 4.0 mg/cm^2:

For those instruments with software versions 4.1 to 4.30 (this guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30):

None

For those instruments with software versions earlier than version 4.1:

Metal

Substrate correction not recommended for:

For those instruments with software versions 4.1 to 4.30:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

For those instruments with software versions earlier than version 4.1:

Brick, Concrete, Drywall, Plaster, and Wood

INCONCLUSIVE RANGE OR THRESHOLD

For those instruments with software versions 4.1 to 4.30 (this guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).:

15-SECOND FIXED MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Results not corrected for substrate bias	Brick	None	0.91 to 1.09
	Concrete	None	0.91 to 1.09
	Drywall	None	0.91 to 1.09
	Metal	None	0.91 to 1.19
	Plaster	1.0	None
	Wood	None	0.91 to 1.09

BRIEF MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD in mg/cm^2
Results not corrected for substrate bias	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0

For those instruments with software versions earlier than version 4.1:

15-SECOND FIXED MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE in mg/cm^2
Results corrected for substrate bias for readings on metal substrates only	Brick	0.91 to 1.29
	Concrete	0.91 to 1.29
	Drywall	0.91 to 1.09
	Metal	0.91 to 1.09
	Plaster	0.91 to 1.09
	Wood	0.91 to 1.09

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from evaluation data collected during the EPA/HUD field evaluation study conducted from March through October 1993. The data were collected from four instruments at approximately 1,200 15-second test locations and 300 60-second test locations. One instrument had a January 1993 source and the other three instruments had July 1993 sources. All four instruments had sources with 40 mCi initial strengths. The results of this study are reported in *A Field Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995.

OPERATING PARAMETERS

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instruments into control before XRF testing proceeds

SUBSTRATE CORRECTION VALUE COMPUTATION

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the paint film nearest 1.0 mg/cm^2 for substrate correction is provided:

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over the NIST SRM paint film nearest to 1.0 mg/cm^2 at test locations that have been scraped bare of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a <u>bare</u> substrate area covered with the NIST SRM paint film nearest 1 mg/cm^2. Repeat this procedure by taking three more readings on a second <u>bare</u> substrate area of the same substrate covered with the NIST SRM.

- Compute the correction value for each substrate type where XRF readings indicate substrate correction is needed by computing the average of all six readings as shown below.

  <u>For each substrate type</u> (the 1.02 mg/cm^2 NIST SRM is shown in this example; use the actual lead loading of the NIST SRM used for substrate correction):

$$\left.\begin{matrix}\mathit{Correction} \\ \mathit{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \mathit{Reading}}{6} - 1.02\,mg/cm^2$$

- Repeat this procedure for each substrate requiring substrate correction in the house or housing development.

EVALUATING THE QUALITY OF XRF TESTING

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing. Use either 15-second readings or 60-second readings.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multi-family housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten retest XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

TESTING TIMES:

For *Fixed Mode*, the LeadStar instrument tests for a set length of time before a result is obtained and displayed. For *Brief Mode*, the LeadStar instrument tests until a reading is obtained relative to an operator set *Action Level*. The following table provides a summary of testing times for readings taken in *Brief Mode* with an *Action Level* set to 1.0 mg/cm^2. All times have been scaled relative to an initial source strength of 15 mCi. Note that source strength and factors such as substrate may affect testing times.

Results from testing in August 1996 and September 1996

BRIEF MODE TESTING TIMES* (Seconds)						
SUBSTRATE	**ALL DATA**			**MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm²)**		
	25th Percentile	**Median**	**75th Percentile**	**Pb < 0.25**	**0.25 ≤ Pb < 1.0**	**1.0 ≤ Pb**
Wood Drywall	7	7	8	7	8	7
Metal	7	7	8	7	8	7
Brick Concrete Plaster	8	8	9	8	8	8

*Testing times are based on readings obtained relative to a 1.0 mg/cm ^{2} *Action Level*.

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. There were 15 test locations taken in *Fixed Mode* with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. The fifteen test locations were each tested four times in *Fixed Mode*, once under software version 4.05, once under software version 4.08, and twice under software version 4.30. Of the 15 test locations tested under software version 4.05, one case resulted in an XRF reading was less than 1.0 mg/cm^2. Of the 45 test locations tested under software versions 4.08 and 4.30, there were no instances in which an XRF reading was less than 1.0 mg/cm^2. Each of the fifteen test locations were tested in *Brief Mode* twice, both under software version 4.30. Out of the 30 *Brief Mode* testing cases, there were no instances in which an XRF reading was less than 1.0 mg/cm^2. The following data are for illustrative purposes only. Actual bias must be determined on-site. Inconclusive ranges provided above already account for bias and precision.

For those instruments with software versions 4.1 to 4.30.

FIXED MODE READINGS MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	0.0	0.1
	Concrete	0.0	0.1
	Drywall	0.0	0.1
	Metal	0.1	0.1
	Plaster	-0.1	0.1
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	0.1	0.2
	Concrete	0.1	0.2
	Drywall	0.0	0.2
	Metal	0.1	0.2
	Plaster	0.0	0.2
	Wood	0.1	0.2
1.0 mg/cm^2	Brick	0.1	0.3
	Concrete	0.1	0.3
	Drywall	0.1	0.3
	Metal	0.2	0.3
	Plaster	0.0	0.3
	Wood	0.1	0.3
2.0 mg/cm^2	Brick	0.2	0.4
	Concrete	0.2	0.4
	Drywall	0.2	0.4
	Metal	0.3	0.4
	Plaster	0.1	0.4
	Wood	0.2	0.4

*Precision at 1 standard deviation

For those instruments with software versions earlier than version 4.1.

FIXED MODE READINGS MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	0.1	0.1
	Concrete	0.1	0.1
	Drywall	0.0	0.1
	Metal	0.1	0.1
	Plaster	0.0	0.1
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	0.2	0.2
	Concrete	0.2	0.2
	Drywall	0.1	0.2
	Metal	0.2	0.2
	Plaster	0.1	0.2
	Wood	0.1	0.2
1.0 mg/cm^2	Brick	0.3	0.3
	Concrete	0.3	0.3
	Drywall	0.1	0.3
	Metal	0.2	0.3
	Plaster	0.1	0.3
	Wood	0.1	0.3
2.0 mg/cm^2	Brick	0.4	0.5
	Concrete	0.4	0.5
	Drywall	0.3	0.5
	Metal	0.4	0.5
	Plaster	0.3	0.5
	Wood	0.3	0.5

*Precision at 1 standard deviation

CLASSIFICATION OF RESULTS

XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, and negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range includes both its upper and lower bounds. Earlier editions of this *XRF Performance Characteristics Sheet* did not include both bounds of the inconclusive range as "inconclusive." While this edition of the Performance Characteristics Sheet uses a different system, the specific XRF readings that are considered positive, negative, or inconclusive for a given XRF model and substrate remain unchanged, so previous inspection results are not affected.

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7, Lead-Based Paint Inspection, of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead Hazard Control (L), U.S. Department of Housing and Urban Development, 451 Seventh St, S.W., Washington, DC 20410.

Performance Characteristic Sheet

EFFECTIVE DATE: December 1, 2006 **EDITION NO.: 1**

MANUFACTURER AND MODEL:

Make: ***Innov-X Systems, Inc.***
Models: ***LBP4000 with software version 1.4 and higher***
Source: ***X-ray tube***

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Inspection mode, variable reading time.

XRF CALIBRATION CHECK LIMITS:

1.0 to 1.1 mg/cm^2 (inclusive)

SUBSTRATE CORRECTION:

Not applicable

INCONCLUSIVE RANGE OR THRESHOLD:

INSPECTION MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results not corrected for substrate bias on any substrate	Brick	0.6 to 1.1
	Concrete	0.6 to 1.1
	Drywall	0.6 to 1.1
	Metal	0.6 to 1.1
	Plaster	0.6 to 1.1
	Wood	0.6 to 1.1

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted on 146 test locations, with two separate instruments, in December 2005.

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If the average (rounded to 1 decimal place) of three readings is outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instrument into control before XRF testing proceeds.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the paint film nearest 1.0 mg/cm^2 for substrate correction is provided:

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over the NIST SRM paint film nearest to 1.0 mg/cm^2 at test locations that have been scraped bare of their paint covering. Compute the correction values as follows:

> Using the same XRF instrument, take three readings on a <u>bare</u> substrate area covered with the NIST SRM paint film nearest 1 mg/cm^2. Repeat this procedure by taking three more readings on a second <u>bare</u> substrate area of the same substrate covered with the NIST SRM.
>
> Compute the correction value for each substrate type where XRF readings indicate substrate correction is needed by computing the average of all six readings as shown below.
>
> <u>For each substrate type</u> (the 1.02 mg/cm^2 NIST SRM is shown in this example; use the actual lead loading of the NIST SRM used for substrate correction):
>
> Correction value = (1st + 2nd + 3rd + 4th + 5th + 6th *Reading*) / 6 - 1.02 mg/cm^2
>
> Repeat this procedure for each substrate requiring substrate correction in the house or housing development.

EVALUATING THE QUALITY OF XRF TESTING:

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing.

Conduct XRF re-testing at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multi-family housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and the retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF readings.

Compute the average of all ten re-test XRF readings.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

TESTING TIMES:

For the variable-time inspection paint test mode, the instrument continues to read until it has determined whether the result is positive or negative (with respect to the 1.0 mg/cm^2 Federal standard), with 95% confidence. The following table provides testing time information for this testing mode.

Testing Times Using Variable Reading Time Inspection Mode (Seconds)

	All Data			Median for laboratory-measured lead levels (mg/cm^2)		
Substrate	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood, Drywall	2.1	2.3	5.4	2.2	5.4	2.2
Metal	2.6	3.2	5.3	2.7	5.1	5.1
Brick, Concrete, Plaster	3.1	4.0	5.7	3.2	4.0	5.9

CLASSIFICATION OF RESULTS:

When an inconclusive range is specified on the *Performance Characteristic Sheet*, XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range includes both its upper and lower bounds. If the instrument reads "> x mg/cm^2", the value "x" should be used for classification purposes, ignoring the ">". For example, a reading reported as ">1.0 mg/cm^2" is classified as 1.0 mg/cm^2 , or inconclusive. When the inconclusive range reported in this PCS is used to classify the readings obtained in the EPA/HUD evaluation, the following False Positive, False Negative and Inconclusive rates are obtained:

FALSE POSITIVE RATE:	2.5% (2/80)
FALSE NEGATIVE RATE**:**	1.9% (4/212)
INCONCLUSIVE RATE:	16.4% (48/212)

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet was developed by the Midwest Research Institute (MRI) and QuanTech, Inc., under a contract between MRI and the XRF manufacturer. XRF Performance Characteristic Sheets were originally developed by the MRI under a grant from the U. S. Environmental Protection Agency and the U.S. Department of Housing and Urban Development. HUD has determined that the information provided here is acceptable when used as guidance in conjunction with Chapter 7, Lead-Based Paint Inspection, of HUD's *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*.

Performance Characteristic Sheet

EFFECTIVE DATE: **September 24, 2004** **EDITION NO.: 1**

MANUFACTURER AND MODEL:

Make: *Niton LLC*

Tested Model: *XLp 300*

Source: ^{109}Cd

Note: This PCS is also applicable to the equivalent model variations indicated below, for the Lead-in-Paint K+L variable reading time mode, in the XLi and XLp series:

XLi 300A, XLi 301A, XLi 302A and XLi 303A.
XLp 300A, XLp 301A, XLp 302A and XLp 303A.
XLi 700A, XLi 701A, XLi 702A and XLi 703A.
XLp 700A, XLp 701A, XLp 702A and XLp 703A.

Note: The XLi and XLp versions refer to the shape of the handle part of the instrument. The differences in the model numbers reflect other modes available, in addition to Lead-in-Paint modes. The manufacturer states that specifications for these instruments are identical for the source, detector, and detector electronics relative to the Lead-in-Paint mode.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Lead-in-Paint K+L variable reading time mode.

XRF CALIBRATION CHECK LIMITS:

0.8 to 1.2 mg/cm^2 (inclusive)

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instruments into control before XRF testing proceeds.

SUBSTRATE CORRECTION:

For XRF results using Lead-in-Paint K+L variable reading time mode, substrate correction is <u>not</u> needed for:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

INCONCLUSIVE RANGE OR THRESHOLD:

K+L MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)
Results not corrected for substrate bias on any substrate	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted in August 2004 on 133 testing combinations. The instruments that were used to perform the testing had new sources; one instrument's was installed in November 2003 with 40 mCi initial strength, and the other's was installed June 2004 with 40 mCi initial strength.

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Substrate correction is not needed for brick, concrete, drywall, metal, plaster or wood when using Lead-in-Paint K+L variable reading time mode, the normal operating mode for these instruments. If substrate correction is desired, refer to Chapter 7 of the HUD Guidelines for guidance on correcting XRF results for substrate bias.

EVALUATING THE QUALITY OF XRF TESTING:

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing. Use the K+L variable time mode readings.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multifamily housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten re-test XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

TESTING TIMES:

For the Lead-in-Paint K+L variable reading time mode, the instrument continues to read until it is moved away from the testing surface, terminated by the user, or the instrument software indicates the reading is complete. The following table provides testing time information for this testing mode. The times have been adjusted for source decay, normalized to the initial source strengths as noted above. Source strength and type of substrate will affect actual testing times. At the time of testing, the instruments had source strengths of 26.6 and 36.6 mCi.

Testing Times Using K+L Reading Mode (Seconds)

	All Data			Median for laboratory-measured lead levels (mg/cm^2)		
Substrate	25^{th} Percentile	Median	75^{th} Percentile	Pb < 0.25	0.25 ≤ Pb<1.0	1.0 ≤ Pb
Wood Drywall	4	11	19	11	15	11
Metal	4	12	18	9	12	14
Brick Concrete Plaster	8	16	22	15	18	16

CLASSIFICATION RESULTS:

XRF results are classified as positive if they are greater than or equal to the threshold, and negative if they are less than the threshold.

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet was developed by the Midwest Research Institute (MRI) and QuanTech, Inc., under a contract between MRI and the XRF manufacturer. HUD has determined that the information provided here is acceptable when used as guidance in conjunction with Chapter 7, Lead-Based Paint Inspection, of HUD's *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*.

Performance Characteristic Sheet

EFFECTIVE DATE: April 17, 1998 **EDITION NO.: 4**

MANUFACTURER AND MODEL:
Make: *Niton Corporation*
Models: X*L-309, 701-A, 702-A, and 703-A Spectrum Analyzers*
Source: ^{109}Cd (10 - 40 mCi initial source strength)
Note: This Performance Characteristic Sheet (PCS) is applicable to the listed Niton XRF instruments which have an operating software version of 5.1 (or equivalent) using a variable-time mode, and to Niton instruments having an operating software version of 1.2C (or equivalent) using a fixed-time mode. This sheet supersedes all previous sheets for the XRF instruments made by the Niton Corporation and the 1993 testing of XL prototypes reported in the document titled: *A Field Test of Lead-Based Paint Testing Technologies*: *Technical Report* (EPA Report No. 747-R-95-002b, May 1995).

FIELD OPERATION GUIDANCE

This PCS provides supplemental information to be used in conjunction with Chapter 7 (Lead-Based Paint Inspection) of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown in this sheet are applicable only when operating the instrument using the manufacturer's instructions and the procedures described in Chapter 7 of the HUD Guidelines.

OPERATING PARAMETERS

Use of variable-time paint test mode ("K & L + Spectra" mode) on instruments running software version 5.1 (or equivalent) using the "Combined Lead Reading" with the instrument's display of a 95%--confident (2-sigma) *Positive* or *Negative* determination versus the action-level as the stopping point of the measurement.

Use of nominal 20-second readings for L-shell results or 120-second readings for K-shell results on instruments running software version 1.2C (or equivalent) in a fixed-time mode.

XRF CALIBRATION CHECK LIMITS

0.9 to 1.2 mg/cm^2 (inclusive) for instruments running software version 5.1 (or equivalent)
0.9 to 1.1 mg/cm^2 (inclusive) for instruments running software version 1.2C (or equivalent)

SUBSTRATE CORRECTION :
(applicable to instruments running software versions 5.1 (or equivalent) or 1.2C (or equivalent))

For XRF results below 4.0 mg/cm^2, substrate correction recommended for:

None.

Substrate correction is <u>not</u> recommended for:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

THRESHOLDS:
(applicable to instruments running software versions 5.1 (or equivalent) or 1.2C (or equivalent))

DESCRIPTION	SUBSTRATE	THRESHOLD* (mg/cm^2)
Results not corrected for substrate bias	Brick Concrete Drywall Metal Plaster Wood	1.0 1.0 1.0 1.0 1.0 1.0

*For instruments running software version 1.2C (or equivalent), application of the decision making methodology recommended in this PCS can result in inconclusive results regardless of whether decisions are based on L-shell readings, K-shell readings, or both.

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE

Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Three rounds of tests were conducted on approximately 150 test locations in each round.

One round of testing was conducted March 1995 using a single instrument with an October 1994 source at 10 mCi initial strength while running software version 1.2C in a fixed-time mode with nominal 20-second readings for L-shell results or 120-second readings for K-shell results.

The two other rounds of testing were conducted December 1997 using three different instruments, each running software version 5.1. Two of these instruments had new sources installed November 1997, the other instrument had a new source installed December 1997, all with 10 mCi initial strength. The December 1997 testing was performed in the variable-time paint test mode “K & L + Spectra” using the “Combined Lead Reading” with 2-sigma confidence interval as the stopping point of the measurement.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film). Measurements should be bracketed by successful XRF calibration check readings. XRF calibration checks are performed at the beginning and end of the day’s inspections or at extended delays in testing, and (at least) every four hours during inspections or at a frequency recommended by the manufacturer, whichever is more stringent. If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instrument into control before XRF testing proceeds. Measurements which are not bracketed by successful calibration checks should be considered suspect.

EVALUATING THE QUALITY OF XRF TESTING

Randomly select ten testing combinations for re-testing from each house or from two randomly selected units in multifamily housing. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines.) For testing combinations involving up to four walls in a room, each wall is classified on its individual XRF reading. (See Chapter 7 for testing procedures if there are more than four walls in a room, and for testing exterior walls.)

For instruments running software version 5.1 (or equivalent), conduct the test in the variable-time paint test mode “K & L + Spectra” using the “Combined Lead Reading” with 2-sigma confidence interval as the stopping point of the measurement. For instruments running software version 1.2C (or equivalent) in the fixed-time mode, use either 20-second readings for the L-shell results or 120-second readings for the K-shell results, as described in the "Classifications of Results" section below.

Conduct XRF re-testing at the ten testing combinations selected for re-testing.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multifamily housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten retest XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

BIAS AND PRECISION:

Bias and precision data were not computed for instruments using software version 5.1 and taking variable mode readings. (See Appendix B, Section B.3.2 of the document titled *Methodology for XRF Performance Characteristic Sheets*, EPA-747-R-45-008, September 1997). During the 1997 testing, there were 12 testing locations with laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead which were tested using two instruments in the variable-time paint test mode. None of these testing locations had XRF readings less than 1.0 mg/cm^2. These data are for illustrative purposes only. Substrate correction is not recommended for this XRF instrument.

The bias and precision data given below are for instruments running software version 1.2C (or equivalent) and were computed without substrate correction using the 20-second L-shell readings from samples with reported laboratory results less than 4.0 mg/cm^2 lead. Readings reported by the instrument in the "*x*" or ">>*x*" format were not used in the computation. During the 1995 testing there were 15 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, 12 readings were reported in the ">*x*" or ">>*x*" format, but of the 3 remaining, 1 had an XRF reading less than 1.0 mg/cm^2.

Bias & Precision Results for Niton Model XL-309 Instruments Using Software Version 1.2C (or equivalent)

MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	All	0.0	<0.1
0.5 mg/cm^2	All	0.0	0.2
1.0 mg/cm^2	All	0.0	0.3
2.0 mg/cm^2	All	-0.1	0.5
*Precision at 1 standard deviation			

CLASSIFICATION OF RESULTS

This section describes how to apply information displayed by this instrument to determine the presence or absence of lead in paint using the procedures recommended in Chapter 7 of the HUD Guidelines. These guidelines recommend classifying XRF results as positive, negative, or inconclusive compared to the lead-based paint 1.0 mg/cm^2 standard.

For Niton Model XL-309, 701-A, 702-A, and 703-A instruments running software version 5.1 (or equivalent), XRF results are classified using a threshold. There is no inconclusive classification when using the threshold for instruments running software version 5.1. In single-family and multifamily housing, an XRF result is a single reading taken on each testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines.) For testing combinations involving up to four walls in a room, each wall is classified on its individual XRF reading. (See Chapter 7 for testing procedures if there are more than four walls in a room, and for testing exterior walls.) For computing the XRF result, use all digits that are displayed by the instrument as the "Combined Lead Reading." Results are classified as positive (i.e., $\geq$ 1.0 mg/cm^2), if greater than or equal to the threshold, or negative (< 1.0 mg/cm^2) if less than the threshold. Threshold values, provided in the tables above, were determined by comparing XRF test results to the 1.0 mg/cm^2 standard.

For Niton Model XL-309 instruments running software version 1.2C (or equivalent), additional procedures are needed to classify readings because this software displays readings <u>and</u> ancillary information useful for classification purposes. An algorithmic procedure is described that makes use of the XRF reading and other displayed information.

The algorithm for classifying results is first applied to 20-second nominal L-shell readings followed by 120-second nominal K-shell readings to resolve inconclusive results, or to recommend laboratory analysis of paint-chip samples, if necessary. A listing of laboratories recognized by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the confirmational analysis of inconclusive results is available from the National Lead Clearinghouse at 1-800-424-LEAD.

XRF results are classified using threshold values for the Model XL-309 software version 1.2C (or equivalent). Results are classified as positive if greater than or equal to the threshold, and as negative if less than the threshold. There is no inconclusive classification when using threshold values. However, in some cases, inconclusive results still may be obtained regardless of whether decisions are based on L-shell readings, K-shell readings, or both, as described below. Use all digits that are reported by the instrument. Threshold values, which were determined for comparing results to the 1.0 mg/cm^2 standard, are provided in the table above.

This instrument displays its lead-based paint measurements as both L-shell and K-shell readings based on the corresponding L-shell and K-shell X-ray fluorescence (refer to Chapter 7 of the HUD Guidelines for more details). The L-shell readings (or L-readings) are displayed as a numerical result alone, or as a numerical result preceded by either one greater-than symbol (">") or preceded by two greater-than symbols (">>"). The two greater-than symbols will only be displayed when the detected lead level is greater than 5.0 mg/cm^2. Since the maximum lead level reported by this instrument is 5.0 mg/cm^2, lead levels greater than 5.0 mg/cm^2 are displayed as ">>5.0". Other examples of how L-readings can be displayed (in mg/cm^2 units) are "0.6" and ">0.9". The numerical display alone implies that the instrument measured the lead in the paint at the displayed level using L-shell X-ray fluorescence; 0.6 mg/cm^2 in the example. A number preceded by a single greater-than symbol indicates that the measurable lead is deeply buried in the paint and the detected lead level is greater than the displayed value. In the example, >0.9 indicates that the instrument detected lead deeply buried in paint at a level greater than 0.9 mg/cm^2. K-shell readings (or K-readings) are displayed in one of two ways: 1) as a single K-reading plus and minus a "precision" value or 2) as an upper K-reading and lower K-reading.

The same method is used for testing in single-family and multifamily housing. The HUD Guidelines recommend taking a single XRF reading on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines.) For testing combinations involving up to four walls in a room, each wall is classified on its individual XRF reading. (See Chapter 7 for testing procedures if there are more than four walls in a room, and for testing exterior walls.)

A. Take a single 20-second nominal reading on each testing combination.

B. Classify the L-reading based on the type of information displayed.

<u>If two greater-than symbols are displayed then</u>:

- Classify the >>5.0 L-reading as POSITIVE

<u>If one greater-than symbol is displayed then</u>:

- Classify the L-reading as POSITIVE if the numerical result that follows the greater than symbol is equal to or greater than 1.0.

- Classify the L-reading as INCONCLUSIVE if the numerical result that follows the greater than symbol is less than 1.0.

<u>If the numerical L-reading is displayed alone (that is, without any preceding greater-than symbols) then</u>:

- Classify the L-reading as POSITIVE if the numerical result is equal to or greater than 1.0.

- Classify the L-reading as NEGATIVE if the numerical result is less than 1.0.

C. Resolution of results classified as inconclusive.

All results classified as inconclusive above require further investigation. Take a 120-second nominal XRF reading and use the K-shell reading. In multifamily housing, resolve the inconclusive classification with a single K-shell reading or laboratory analysis as described below.

- Classify the result as POSITIVE if either the K-reading minus the displayed precision value <u>or</u> the lower K-reading is equal to or greater than 1.0.

- Classify the result as NEGATIVE if either the K-reading plus the displayed precision value <u>or</u> the upper K-reading is less than 1.0.

- Classify the result as INCONCLUSIVE if neither of the above decision rules using the K-reading provided a classification which can occur when the upper K-reading is equal to or greater than 1.0 or the lower K-reading is less than 1.0.

- To resolve a remaining INCONCLUSIVE classification, remove a paint-chip sample as described in Chapter 7 of the HUD Guidelines and have it analyzed by a qualified laboratory as described in Chapter 7.

TESTING TIMES (FOR SOFTWARE VERSION 5.1)

For the variable-time paint test mode "K & L + Spectra," the instrument continues measuring until a positive or negative result is indicated relative to an action level (1.0 mg/cm^2 for archive testing) and the current precision, or until the reading is terminated by moving the instrument away from the testing surface. None of the variable mode readings were terminated because of the two-minute limit used for archive testing. The following table provides testing time information for this testing mode. Source strength and type of substrate will affect actual testing times.

Testing Times for Instruments Running Software Version 5.1						
Variable mode testing times (seconds)						
	All data			Median for laboratory—measured lead levels (mg/cm ^{2})		
Substrate	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 <= Pb < 1.0	1.0 <= Pb
Wood Drywall	6	8	15	6	20	5
Metal	6	13	20	13	20	6
Brick Concrete Plaster	6	11	20	9	18	6

DOCUMENTATION:

This PCS was developed in accordance with the methodology in the EPA report titled *Methodology for XRF Performance Characteristic Sheets* (EPA 747-R-95-008, September 1997). This report provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet was developed by the Midwest Research Institute (MRI) under a grant from the U. S. Environmental Protection Agency and a separate contract between MRI and the XRF manufacturer. The U.S. Department of Housing and Urban Development (HUD) has determined that the information provided here is acceptable when used as guidance in conjunction with Chapter 7, Lead-Based Paint Inspection, of HUD's *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. While MRI reserves the right to revise this XRF Performance Characteristic Sheet at any time, HUD's statement of acceptance would not apply to a revision until HUD has reviewed the revision and made a determination of its acceptability.

Performance Characteristic Sheet

EFFECTIVE DATE: **September 25, 1995** **EDITION NO.: 3**

MANUFACTURER AND MODEL :

Make: *Princeton Gamma-Tech, Inc.*
Model: *XK-3*
Source: ^{57}Co
Note: This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS

Nominal Time Reading is 15 seconds.

XRF CALIBRATION CHECK LIMITS

0.5 to 2.3 mg/cm^2 (inclusive)

SUBSTRATE CORRECTION:

For XRF results below 4.0 mg/cm^2, substrate is correction recommended for:

Brick, Concrete, Drywall, Metal, Plaster and Wood.

Substrate correction is <u>not</u> recommended for:

None.

INCONCLUSIVE RANGE OR THRESHOLD

DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings corrected for substrate bias on all substrates	Brick	None	1.0 to 1.2
	Concrete	None	0.9 to 1.6
	Drywall	1.0	None
	Metal	None	0.4 to 1.7
	Plaster	None	0.8 to 1.3
	Wood	None	1.0 to 1.3

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from evaluation data collected during the EPA/HUD field evaluation study conducted from March through October 1993. The data were collected from approximately 1,200 test locations using three instruments. One instrument had a March 1993 source and the other two instruments had April 1993 sources. All three instruments had sources with 10 mCi initial strengths. The results of this study are reported in *A Field Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995.

OPERATING PARAMETERS

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instruments into control before XRF testing proceeds

SUBSTRATE CORRECTION VALUE COMPUTATION

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the paint film nearest 1.0 mg/cm^2 for substrate correction is provided:

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over the NIST SRM paint film nearest to 1.0 mg/cm^2 at test locations that have been scraped bare of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a <u>bare</u> substrate area covered with the NIST SRM paint film nearest 1 mg/cm^2. Repeat this procedure by taking three more readings on a second <u>bare</u> substrate area of the same substrate covered with the NIST SRM.

- Compute the correction value for each substrate type where XRF readings indicate substrate correction is needed by computing the average of all six readings as shown below.

  <u>For each substrate type</u> (the 1.02 mg/cm^2 NIST SRM is shown in this example; use the actual lead loading of the NIST SRM used for substrate correction):

$$\left.\begin{matrix}\textit{Correction}\\ \textit{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \textit{Reading}}{6} - 1.02\,mg/cm^2$$

- Repeat this procedure for each substrate requiring substrate correction in the house or housing development.

EVALUATING THE QUALITY OF XRF TESTING

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing. Use either 15-second readings or 60-second readings.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multi-family housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten retest XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

BIAS AND PRECISION:
Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. There were 143 testing locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, 1 had XRF readings less than 1.0 mg/cm^2. These data are for illustrative purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above already account for bias and precision. Bias and precision ranges are provided whenever significant variability was found between machines of the same model.

MEASURED AT	SUBSTRATE	BIAS (mg/cm²)	BIAS RANGES (mg/cm²)	PRECISION* (mg/cm²)	PRECISION RANGES (mg/cm²)
0.0 mg/cm²	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.6, 1.9)	0.6	(0.2, 0.6)
	Drywall	-0.1	(-0.3, 0.2)	0.3	(0.2, 0.3)
	Metal	0.9	(0.5, 1.4)	0.5	(0.4, 0.5)
	Plaster	0.8	(0.4, 1.7)	0.5	(0.4, 0.5)
	Wood	0.2	(-0.1, 1.0)	0.4	(0.3, 0.5)
0.5 mg/cm²	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.7, 1.9)	0.6	(0.5, 0.7)
	Drywall	0.0	(-0.2, 0.2)	0.4	(0.3, 0.4)
	Metal	1.1	(0.7, 1.6)	0.8	(0.4, 0.9)
	Plaster	0.8	(0.2, 1.6)	0.6	(0.4, 0.6)
	Wood	0.4	(0.1, 1.1)	0.6	(0.3, 0.9)
1.0 mg/cm²	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.7, 2.0)	0.7	(0.6, 0.8)
	Drywall	0.0	(-0.1, 0.2)	0.4	(0.4, 0.5)
	Metal	1.3	(0.9, 1.7)	1.0	(0.5, 1.1)
	Plaster	0.8	(0.0, 1.6)	0.6	(0.4, 0.7)
	Wood	0.6	(0.3, 1.3)	0.7	(0.3, 1.2)
2.0 mg/cm²	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.7, 2.0)	0.8	(0.6, 0.9)
	Drywall	0.1	(0.1, 0.2)	0.6	(0.5, 0.6)
	Metal	1.7	(1.4, 2.1)	1.4	(0.6, 1.6)
	Plaster	0.7	(-0.3, 1.6)	0.7	(0.4, 0.8)
	Wood	1.0	(0.8, 1.5)	0.9	(0.3, 1.7)
*Precision at 1 standard deviation					

CLASSIFICATION OF RESULTS

XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, and negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range includes both its upper and lower bounds. Earlier editions of this *XRF Performance Characteristics Sheet* did not include both bounds of the inconclusive range as "inconclusive." While this edition of the Performance Characteristics Sheet uses a different system, the specific XRF readings that are considered positive, negative, or inconclusive for a given XRF model and substrate remain unchanged, so previous inspection results are not affected.

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7, Lead-Based Paint Inspection, of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead Hazard Control (L), U.S. Department of Housing and Urban Development, 451 Seventh St, S.W., Washington, DC 20410.

Performance Characteristic Sheet

EFFECTIVE DATE: **December 1, 2006** **EDITION NO.: 5**

MANUFACTURER AND MODEL:

Make: ***Radiation Monitoring Devices***
Model: ***LPA-1***
Source: ^{57}***Co***
Note: This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above ***for instruments sold or serviced after June 26, 1995. For other instruments, see prior editions.***

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Quick mode or 30-second equivalent standard (Time Corrected) mode readings.

XRF CALIBRATION CHECK LIMITS:

0.7 to 1.3 mg/cm^2 (inclusive)

SUBSTRATE CORRECTION:

For XRF results below 4.0 mg/cm^2, substrate correction is recommended for:

Metal using 30-second equivalent standard (Time Corrected) mode readings.
None using quick mode readings.

Substrate correction is not needed for:

Brick, Concrete, Drywall, Plaster, and Wood using 30-second equivalent standard (Time Corrected) mode readings
Brick, Concrete, Drywall, Metal, Plaster, and Wood using quick mode readings

THRESHOLDS:

30-SECOND EQUIVALENT STANDARD MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)
Results corrected for substrate bias on metal substrate only	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	0.9
	Plaster	1.0
	Wood	1.0

QUICK MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)
Readings not corrected for substrate bias on any substrate	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted on approximately 150 test locations in July 1995. The instrument that performed testing in September had a new source installed in June 1995 with 12 mCi initial strength.

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instruments into control before XRF testing proceeds.

SUBSTRATE CORRECTION VALUE COMPUTATION :

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the paint film nearest 1.0 mg/cm^2 for substrate correction is provided:

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over the NIST SRM paint film nearest to 1.0 mg/cm^2 at test locations that have been scraped bare of their paint covering. Compute the correction values as follows:

> Using the same XRF instrument, take three readings on a <u>bare</u> substrate area covered with the NIST SRM paint film nearest 1 mg/cm^2. Repeat this procedure by taking three more readings on a second <u>bare</u> substrate area of the same substrate covered with the NIST SRM.
>
> Compute the correction value for each substrate type where XRF readings indicate substrate correction is needed by computing the average of all six readings as shown below.
>
> For each substrate type (the 1.02 mg/cm^2 NIST SRM is shown in this example; use the actual lead loading of the NIST SRM used for substrate correction):
>
> Correction value = (1st + 2nd + 3rd + 4th + 5th + 6th *Reading*) / 6 - 1.02 mg/cm^2
>
> Repeat this procedure for each substrate requiring substrate correction in the house or housing development.

EVALUATING THE QUALITY OF XRF TESTING:

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing. Use either the Quick Mode or 30-second equivalent standard (Time Corrected) Mode readings.

Conduct XRF re-testing at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multi-family housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten re-test XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. The data which were used to determine the bias and precision estimates given in the table below have the following properties. During the July 1995 testing, there were 15 test locations with a laboratory-reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, one 30-second standard mode reading was less than 1.0 mg/cm^2 and none of the quick mode readings were less than 1.0 mg/cm^2. The instrument that tested in July is representative of instruments sold or serviced after June 26, 1995. These data are for illustrative purposes only. Actual bias must be determined on the site. Results provided above already account for bias and precision. Bias and precision ranges are provided to show the variability found between machines of the same model.

30-SECOND STANDARD MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick Concrete Drywall Metal Plaster Wood	0.0 0.0 0.1 0.3 0.1 0.0	0.1 0.1 0.1 0.1 0.1 0.1
0.5 mg/cm^2	Brick Concrete Drywall Metal Plaster Wood	0.0 0.0 0.0 0.2 0.0 0.0	0.2 0.2 0.2 0.2 0.2 0.2
1.0 mg/cm^2	Brick Concrete Drywall Metal Plaster Wood	0.0 0.0 0.0 0.2 0.0 0.0	0.3 0.3 0.3 0.3 0.3 0.3
2.0 mg/cm^2	Brick Concrete Drywall Metal Plaster Wood	-0.1 -0.1 -0.1 0.1 -0.1 -0.1	0.4 0.4 0.4 0.4 0.4 0.4

*Precision at 1 standard deviation.

CLASSIFICATION RESULTS:

XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, and negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range includes both its upper and lower bounds. Earlier editions of this *XRF Performance Characteristic Sheet* did not include both bounds of the inconclusive range as "inconclusive." While this edition of the Performance Characteristics Sheet uses a different system, the specific XRF readings that are considered positive, negative, or inconclusive for a given XRF model and substrate remain unchanged, so previous inspection results are not affected.

DOCUMENTATION:

An EPA document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD. A HUD document titled *A Nonparametric Method for Estimating the 5th and 95th Percentile Curves of Variable-Time XRF Readings Based on Monotone Regression* provides supplemental information on the methodology for variable-time XRF instruments. A copy of this document can be obtained from the HUD lead web site, www.hud.gov/offices/lead.

This XRF Performance Characteristic Sheet was developed by QuanTech, Inc., under a contract from the U.S. Department of Housing and Urban Development (HUD). HUD has determined that the information provided here is acceptable when used as guidance in conjunction with Chapter 7, Lead-Based Paint Inspection, of HUD's *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*.

Performance Characteristic Sheet

EFFECTIVE DATE: **August 24, 1995** **EDITION NO.: 3**

MANUFACTURER AND MODEL:

Make: *Scitec Corporation*
Model: *MAP-3*
Source: ^{57}Co
Note: This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS

Nominal Time Reading is 15 seconds or 60 seconds.

XRF CALIBRATION CHECK LIMITS

15-SECOND READINGS	60-SECOND READINGS
0.4 to 1.3 mg/cm^2 (inclusive)	0.6 mg/cm^2 to 1.1 mg/cm^2 (inclusive)

SUBSTRATE CORRECTION:

For XRF results below 4.0 mg/cm^2, substrate is correction recommended for:

Metal and Wood

Substrate correction is <u>not</u> recommended for:

Brick, Concrete, Drywall, and Plaster

INCONCLUSIVE RANGE OR THRESHOLD

15-SECOND READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results corrected for substrate bias for 15-second readings on metal and wood substrates only	Brick Concrete Drywall Metal Plaster Wood	0.01 to 1.49 0.01 to 1.49 0.91 to 0.99 0.91 to 1.29 0.31 to 1.29 0.91 to 1.29

60-SECOND READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings corrected for substrate bias for 60-second readings on metal and wood substrates only	Brick Concrete Drywall Metal Plaster Wood	None None None None None 1.0	0.31 to 0.89 0.31 to 0.89 0.61 to 0.79 0.91 to 1.19 0.21 to 0.91 None

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from evaluation data collected during the EPA/HUD field evaluation study conducted from March through October 1993. The data were collected from four instruments at approximately 1,200 15-second test locations and 300 60-second test locations. One instrument had a January 1993 source and the other three instruments had July 1993 sources. All four instruments had sources with 40 mCi initial strengths. The results of this study are reported in *A Field Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995.

OPERATING PARAMETERS

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instruments into control before XRF testing proceeds

SUBSTRATE CORRECTION VALUE COMPUTATION

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the paint film nearest 1.0 mg/cm^2 for substrate correction is provided:

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over the NIST SRM paint film nearest to 1.0 mg/cm^2 at test locations that have been scraped bare of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a <u>bare</u> substrate area covered with the NIST SRM paint film nearest 1 mg/cm^2. Repeat this procedure by taking three more readings on a second <u>bare</u> substrate area of the same substrate covered with the NIST SRM.

- Compute the correction value for each substrate type where XRF readings indicate substrate correction is needed by computing the average of all six readings as shown below.

  <u>For each substrate type</u> (the 1.02 mg/cm^2 NIST SRM is shown in this example; use the actual lead loading of the NIST SRM used for substrate correction):

$$\left.\begin{matrix}\mathit{Correction}\\ \mathit{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \mathit{Reading}}{6} - 1.02\,mg/cm^2$$

- Repeat this procedure for each substrate requiring substrate correction in the house or housing development.

EVALUATING THE QUALITY OF XRF TESTING

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing. Use either 15-second readings or 60-second readings.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multi-family housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten retest XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

BIAS AND PRECISION

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. There were 124 15-second testing locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, none had XRF readings less than 1.0 mg/cm^2. For the 60-second testing locations, 34 had laboratory reported results equal to or greater than 4.0 mg/cm^2 lead, with 2 of those having XRF readings less than 1.0 mg/cm^2. These data are for illustrative purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above already account for bias and precision.

15-SECOND READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	-0.7	0.9
	Concrete	-0.7	0.9
	Drywall	0.0	0.4
	Metal	0.3	0.3
	Plaster	-0.7	0.8
	Wood	-0.1	0.5
0.5 mg/cm^2	Brick	-0.5	1.0
	Concrete	-0.5	1.0
	Drywall	-0.1	0.4
	Metal	0.4	0.5
	Plaster	-0.6	0.8
	Wood	0.2	0.6
1.0 mg/cm^2	Brick	-0.4	1.0
	Concrete	-0.4	1.0
	Drywall	-0.1	0.4
	Metal	0.5	0.6
	Plaster	-0.4	0.9
	Wood	0.4	0.7
2.0 mg/cm^2	Brick	-0.1	1.2
	Concrete	-0.1	1.2
	Drywall	-0.3	0.4
	Metal	0.6	0.7
	Plaster	-0.2	0.9
	Wood	0.8	0.8
*Precision at 1 standard deviation			

60-SECOND READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	-0.8	0.7
	Concrete	-0.8	0.7
	Drywall	0.0	0.3
	Metal	0.3	0.2
	Plaster	-0.8	0.5
	Wood	-0.2	0.4
0.5 mg/cm^2	Brick	-0.7	0.7
	Concrete	-0.7	0.7
	Drywall	-0.2	0.3
	Metal	0.4	0.3
	Plaster	-0.6	0.7
	Wood	0.1	0.4
1.0 mg/cm^2	Brick	-0.7	0.7
	Concrete	-0.7	0.7
	Drywall	-0.4	0.3
	Metal	0.6	0.4
	Plaster	-0.5	0.8
	Wood	0.3	0.4
2.0 mg/cm^2	Brick	-0.6	0.7
	Concrete	-0.6	0.7
	Drywall	-0.8	0.3
	Metal	0.9	0.5
	Plaster	-0.1	1.0
	Wood	0.8	0.4
*Precision at 1 standard deviation			

CLASSIFICATION OF RESULTS

XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, and negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range includes both its upper and lower bounds. Earlier editions of this *XRF Performance Characteristics Sheet* did not include both bounds of the inconclusive range as "inconclusive." While this edition of the Performance Characteristics Sheet uses a different system, the specific XRF readings that are considered positive, negative, or inconclusive for a given XRF model and substrate remain unchanged, so previous inspection results are not affected.

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

Performance Characteristic Sheet

EFFECTIVE DATE: June 26, 1996 EDITION NO.: 3

MANUFACTURER AND MODEL:

Make: *Scitec Corporation*
Model: *MAP-4*
Source: ^{57}Co
Note: This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS

Test mode, Screen mode, or Unlimited mode.

XRF CALIBRATION CHECK LIMITS

0.6 to 1.2 mg/cm^2 (inclusive)

SUBSTRATE CORRECTION:

When using Unlimited mode, substrate correction recommended for:

None

When using Unlimited mode, substrate correction not recommended for:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

When using Screen or Test mode, for XRF results below 4.0 mg/cm^2, substrate correction recommended for:

Drywall, Metal, and Wood

When using Screen or Test mode, substrate correction not recommended for:

Brick, Concrete, and Plaster

INCONCLUSIVE RANGE OR THRESHOLD

UNLIMITED MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results not corrected for substrate bias for unlimited mode readings	Brick	0.91 to 1.19
	Concrete	0.91 to 1.19
	Drywall	0.91 to 1.19
	Metal	0.91 to 1.19
	Plaster	0.91 to 1.19
	Wood	0.91 to 1.19

SCREEN MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results corrected for substrate bias for screen mode readings on drywall, metal, and wood substrates only	Brick Concrete Drywall Metal Plaster Wood	0.91 to 1.09 0.91 to 1.09 0.91 to 1.39 0.91 to 1.19 0.91 to 1.09 0.91 to 1.29

TEST MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings corrected for substrate bias for test mode readings on drywall, metal, and wood substrates only	Brick Concrete Drywall Metal Plaster Wood	0.9 0.9 None None 0.9 None	None None 0.91 to 1.39 0.91 to 1.09 None 0.91 to 1.29

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from an EPA/HUD evaluation using archived building components. Testing was conducted on approximately 150 test locations. All of the test locations were tested in February 1996 using two different instruments. One instrument had a new source installed in July 1994 and its strength at the time of testing was calculated as 9.4 mCi. The other instrument had a new source installed in September 1994 and its strength at the time of testing was calculated as 10.6 mCi.

OPERATING PARAMETERS

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instruments into control before XRF testing proceeds

SUBSTRATE CORRECTION VALUE COMPUTATION

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the paint film nearest 1.0 mg/cm^2 for substrate correction is provided:

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over the NIST SRM paint film nearest to 1.0 mg/cm^2 at test locations that have been scraped bare of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a <u>bare</u> substrate area covered with the

NIST SRM paint film nearest 1 mg/cm^2. Repeat this procedure by taking three more readings on a second <u>bare</u> substrate area of the same substrate covered with the NIST SRM.

- Compute the correction value for each substrate type where XRF readings indicate substrate correction is needed by computing the average of all six readings as shown below.

  <u>For each substrate type</u> (the 1.02 mg/cm^2 NIST SRM is shown in this example; use the actual lead loading of the NIST SRM used for substrate correction):

$$\left.\begin{matrix}\textit{Correction}\\ \textit{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \textit{Reading}}{6} - 1.02\,mg/cm^2$$

- Repeat this procedure for each substrate requiring substrate correction in the house or housing development.

EVALUATING THE QUALITY OF XRF TESTING

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing. Use either 15-second readings or 60-second readings.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multi-family housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten retest XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

TESTING TIMES:

For screen, test, and confirm modes, the MAP 4 instrument tests until a K-shell result is obtained relative to a level of precision. A result is "positive", "negative" or "retest" as displayed by indicator lights. For the unlimited mode, the MAP 4 instrument tests until a K-shell result is indicated relative to an action level (1.0 mg/cm ^{2} for archive testing) and the current precision, or until the the reading is terminated by releasing the trigger. A few unlimited mode readings were terminated because they exceeded the two-minute limit used for archive testing. The following tables provide testing time information for three testing modes. Insufficient information is available to provide this information for confirm mode. All times have been scaled to match an initial 12 miC source. Note that source strength and factors such as substrate may affect testing times.

UNLIMITED MODE TESTING TIMES (Seconds)

SUBSTRATE[a]	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	3	4	6	4	13	3
Metal	3	4	8	4	9	3
Brick Concrete Plaster	4	5	8	6	6	3

[a]The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

SCREEN MODE TESTING TIMES (Seconds)

SUBSTRATE[a]	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	4	6	7	5	6	7
Metal	4	5	6	5	5	5
Brick Concrete Plaster	11	11	13	11	11	11

[a]The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

TEST MODE TESTING TIMES (Seconds)						
SUBSTRATE	**ALL DATA**			**MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)**		
	25th Percentile	**Median**	**75th Percentile**	**Pb < 0.25**	**0.25 ≤ Pb < 1.0**	**1.0 ≤ Pb**
Wood Drywall	17	22	27	21	20	28
Metal	13	20	23	20	20	20
Brick Concrete Plaster	41	42	52	41	46	43

[a]The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with laboratory-measured lead levels less than 4.0 mg/cm^2 lead. There were 15 testing locations taken in the screen mode with a laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead. None of these had XRF readings less than 1.0 mg/cm^2. There were 15 testing locations taken in the test mode with a laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead. None of these had XRF readings less than 1.0 mg/cm^2. There were not any testing locations taken in the confirm mode with a laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead. There were 15 testing locations taken in the unlimited mode with a laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead. None of these had XRF readings less than 1.0 mg/cm^2. All testing was done in February 1996 with two different instruments. The following data are for illustrative purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above already account for bias and precision.

SCREEN MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick Concrete Drywall Metal Plaster Wood	-0.1 -0.1 0.1 0.1 -0.1 0.0	0.3 0.3 0.2 0.3 0.3 0.2
0.5 mg/cm^2	Brick Concrete Drywall Metal Plaster Wood	0.0 0.0 0.3 0.2 0.0 0.2	0.3 0.3 0.4 0.3 0.3 0.4
1.0 mg/cm^2	Brick Concrete Drywall Metal Plaster Wood	0.1 0.1 0.5 0.3 0.1 0.4	0.4 0.4 0.6 0.3 0.4 0.6

2.0 mg/cm²	Brick Concrete Drywall Metal Plaster Wood	0.4 0.4 0.9 0.5 0.4 0.7	0.5 0.5 0.8 0.3 0.5 0.8
*Precision at 1 standard deviation			

TEST MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm²	Brick Concrete Drywall Metal Plaster Wood	-0.1 -0.1 0.1 0.1 -0.1 0.0	0.2 0.2 0.1 0.2 0.2 0.1
0.5 mg/cm²	Brick Concrete Drywall Metal Plaster Wood	-0.1 -0.1 0.3 0.2 -0.1 0.2	0.3 0.3 0.4 0.2 0.3 0.4
1.0 mg/cm²	Brick Concrete Drywall Metal Plaster Wood	-0.1 -0.1 0.5 0.3 -0.1 0.4	0.3 0.3 0.6 0.2 0.3 0.6
2.0 mg/cm²	Brick Concrete Drywall Metal Plaster Wood	0.0 0.0 1.0 0.5 0.0 0.8	0.4 0.4 0.8 0.2 0.4 0.8
*Precision at 1 standard deviation			

CLASSIFICATION OF RESULTS

XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, and negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range includes both its upper and lower bounds. Earlier editions of this *XRF Performance Characteristics Sheet* did not include both bounds of the inconclusive range as "inconclusive." While this edition of the Performance Characteristics Sheet uses a different system, the specific XRF readings that are considered positive, negative, or inconclusive for a given XRF model and substrate remain unchanged, so previous inspection results are not affected.

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7, Lead-Based Paint Inspection, of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead Hazard Control (L), U.S. Department of Housing and Urban Development, 451 Seventh St, S.W., Washington, DC 20410.

Performance Characteristics Sheet

EFFECTIVE DATE: **October 31, 1995** **EDITION NO.: 3**

MANUFACTURER AND MODEL:

Manufacturer: *TN Technologies, Inc. (TN Spectrace)*
Make: *Pb Analyzer*
Model: *9292*
Source: ^{109}Cd
Note: This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS

Nominal Time Reading is 15 seconds.

XRF CALIBRATION CHECK LIMITS

0.7 to 1.4 (inclusive)

SUBSTRATE CORRECTION:

Not required for any substrate.

INCONCLUSIVE RANGE OR THRESHOLD

DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE in mg/cm^2	
		LOWER BOUND	UPPER BOUND
Results not corrected for substrate bias	Brick	0.91	1.19
	Concrete	0.91	1.19
	Drywall	0.91	1.19
	Metal	0.91	1.19
	Plaster	0.91	1.09
	Wood	0.91	1.29

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE

This sheet supplements Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are derived from measurements of real world archived paint samples collected during the EPA/HUD field evaluation study, and from data collected during testing in January 1995 and in September 1995. The field evaluation data were collected from approximately 1,200 test locations using two instruments both with radiation sources installed in April 1993. See *A Field Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995 for further information. The archival testing data were collected from approximately 150 test locations using two instruments. The instrument that was used in January had a radiation source installed in July 1994 and the instrument that was used in September 1995 had a radiation source installed in January 1995. All of the instruments mentioned had 30 mCi initial strengths.

OPERATING PARAMETERS

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK

The calibration of the XRF instrument should be checked using the film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instruments into control before XRF testing proceeds

EVALUATING THE QUALITY OF XRF TESTING

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multi-family housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten retest XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. There were 88 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, none had XRF readings less than 1.0 mg/cm^2. These data are for illustrative purposes only. Bias and precision ranges are provided to show the variability found between machines of the same model.

MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	BIAS RANGE[P] (mg/cm^2)	PRECISION[*] (mg/cm^2)	PRECISION RANGE[P] (mg/cm^2)
0.0 mg/cm^2	Brick	0.0	(0.0, 0.0)	0.1	(0.1, 0.1)
	Concrete	0.0	(0.0, 0.0)	0.1	(0.1, 0.1)
	Drywall	0.0	(0.0, 0.0)	0.1	(0.1, 0.1)
	Metal	0.0	(-0.1, 0.1)	0.1	(0.1, 0.1)
	Plaster	0.0	(-0.1, 0.0)	0.1	(0.1, 0.1)
	Wood	0.0	(0.0, 0.0)	0.1	(<0.1, 0.1)
0.5 mg/cm^2	Brick	0.1	(0.0, 0.2)	0.3	(0.3, 0.3)
	Concrete	0.1	(0.0, 0.2)	0.3	(0.2, 0.3)
	Drywall	0.1	(0.0, 0.2)	0.3	(0.1, 0.3)
	Metal	0.1	(0.0, 0.3)	0.3	(0.3, 0.3)
	Plaster	0.0	(-0.1, 0.2)	0.3	(0.1, 0.3)
	Wood	0.1	(0.1, 0.2)	0.3	(0.3, 0.3)
1.0 mg/cm^2	Brick	0.2	(0.0, 0.4)	0.4	(0.4, 0.5)
	Concrete	0.2	(0.0, 0.4)	0.4	(0.3, 0.5)
	Drywall	0.2	(0.1, 0.4)	0.4	(0.2, 0.5)
	Metal	0.2	(0.0, 0.5)	0.4	(0.4, 0.5)
	Plaster	0.1	(-0.1, 0.3)	0.4	(0.1, 0.5)
	Wood	0.3	(0.1, 0.4)	0.4	(0.4, 0.5)
2.0 mg/cm^2	Brick	0.4	(0.0, 0.7)	0.6	(0.5, 0.6)
	Concrete	0.3	(0.0, 0.7)	0.5	(0.4, 0.6)
	Drywall	0.5	(0.3, 0.7)	0.5	(0.3, 0.6)
	Metal	0.4	(0.0, 0.8)	0.6	(0.5, 0.6)
	Plaster	0.2	(-0.3, 0.7)	0.5	(0.1, 0.6)
	Wood	0.5	(0.3, 0.7)	0.6	(0.5, 0.6)

[P]Ranges are provided to show the variability between machines of the same model.
[*]Precision at 1 standard deviation.

CLASSIFICATION OF RESULTS

XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, and negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range includes both its upper and lower bounds. Earlier editions of this *XRF Performance Characteristics Sheet* did not include both bounds of the inconclusive range as "inconclusive." While this edition of the Performance Characteristics Sheet uses a different system, the specific XRF readings that are considered positive, negative, or inconclusive for a given XRF model and substrate remain unchanged, so previous inspection results are not affected.

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7, Lead-Based Paint Inspection, of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead Hazard Control (L), U.S. Department of Housing and Urban Development, 451 Seventh St, S.W., Washington, DC 20410.

Performance Characteristic Sheet

EFFECTIVE DATE: September 25, 1995 EDITION NO.: 3

MANUFACTURER AND MODEL:

Make: *Warrington, Inc.*
Model: *Microlead I revision 4*
Source: ^{57}Co
Note: This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS

Nominal Reading Time is 15 seconds.

XRF CALIBRATION CHECK LIMITS

0.4 to 1.6 mg/cm^2 (inclusive)

SUBSTRATE CORRECTION:

For XRF results below 4.0 mg/cm^2, substrate is correction recommended for:

Brick, Concrete, Drywall, Metal, and Wood.

Substrate correction is not needed for:

Plaster.

INCONCLUSIVE RANGE OR THRESHOLD

DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE in mg/cm^2
Results corrected for substrate bias on all substrates except plaster	Brick	0.9 to 1.2
	Concrete	0.6 to 1.3
	Drywall	1.0 to 1.0
	Metal	1.0 to 1.3
	Plaster	0.8 to 1.5
	Wood	1.0 to 1.5

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from evaluation data collected during the EPA/HUD field evaluation study conducted from March through October 1993. The data were collected from approximately 1,200 test locations using five instruments with source dates ranging from March 1993 to October 1993. All five instruments had sources with 10 mCi initial strengths. The results of this study are reported in *A Field Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995.

OPERATING PARAMETERS

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If readings are outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instruments into control before XRF testing proceeds

SUBSTRATE CORRECTION VALUE COMPUTATION

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the paint film nearest 1.0 mg/cm^2 for substrate correction is provided:

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over the NIST SRM paint film nearest to 1.0 mg/cm^2 at test locations that have been scraped bare of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a <u>bare</u> substrate area covered with the NIST SRM paint film nearest 1 mg/cm^2. Repeat this procedure by taking three more readings on a second <u>bare</u> substrate area of the same substrate covered with the NIST SRM.

- Compute the correction value for each substrate type where XRF readings indicate substrate correction is needed by computing the average of all six readings as shown below.

  <u>For each substrate type</u> (the 1.02 mg/cm^2 NIST SRM is shown in this example; use the actual lead loading of the NIST SRM used for substrate correction):

$$\left.\begin{matrix}\mathit{Correction}\\ \mathit{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \mathit{Reading}}{6} - 1.02\,mg/cm^2$$

- Repeat this procedure for each substrate requiring substrate correction in the house or housing development.

EVALUATING THE QUALITY OF XRF TESTING

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing. Use either 15-second readings or 60-second readings.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multi-family housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF results.

Compute the average of all ten retest XRF results.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. There were 143 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, 1 had an XRF reading less than 1.0 mg/cm^2. These data are for illustrative purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above already account for bias and precision. Bias and precision ranges are provided whenever significant variability was found between machines of the same model.

MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	BIAS RANGES (mg/cm^2)	PRECISION* (mg/cm^2)	PRECISION RANGES (mg/cm^2)
0.0 mg/cm^2	Brick	0.1	-	0.6	-
	Concrete	0.3	(0.0, 0.9)	0.6	(0.5, 1.2)
	Drywall	0.0	(0.0, 0.7)	0.3	(0.3, 0.5)
	Metal	-0.3	(-0.4, 1.1)	0.5	(0.3, 0.8)
	Plaster	0.1	(-0.3, 0.2)	0.5	(0.3, 0.6)
	Wood	0.4	(0.0, 0.5)	0.6	(0.5, 0.8)
0.5 mg/cm^2	Brick	-	-	-	-
	Concrete	0.3	(0.1, 1.1)	0.6	(0.5, 1.3)
	Drywall	0.1	(0.1, 1.3)	0.3	(0.3, 0.5)
	Metal	-0.2	(-0.3, 1.2)	0.6	(0.5, 0.8)
	Plaster	0.1	(-0.3, 0.1)	0.6	(0.4, 0.8)
	Wood	0.7	(0.2, 0.7)	0.7	(0.6, 0.8)

1.0 mg/cm^2	Brick Concrete Drywall Metal Plaster Wood	-0.3 0.3 0.2 -0.1 0.1 1.0	- (0.2, 1.2) (0.2, 1.9) (-0.1, 1.4) (-0.3, 0.3) (0.3, 1.0)	0.6 0.7 0.3 0.6 0.7 0.7	- (0.6, 1.4) (0.3, 0.5) (0.5, 0.8) (0.5, 1.0) (0.6, 0.8)
2.0 mg/cm^2	Brick Concrete Drywall Metal Plaster Wood	- 0.2 0.4 0.2 0.2 1.6	- (0.2, 1.5) (0.1, 3.1) (0.1, 1.7) (-0.3, 0.7) (0.6, 1.7)	- 0.8 0.3 0.7 0.9 0.8	- (0.7, 1.7) (0.3, 0.5) (0.5, 0.8) (0.6, 1.2) (0.7, 0.8)
*Precision at 1 standard deviation					

CLASSIFICATION OF RESULTS

XRF results are classified as positive if they are greater than the upper boundary of the inconclusive range, and negative if they are less than the lower boundary of the inconclusive range, or inconclusive if in between. The inconclusive range includes both its upper and lower bounds. Earlier editions of this *XRF Performance Characteristics Sheet* did not include both bounds of the inconclusive range as "inconclusive." While this edition of the Performance Characteristics Sheet uses a different system, the specific XRF readings that are considered positive, negative, or inconclusive for a given XRF model and substrate remain unchanged, so previous inspection results are not affected.

DOCUMENTATION:

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7, Lead-Based Paint Inspection, of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead Hazard Control (L), U.S. Department of Housing and Urban Development, 451 Seventh St, S.W., Washington, DC 20410.

A Nonparametric Method for Estimating the 5th and 95th Percentile Curves of Variable-Time XRF Readings Based on Monotone Regression

Prepared for the
HUD Office of Healthy Homes and Lead Hazard Control
by
QuanTech, Inc.

October 24, 2000

For some newer XRF instruments, readings are typically taken in a "variable-time" mode where the reading time depends on the lead level in the paint. As detailed in Appendix B of *Methodology for XRF Performance Characteristic Sheets* (EPA 747-R-95-008, September 1997), it is not appropriate to apply the parametric XRF measurement model to such readings.

Since the underlying distribution is unknown and suspected to be nonnormal, a nonparametric method, based on monotone regression, was developed to obtain estimates of the 5^{th} and 95^{th} percentile XRF readings, as functions of the true lead level. This method applies the assumption that the percentiles are increasing functions of the lead level. Monotone regression is the solution to a quadratic programming problem, and is obtained with the "pool adjacent violators" (PAV) algorithm. The solution takes the form of a step function, formed by percentiles of the data over subgroups in a way that the percentiles do not decrease. Although a monotone regression cannot be "smooth" in appearance, it will approximate the true response if the sample is large, and if the true response is itself a nondecreasing function. A full treatment of monotone regression can be found in *Statistical Inference Under Order Restrictions* (Barlow, Bartholomew, Bremner, and Brunk, Wiley 1972). The nonparametric 5th and 95th percentile curves are applied to determine the threshold/inconclusive range for the PCS for an instrument with variable-time readings. Because the method is nonparametric, there is typically insufficient data to develop thresholds/inconclusive ranges separately by substrate.

U. S. Department of Housing and Urban Development
Washington, D.C. 20410

OFFICE OF LEAD HAZARD CONTROL

October 1, 1996

MEMORANDUM

SUBJECT: Errata sheet for the Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995.

Page xvii - List of Appendices: Appendix 13.5 should read "EPA Water Information" (This Appendix, which was omitted in the original printing, is included in the reprint).

Page 1-13: 8. Waste
5 ppb (parts per billion)... should read: "5.0 ppm (milligrams/liter) by TCLP test."

Page 2-4: Telephone Correction:
HUD Office of Lead-Based Paint Abatement and Poisoning Prevention
1-202-755-1785

Page 2-12: Address correction:
Lead Poisoning Report
IAQ Publications
2 Wisconsin Circle, Suite 430
Chevy Chase, MD 20815

Page 5-18: Photo in Figure 5.3b should be rotated 90 degrees counter clockwise.

Page 5-21: Sixteen lines from the bottom, left column: replace "Chapter 7" with "Chapter 5."

Page 7-48: Thirteen lines from bottom, right column, should read: "The average of the 10 retest XRF results was computed to be 0.674 mg/cm^2 and the average of the 10 original XRF results was computed to be 0.872 mg/cm^2."

Page 7-50, Figure 7.20: Thirteen lines from the top: Should read "Compute the square of each of the ten original and ten retest XRF results."

Page 9-13, Table 9.3, Category II: Should read "Conduct exposure monitoring every 6 months."

Category III: Should read "Develop monitoring every 3 months."

NOTES:

The original printing of 16,000+ copies of the Guidelines was exhausted by December 1995. The Guidelines are now accessible on the Internet. Xerographic copies are available from HUD USER at 1-800-245-2691 for a fee of $45.00, including postage. CD-ROM versions will be available in October, 1996. A second printing of the document is expected to be available at HUD USER by Dec.15, 1996.

The following are accessible on the Internet at **http://www.hud.gov/lea/leadwnlo.html:**

1. Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, June 1995. (The Guidelines).

2. The Performance Characteristics Sheets (PCSs) for portable x-ray fluorescence lead detectors that have been evaluated by HUD. (The PCSs are referenced in Chapter 7 of the Guidelines.)

(The Office of Lead Hazard Control home page is located at http://www.hud.gov/lea/leahome.html)