

Chapter 14: Cleaning

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1. **Include cleaning in plans for the work.** Include written step-by-step procedures for precleaning, cleaning during the job, and daily and final cleanings in the project design or specifications, using information contained in this chapter. Assign responsibilities to specific workers for cleaning and for maintaining cleaning equipment. Have sufficient cleaning equipment and supplies *before* beginning work, including:
 - ◆ Detergent
 - ◆ Waterproof gloves
 - ◆ Disposable rags
 - ◆ Mops
 - ◆ Buckets
 - ◆ Vacuum (preferably HEPA-equipped) with attachments (crevice tools, beater bar for cleaning rugs, etc.)
 - ◆ Plastic bags for disposal of debris and heavy duty protective sheeting (of sufficient thickness to prevent puncture)
 - ◆ Debris containers (heavy duty plastic bags are adequate for most jobs)
 - ◆ Containers for dirty wash water
 - ◆ Shovels
 - ◆ Rakes
 - ◆ Water-misting sprayers
 - ◆ Heavy duty polyethylene sheeting (or equivalent) of sufficient thickness to prevent puncture (e.g., 6 mil).
2. **Restrict access to work area.** Do not allow residents to enter the work area until cleaning is completed and clearance is established.
3. **Clean before starting work.** If contamination is extensive, conduct precleaning of the dwelling unit and furnishings, if needed, before beginning paint-disturbing work. Move and/or cover all furniture and other objects.
4. **Conduct ongoing cleaning during the work.** Conduct ongoing, continual cleaning during high-dust jobs, including regular removal of large and small debris and dust. Decontamination of all tools, equipment, and worker protection gear is required before such items are removed from containment areas. Electrical equipment should be wiped and vacuumed, not wetted down, to minimize electrocution hazards.

5. **Clean at the end of each work day.** For high-dust jobs, schedule sufficient time (usually 30 minutes to one hour) for a complete daily cleaning, starting at the same time near the end of each work day after paint-disturbing activity has ceased.
6. **Wait one hour before final cleaning.** For final cleaning, wait at least 1 hour after active paint-disturbing activity and other dust-generating work has ceased to let dust particles settle.
7. **Clean and remove protective sheeting used for dust containment.**
8. **Use both vacuuming and wet cleaning.** Clean all surfaces, using the two basic cleaning methods, vacuuming and/or wet cleaning. Cleaning procedures may vary, depending on the amount of dust generated by the job and the smoothness of the surfaces to be cleaned. A three-phase, vacuum-wet cleaning-vacuum cycle is recommended for high-dust jobs with some rough or porous surfaces. For low-dust jobs with all smooth surfaces, wet cleaning may be adequate to pass clearance. Surfaces that are badly soiled often require extra manual effort, involving hand wiping until no more visible dirt comes up. Other cleaning methods are acceptable, as long as clearance criteria are met and workers are not overexposed.
9. **A HEPA vacuum is required if a vacuum is used.**
10. **Follow the cleaning sequence, "ceiling to floor and out the door."** For high-dust jobs, vacuum all surfaces in the room (ceilings, walls, trim, interior window sills, window troughs, hard surface floors, and other horizontal surfaces). Start with the ceiling and work down, moving toward the entry door ("ceiling to floor and out the door"). Completely clean each room before moving on. For low-dust jobs, it is not necessary to clean ceilings and walls, except that they should be cleaned if they were the surfaces on which the work was done. See Chapter 8 for a description of low-dust and high-dust jobs.
11. **Use a common detergent, not TSP (Trisodium Phosphate).** Use a standard household detergent, not a high-phosphate detergent, to dislodge any ground-in contamination. Use either the three-bucket system described in this chapter, or a use-once-and-toss system, as also described below. If buckets are used.
12. **Inspect visually.** After final cleaning, the supervisor should perform a visual inspection to ensure that all visible dust and debris has been removed. Reclean if necessary.
13. **Paint and/or seal, if necessary.** Paint or otherwise seal treated surfaces and interior floors, if necessary.
14. **Final wet cleaning.** After painting that has followed high-dust jobs, conduct a final wet cleaning of horizontal surfaces.
15. **Clearance.** Workers should stay out of cleaned rooms until after the clearance examination. Conduct a clearance examination (see Chapter 15). (Clearance, while recommended by HUD, is not required by regulations in certain circumstances, such as for *de minimis* projects under HUD's Lead Safe Housing Rule or under the EPA's Renovation, Repair, and Painting Rule., which requires cleaning verification for most projects; see Chapter 11.)
16. **Repeat cleaning and clearance (or cleaning verification), if necessary. Continue clearance testing (or cleaning verification) until the dwelling unit or work area passes.** If the unit fails, repeat cleaning of all of the surfaces that failed and all other surfaces represented by the surfaces that failed.
 - ◆ As an incentive to conduct ongoing cleaning and a thorough final cleaning, the cost of repeated cleaning after failing to pass clearance or cleaning verification should be borne by the contractor, not the owner, as a matter of the job specification.

I. Introduction

This chapter describes cleaning procedures to be employed before, during and following lead-based paint abatement, interim controls and other renovation or maintenance work that may create lead-contaminated dust. Dust removal as an interim control measure is covered in Chapter 11.

All lead hazard control activities and many other paint-disturbing jobs can produce dangerous quantities of lead-contaminated dust. Unless this dust is properly removed, a dwelling unit may be more hazardous after the work is completed than it was originally. Whenever possible, ongoing and daily cleaning of settled dust during lead hazard control and renovation projects is recommended. Ongoing and daily cleaning are also necessary to minimize worker exposures by removing excess dust from the work area.

Cleaning is the process of removing visible dust and 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 the work or generated by the work 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.

The cleaning methods and procedures described in this chapter are for hard surfaces. Workers should not attempt to clean carpets or rugs following lead hazard control or other paint disturbing work unless they know that the carpets are new and therefore are not likely to contain lead-contaminated dust embedded in the fibers and backing, or unless the workers are prepared to spend hours vacuuming the carpeting over and over again until the deeply embedded dust is removed. Vacuuming an old carpet may bring some of the embedded dust to the surface of the carpet, increasing the dust-lead loading levels on the surface and thus increasing the likelihood that children will be exposed to lead in the dust and that the carpet will *not* pass clearance (Ewers, 1994). Therefore it is better to clean and carefully remove the protective sheeting that is over the carpet (as described later in this chapter), and then have clearance dust-wipe sampling performed on the carpet. If lead levels on the surface of the carpet are found to exceed the clearance standard (which is the same as the hazard standard in EPA regulations), it will be necessary to either thoroughly clean the carpet or dispose of it. See Section V.B.2 of Chapter 11 for guidance on dust removal from carpets.

A. Performance Standard

The cleaning methods described in this chapter are designed to achieve clearance. (The clearance examination, which includes a visual assessment and dust sampling, is described in Chapter 15.) Although these cleaning methods 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.

According to EPA (40 CFR 745.227(d)(8)(viii)) and the HUD regulations (24 CFR 35.1320(b)(2)(i)) that follow the EPA regulations, the permissible amount of lead in dust remaining on each of the following surfaces following lead hazard control work – the clearance standards – must be less than the following levels:

- ◆ 40 µg/ft² on floors (both hard-surfaced and carpeted),
- ◆ 250 µg/ft² on interior window sills (stools), and

- ◆ 400 µg/ft² on window troughs (the area where the sash sits when closed, plus the area of the exterior sill between the sash and the frame for the screen and/or storm window, if present).

These levels are based on wipe sampling. They apply to single-surface wipe samples and to composite wipe samples with only two subsamples. To evaluate the results of a composite sample with more than two subsamples, the standards listed above must be divided by one-half the number of subsamples. (Note that these *Guidelines* do not recommend the use of composite wipe sampling; see Chapter 15.)

If state, local or tribal standards are more stringent, they apply. Note that EPA and HUD require clearance of window troughs for abatement and for other lead hazard control work covered by HUD's Lead Safe Housing Rule above *de minimis* amounts. A clearance examination includes wipe sampling of window troughs as well as interior window sills and floors.

Clearance is not easily attained. Over 20 percent of the dwellings enrolled in the evaluation of the HUD Lead Hazard Control Grant Program failed to pass clearance on the first try, and the clearance levels applicable at the time of the study were at least twice as high as those listed above and thus less difficult to achieve (NCHH, 2004).

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 unacceptably high levels of lead in dust particles and require special cleaning procedures.

C. Difficulties in Cleaning

Although cleaning is an integral and essential component of any lead hazard control activity, it is also the part of the activity that when conducted improperly is most likely to cause clearance failure. Common causes for this failure include worker inexperience, high dust-producing methods, rough surfaces, and tight deadlines.

1. Worker Inexperience

To understand the level of cleanliness required to meet the established clearance standards, workers often require a significant reorientation to cleaning. Many construction and maintenance workers are used to cleaning only dust that they can see, not the invisible dust particles that are also important to remove.

Any worker performing cleaning for either clearance or cleaning verification needs training and hands-on practice in the stringent levels of cleaning required to pass clearance or cleaning verification.

Many of the cleaning methods described in this chapter are not standard, traditional procedures for general home improvement contractors and maintenance crews. Therefore, owners and managers must ensure that contractors and crews follow the specialized cleaning procedures recommended herein or specially designed alternative procedures, even though some steps may appear to be redundant or unnecessary. These methods have been shown to be feasible and effective in many situations, and skipping steps in the cleaning procedures may increase the possibility of failing clearance and harming children.

2. High Dust-Producing Methods and/or Inadequate Containment

High dust-generating methods during the hazard control or renovation work, inadequate dust containment, and poor work practices can all make achievement of clearance particularly difficult. Dust generated by the work should be contained, to the extent possible, to the inside of work areas. Floors and any furnishings left in the work area should be carefully covered with impermeable protective sheeting. Inadequately constructed or maintained containment or poor work practices will result in additional cleaning efforts, due to dust that has blown out or been tracked out of the work area. Work practices necessary to prevent spreading of dust throughout a dwelling (e.g., by tracking dust out of work areas) are essential. See Chapter 8 for guidance on worksite preparation and other work practices.

3. Rough Surfaces

It is often difficult to dislodge dust in the crevices of rough, pitted or cracked surfaces, yet small amounts of dust in such locations can be picked up in clearance wipe samples and cause clearance failure. Making surfaces smooth and cleanable increases the likelihood of achieving clearance.

4. Rushing to Meet Tight 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 projects are often the result of repeated, unplanned recleanings that are necessitated by inadequate containment and careless work practices, including rushed clean-ups.

II. Coordination of Cleaning Activities

A. Checklist

The owner or contractor may use the following cleaning checklist before any lead hazard control or renovation activity.

- ◆ Is the critical importance of cleaning understood by the project supervisor / certified renovator / abatement supervisor, and all workers on the job?
- ◆ Have all workers been trained for hazard control work or lead-safe work practices?
- ◆ Have all workers carefully studied the step-by-step procedures for precleaning before the work begins (if needed), in-progress cleaning, and daily and final cleanings?
- ◆ Have the before-work, daily, and final cleanings been scheduled properly and coordinated with the other participants in the project?
- ◆ Have cleaning equipment, materials and supplies been obtained?
- ◆ Do the workers know how to operate and maintain special cleaning equipment, do they have directions for the proper use of all cleaning materials, and are they receiving adequate supervision of their cleaning activities?

- ◆ Are all workers properly protected during the cleaning processes (see Chapter 9)?
- ◆ Have provisions been made to properly handle and dispose of waste (see Chapter 10)?
- ◆ Have visual inspections and clearance testing (or cleaning verification) been arranged (see Chapter 15)?
- ◆ Are the clearance (or cleaning verification) criteria to be met fully understood?
- ◆ Have all appropriate surfaces been properly painted or otherwise sealed?

B. Equipment Needed for Cleaning

The following equipment is needed to conduct cleaning: a high-efficiency particulate air (HEPA) filter vacuum cleaner, and attachments (crevice tools, beater bar or agitator head for cleaning carpets and rugs, etc.) (see Figure 14.1); detergent; water-proof gloves; rags, mops, and buckets; heavy-duty plastic bags (preferably 6-mil) for debris; waste water containers; shovels (and rakes, if needed) for debris removal; water-misting sprayers; and disposable, impermeable protective sheeting, such as polyethylene plastic sheeting of a thickness to prevent puncture (e.g., 6-mil).



FIGURE 14.1 There are many brands of HEPA vacuums on the market.

C. Waste Handling and Disposal

Generally, dirty water used in cleaning should be disposed of down a toilet. Do not pour dirty water onto the ground or down a storm sewer. Vacuum and/or wet clean protective sheeting. Vacuum contaminated disposable clothing. Wrap or bag (with heavy-duty plastic) disposable clothing and protective sheeting, architectural debris, paint strippings, paint chips and dust, vacuumed debris and vacuum filters, rags, and other material. Seal the packages with tape and store them temporarily in a secure location (such as a locked large metal bin for refuse, e.g., a Dumpster®). Dispose of the waste in an appropriate State-permitted solid waste facility, unless the waste is exempt from that requirement. See the next paragraph and Chapter 10 for further information on waste disposal.

EPA has stated that waste generated by lead-based paint activities in housing falls under the household waste exemption in the Resource Conservation and Recovery Act (RCRA) (EPA, 2000b). The household waste exemption applies to waste generated by contractors as well as to waste generated by residents, and it applies to all lead-based paint activities, including abatement, interim control, and renovation and remodeling of housing. Types of housing included in the household waste exemption are single-family homes, apartment buildings, public housing, and military barracks. HUD and EPA both recommend that the lead-safe practices described above and in Chapter 10 be followed to reduce the likelihood that household waste will contaminate the environment.

States and local governments may institute hazardous waste requirements applicable to lead activities in housing. Owners and contractors should determine what, if any, state or local regulations apply, and should comply with them.

III. Cleaning Methods

Two basic cleaning methods have proven effective, especially when used concurrently: (1) vacuuming, using a high-quality vacuum cleaner equipped with a HEPA exhaust filter, and (2) wet cleaning with a household detergent and rinsing. Trisodium phosphate (TSP) is not recommended, as explained below in Section III.D. A proven cleaning procedure is a three-pass system, in which the surface is first vacuumed to remove as much dust and small debris as possible, then wet-cleaned to dislodge fine dust, and finally vacuumed again to remove any remaining particles. However, it may not be necessary to use all three steps on all surfaces. As explained in Section V below, research indicates that the way these methods should be used depends on whether the work was a high-dust or low-dust job and whether the surfaces being cleaned are smooth or rough (Dixon, 2004; California Dept. of Health Services, 2004).

A. Vacuums: HEPA vs. non-HEPA

If a vacuum cleaner is used during lead hazard control projects, renovation projects, or other work covered by OSHA regulations, the vacuums must be a HEPA vacuum. This section provides technical information on the various types of vacuum cleaners.

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. (Note that, when HEPA vacuums are specified by regulations or specifications, ULPA filter vacuums may be used because of their greater dust collection efficiency.)

Experts have recommended using HEPA vacuums to cleanup leaded-dust because conventional vacuums, without the high efficiency filter, may send very fine lead-dust particles out the exhaust and back into the indoor environment. One study in 1992 supported this view (CMHC, 1992). More recent studies, however, have found that the difference in collection efficiency between HEPA and non-HEPA vacuums is not significant (California Department of Health Services, 2004; Rich, 2002; and Yiin, 2002).

There is more to a vacuum than the filter. Other important factors that determine the effectiveness of a vacuum are particle lifting velocity (which is a function of the motor, the design of the suction tool, and the extent to which the rest of the system does not release air before it is supposed to), quality of construction (which may determine the durability of the machine and whether there are air pressure leaks before the filtration), and whether the vacuum has special tools, such as a crevice tool (see Figure 14.1). These *Guidelines* recommend that a high-quality HEPA vacuum be used if possible; however, a high-quality household or commercial vacuum should be used if a HEPA vacuum is not available. The California study cited in the previous paragraph found that a HEPA vacuum was actually less effective in removing dust-lead from vinyl floors than non-HEPA vacuums, probably because the suction tool was not well designed for the job. Also, filters are available that, while not HEPA, are better than those that formerly were standard on household and commercial vacuums. One additional benefit of a HEPA filter is that it may catch other contaminants in the residential environment, such as allergens, in addition to very fine lead particles.

B. HEPA Vacuums

This section provides background information on HEPA vacuums.

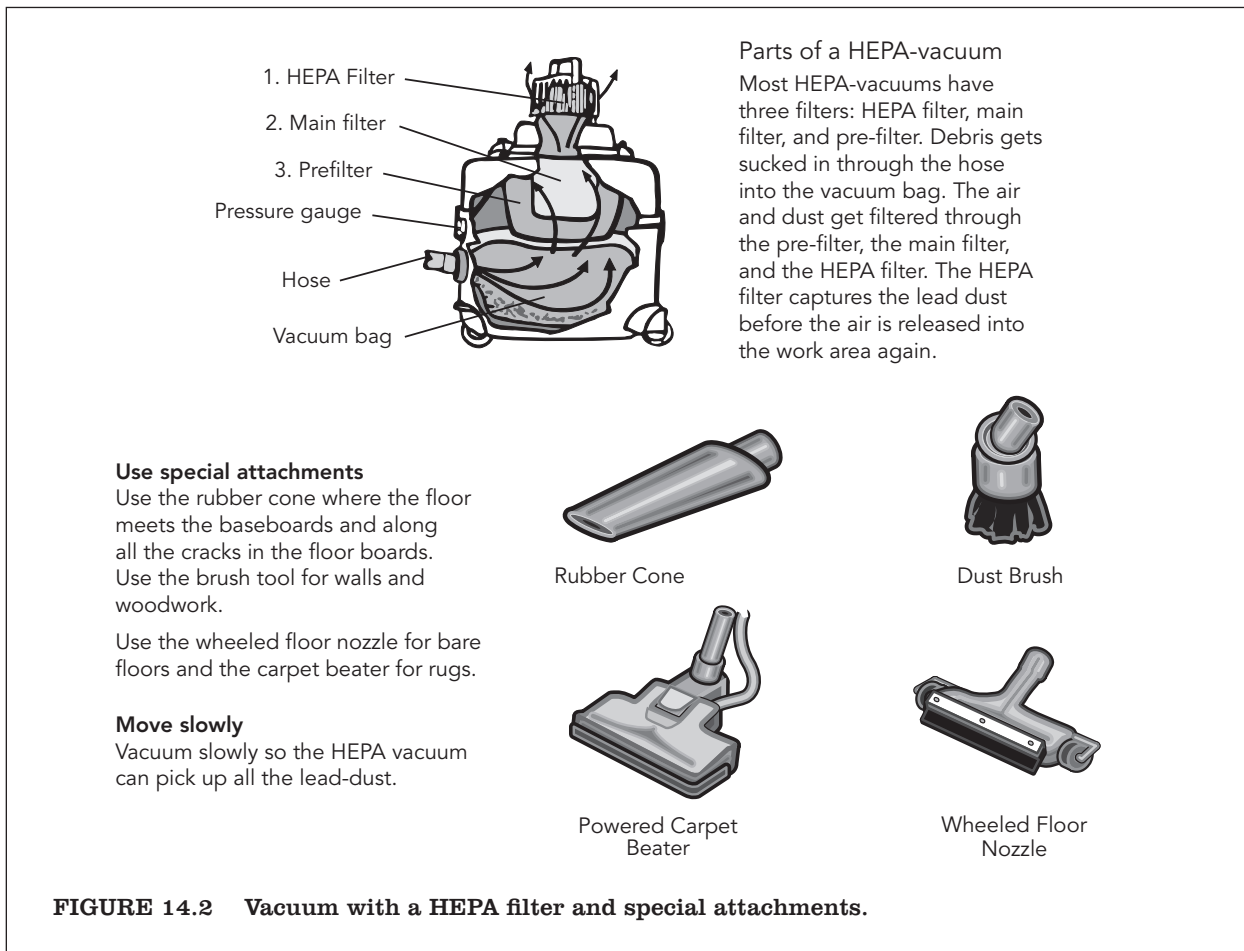
Operating Instructions

There are 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, angular tools, etc.), as is true with conventional vacuums (see Figure 14.2).



Selecting Appropriate Size(s)

HEPA vacuums are available in numerous sizes, ranging from a small lunch bucket-sized unit, which may be carried like a backpack, up to truck-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 (see Figure 14.3).

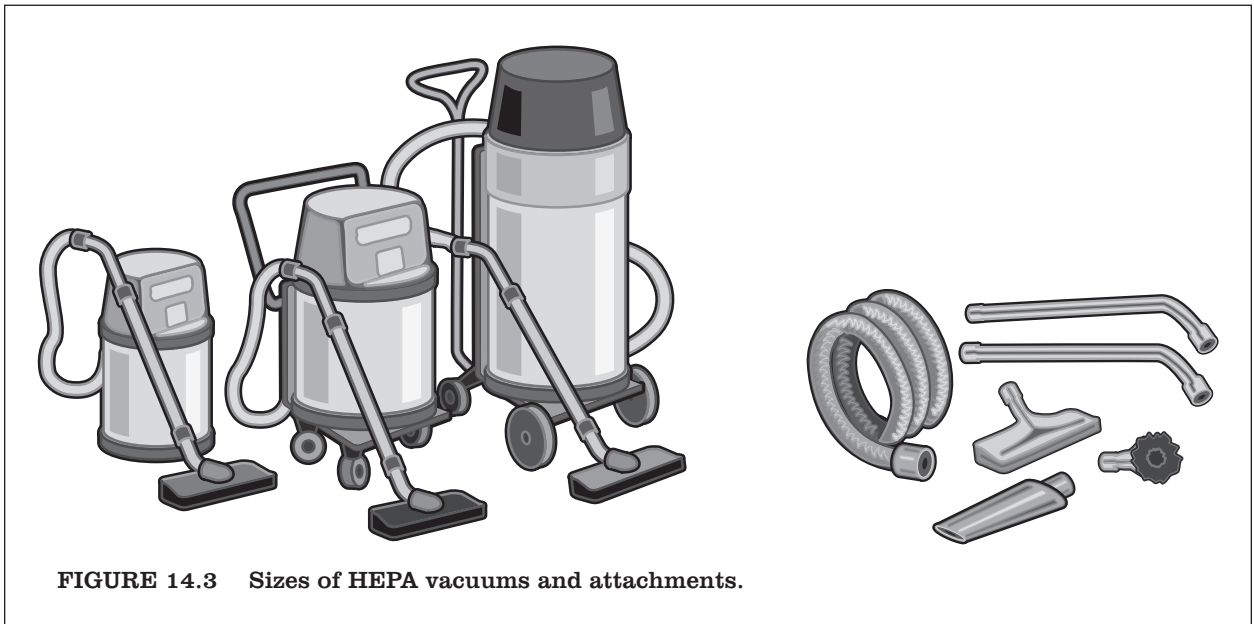


FIGURE 14.3 Sizes of HEPA vacuums and attachments.

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 air stream, 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.

Wet-Dry HEPA Vacuums

Wet-dry HEPA vacuums are equipped with a special shut-off float switch to protect the electrical motor and the HEPA filter from water contact. Some hazard control contractors have found these vacuums to be particularly effective in meeting clearance standards and in avoiding damage to vacuum equipment.

C. Emptying the Vacuum

Used filters and vacuumed debris should be handled and disposed of in accordance with guidance provided in Chapter 10. Emptying should be done in the containment area or in a secure

and controlled space off-site (such as at the contractor's facility). The vacuum should be placed on a large sheet of plastic to contain dust and debris released during the opening, emptying and replacement steps. Vacuum users should use extreme caution when opening the 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. Operators should wear protective clothing and appropriate respiratory protection when performing this maintenance function

D. Wet Cleaning

It is recommended that a general all-purpose household cleaner be used for wet cleaning. Cleaners made specifically for lead may also be useful, although one study found that lead specific cleaners performed no better than all-purpose household cleaners, and that no published studies have shown lead-specific cleaners to be more effective than all-purpose cleaners (Lewis, 2006). Cleaning with water alone can also be effective, but detergents and lead-specific cleaners are recommended because they probably keep dust and soil in suspension better than plain water (EPA, 1997a; EPA, 1998). HUD does not recommend trisodium phosphate (TSP). Not only has TSP been banned in some areas because of negative effects on the ecology of aquatic systems, but research indicates that phosphate content is not associated with effectiveness in removing lead-contaminated dust from residential surfaces (EPA, 1997a; EPA, 1998, Lewis, 2006).

Research also indicates that the effort put into the cleaning, i.e., the amount of pressure applied to the surface and the thoroughness of the cleaning, may be more important than the choice of cleaning agent (EPA, 1997a). Note that 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.

Proper procedures for using detergents 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.

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 (including several clean mop heads), brushes, and rags. Follow manufacturer's instructions for the equipment used. Using the proper equipment on each surface is essential to the quality of the wet wash process.

Wet Cleaning Procedures

Some wallpaper surfaces may be damaged by wet washing with detergents. Test a small area first. If it appears that damage will occur, try another detergent, use plain water, or as a last resort clean by repeated vacuuming only.

Use of string mops is recommended for floors. Sponge mops may only push the lead around on the floor, not pick it up. A three-bucket system is recommended with mops (see Figure 14.4). The first bucket contains the cleaning solution, the second includes a mop squeezer, and the third



FIGURE 14.4 Three-bucket cleaning system.

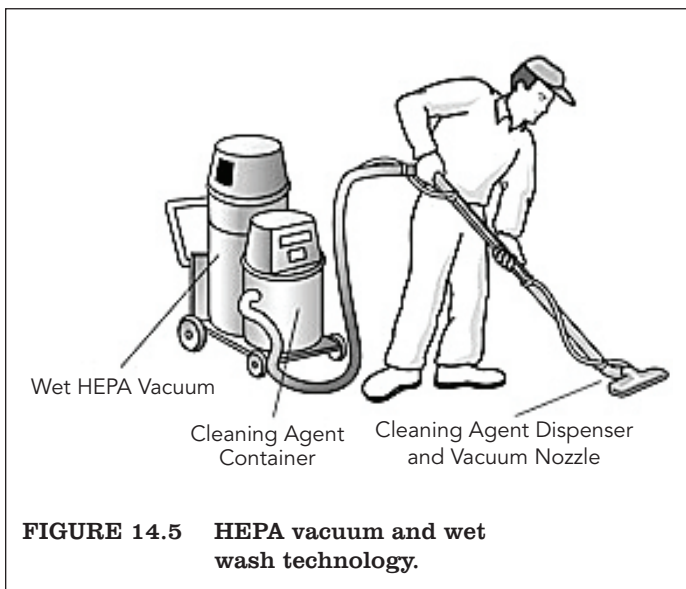


FIGURE 14.5 HEPA vacuum and wet wash technology.

contains rinse water. Use a clean mop head for rinsing. Three-bucket system is also discussed below under Section V.E, Final Cleaning.

Some experienced contractors have used, instead of the three-bucket mopping system, a “wet, wipe and toss” procedure. This method requires a large quantity of clean rags, which are put into a bucket of detergent and water solution to wet them. The worker pulls a rag from the bucket, wrings it out over the bucket, *wipes* clean an area of about 16 sq. ft., *tosses* the used rag away, pulls another rag, and so on. If the detergent requires rinsing, repeat with clean water. For sills, troughs, counters, shelves, walls and tight floor spaces like behind toilets, the wet wipe and toss method is the best alternative to the mop. Some contractors prefer the method even for large floor areas. A major advantage is that it avoids the potential problem of recontaminating the area by cleaning with dirty water. This method may also use less water than a mop, which can be an advantage for some household areas. The rags are commercially available, disposable cloth scraps or paper products. Cloth rags usually are not cleaned and reused because of the risk of contaminating other laundry (White, 2003). Alternatively, some people use wet-dry HEPA vacuums (see Figure 14.5).

Changing the 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. (Note that this issue is largely avoided if the “wet, wipe and toss” method is used, because each rag is used only once.) However, regard-

less 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 more than 1000 square feet. Dirty cleaning mixture should be handled and disposed of in accordance with guidance provided in Chapter 10. Wash water should never be poured onto the ground. It is sometimes filtered, and usually poured down a toilet.

IV. Cleaning Procedures Before and During the Work

The special cleaning procedures to be followed *before and during* a hazard control or renovation project are discussed in chronological order below. Skipping steps in the process may result in failure to meet clearance standards.

A. Cleaning Before Work Begins

Precleaning (i.e., cleaning conducted before lead hazard control or other paint-disturbing work is begun) is necessary only in dwelling units or common areas that are heavily contaminated with lead in dust and paint chips. Precleaning involves the removal of debris and paint chips, followed by vacuuming (see Figure 14.4). These steps may be followed by removal of occupant personal possessions, furniture, or carpeting, depending on the worksite preparation being used (see Chapter 8). If the furniture will not be cleaned, it should be removed from the area and/or covered with protective sheeting prior to beginning the precleaning procedure. Carpeting (including rugs) should always be misted before 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, with necessary boxes, packing materials, and staff, to complete this activity before lead hazard control work begins. As a last resort, the contractor or the maintenance staff may pack any remaining belongings and carefully seal and move the boxes from the work area.

Once the residents' possessions that can be removed from the work area have been removed, the contractor shall ensure that the residents leave the work area and do not return until after clearance (or cleaning verification) has been passed.

Clearance should be conducted after final cleaning but *before* resident's items are moved back in. (See Chapter 15.) Following cleaning and clearance, the contractor should return all resident-owned items to their appropriate places. Leaving these tasks to the contractor or the management may be expensive and inefficient, since the contractor will need to be insured against the possibility that the occupant's belongings may be damaged.

B. Ongoing Cleaning During the Job

On all jobs, it is good practice to regularly clean the work area and the travel pathways used by workers, by removing debris and vacuuming dust during the work shift, in order to keep the areas free of excessive accumulations of dust and/or debris.

For high-dust jobs, when a large amount of paint chips or dust is being generated, continual debris removal and vacuuming of dust during the work day may be necessary to minimize worker exposure and tracking of dust and paint chips from one area to another. Extra attention should be paid to ongoing cleaning so that daily clean-up goes quickly.

Research conducted shortly before the publication of this edition of these *Guidelines* on whether if differences exist between two new and two older methods for removal of lead-contaminated dust from three wood surfaces of varying roughness or texture found that the reduction in lead dust achieved by vacuuming and wet wiping, the traditional method, was somewhat greater and more consistent than the electrostatic dry cloth and wet Swiffer-brand mop, a newer method. (Lewis, 2012) As noted in that paper, the wipe product industry continues to develop products; future cloths may have higher dust reduction efficiencies.

C. Daily Cleaning

Cleaning activity should be scheduled at the end of each work day when all active work has ceased, whether or not this is a regulatory requirement for the particular job. Sufficient time should be allowed for a thorough and complete cleaning, usually about 30 minutes to an hour, less if cleaning has been done throughout the work shift. (If work is being done in multiple shifts, it is recommended

that there be a cleanup at the end of each shift.) Daily cleaning helps achieve clearance dust-lead levels by minimizing problems that may otherwise occur during final cleaning, and it limits worker exposures. Daily cleaning can be skipped within vacant buildings. Daily cleaning is essential when occupants will return in the evening to occupy spaces outside the containment area. Under no circumstances should dust or debris from the project, or protective sheeting be left outside overnight, even if the dwelling is vacant. (Storing bagged dust and debris from the project, and protective sheeting in secure containers outside is permissible.) Daily cleaning should consist of:

- ◆ Wrapping or bagging dust and debris from the project, and storing it in a secure area
- ◆ Vacuuming protective sheeting on floors and furnishings
- ◆ Vacuuming other horizontal surfaces
- ◆ Vacuuming and wet cleaning floors of hallways and rooms used as pathways by workers to travel outside the work area, if such spaces are accessible to residents during non-work hours
- ◆ Cleanup of exterior debris and paint chips, and removal of exterior protective sheeting
- ◆ Patching and repairing protective sheeting
- ◆ Putting any protective sheeting that is removed in a secure place

1. Large Debris

Large demolition-type debris (e.g., doors, windows, trim) should be wrapped in heavy duty (6-mil plastic or similar sheeting that will resist puncture), 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 should be designated as a temporary waste-storage area. Covered, secured, and labeled dumpsters placed on or near the property may be used. (See Chapter 10.)

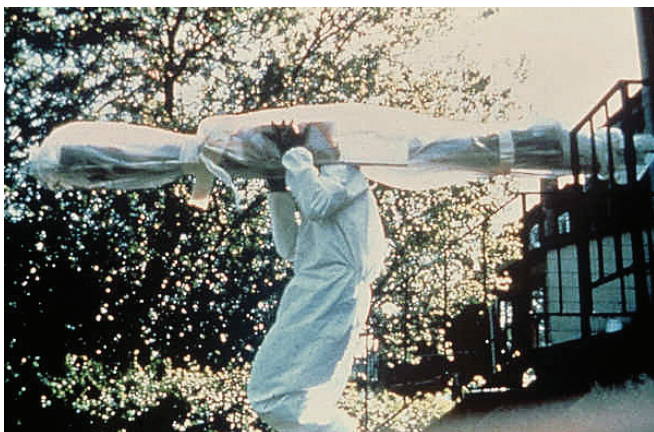


FIGURE 14.6 Removing large debris.

2. Dust and Small Debris

Dust and small debris should be vacuumed and wet wiped or mopped, or, alternatively, after being misted with water, it should be swept up, collected, and disposed of properly. The swept debris should be placed in heavy duty (double 4-mil or single 6-mil polyethylene plastic bags or equivalent), properly sealed, and moved to the designated trash storage area. Trash bags should not be overloaded, as overloaded bags may rupture or puncture during handling and transport.

3. Exterior Cleaning

Exterior and interior areas potentially affected by exterior lead hazard control or other paint-disturbing work should

be protected with a containment system (see Chapter 8). Because weather can adversely affect the efficacy of exterior containment, the protective sheeting on the ground should be removed at the end of each work day. On a daily basis, as well as during final cleaning, the immediate exterior 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 (see Figure 14.7). Vacuuming is appropriate for hard exterior surfaces, but not for soil.

4. Worker Protection Measures

Worker protection measures are discussed in Chapter 9. Studies indicate that during daily cleaning activities, especially while sweeping, lead hazard control workers may be exposed to high levels of airborne dust. When appropriate, workers should wear protective clothing and equipment respiratory protection.

5. Maintaining Containment

The integrity of the protective sheeting used in a lead hazard control project should be maintained. During their daily cleaning activities, workers should monitor the sheeting and immediately repair any holes or rips with durable sheeting (e.g., 6-mil polyethylene) and duct tape.



FIGURE 14.7 Exterior clean up.

V. Final Cleaning Procedures

Before treated surfaces can be painted or sealed, final cleaning should 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 or other paint-disturbing work has ceased in the room.

A. 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 containment areas should be implemented, as described below and in Chapter 9.

Work clothing, work shoes, and tools should not be placed in a worker's automobile unless they have been laundered, cleaned, or placed in sealed bags. All vacuums and tools that were used should be wiped using rags wetted with detergent solution. In addition, workers should dispose of the rags.

Consumable/disposable supplies, such as mop heads and rags, should be replaced after each dwelling is completed. Using a contaminated mop head can be a major impediment to achieving clearance. Soiled items should be handled and disposed of in accordance with guidance provided in Chapter 10.



FIGURE 14.8 Vacuuming the floor containment.

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 vacuuming followed by wet wiping.

B. Cleaning and Removal of Protective Sheeting

Protective sheeting should be cleaned before being removed. This minimizes the generation of airborne dust and/or spillage of dust and debris while the sheeting is being folded up and bagged. Remove large debris as described above in Section IV.C.1. Clean dust and small debris by vacuuming and wet wiping or mopping (see Figure 14.8). Remove upper-level sheeting, such as that on cabinets and counters, first, after it has been cleaned. When removing sheeting, it should be carefully rolled or folded up so that the more-contaminated side is inward. Next, remove sheeting from the floor. All protective sheeting should be folded carefully from the corners/ends to the middle to trap any remaining dust.

Protective sheeting used to isolate work areas from other spaces should remain in place until after the cleaning and removal of other sheeting. These should then be vacuumed, wet-wiped, and removed last.

Removed sheeting 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 removal process usually requires workers to use protective clothing and respiratory protection, especially for high-dust jobs.

C. Vacuuming and Wet Cleaning

After the protective sheeting has been removed, the entire area should be cleaned, using the combination of vacuuming and wet cleaning recommended below. The area to be cleaned is the area that will be subject to the clearance examination, including all rooms, hallways, stairways, elevators, etc. used by workers as passageways to and from the work area, plus areas used to store tools and bagged or packaged debris from the work. (See Section IV.A of Chapter 15 regarding the determination of the clearance area.) Porches, sidewalks, driveways, and other hard exterior surfaces should be vacuumed if exterior hazard control or other paint-disturbing work was conducted, or if debris was stored or dropped on such surfaces.

Interior cleaning for high-dust jobs should begin on the ceilings and end on the floors (following the catch phrase “ceiling to floor and out the door”) For low-dust jobs, it is not necessary to clean ceilings and walls unless paint-disturbing work has been conducted on those surfaces. (See Chapter 8 for a description of low-dust and high-dust jobs.) Cleaning should be sequenced to avoid passing through rooms already cleaned, with the dwellings’ entryway cleaned last.

Surfaces frequently cleaned include ceilings, walls, floors, window panes and mullions, interior window sills, window troughs, exterior window 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.

Surfaces such as porous concrete, old uncoated, worn and 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.

After a high-dust job, the recommended first cleaning step is vacuuming to pick up large amounts of dust and small debris. All surfaces should be vacuumed: ceilings, walls, windows, doors, shelves, floors, etc. Research indicates that walls and ceilings retain leaded-dust after lead hazard control projects (Dixon, 2004). Vacuuming is especially important if some of the surfaces are rough. The second step is a wet cleaning, using the wipe or mopping method, as described above in Section III.D. Wet cleaning is probably the most effective method of picking up small particles of lead-dust (California Dept. of Health Services, 2004). (Be sure to vacuum and wet-wipe window troughs, because they are tested for dust-lead by the clearance examiner.) Vacuuming and wet-cleaning once should be sufficient if the surfaces are smooth, but it is recommended that rough surfaces be vacuumed a second time, after the wet-cleaned surface has dried, to increase the likelihood of achieving clearance. As an alternative to the second vacuum pass, some contractors have found that better clearance results on rough surfaces are achieved by thoroughly wiping by hand the wet-cleaned surface until it is dry, using disposable towels (Rupp, 2003). The amount of wiping needed to clean a surface may depend on how soiled it is, as well as its smoothness or roughness.

After low-dust jobs, the first pass with the vacuum is usually not necessary, especially if the surface is smooth. It is often effective to begin with a wet cleaning. But if there is a substantial amount of dust or small debris on the surfaces to be cleaned, begin with the vacuum and then go to the wet cleaning. This will make the wet cleaning more efficient. Vacuuming following the wet cleaning is recommended for rough surfaces but may not be necessary for smooth surfaces. It is generally not necessary to clean ceilings and walls after low-dust jobs, unless paint disturbing work has been conducted on those surfaces. Remember to clean the window troughs. These recommendations are summarized in Table 14.1.

Table 14.1 Summary Guidance on Cleaning Methods by Dustiness of Work and Condition of the Surface.

Conditions	Cleaning Procedure	Surfaces
High-dust job, with some rough surfaces	Vacuum, wet clean, vacuum (after surface is dry)	All surfaces, including ceilings, walls, and window troughs.
High-dust job, with all smooth surfaces	Vacuum, wet clean	
Low-dust job, with some rough surfaces	Vacuum (optional, depends on amount of dust), wet clean, vacuum (after surface is dry)	All surfaces except ceilings and walls, unless those surfaces have been treated.
Low-dust job, with all smooth surfaces	Vacuum (optional, depends on amount of dust), wet clean	



FIGURE 14.9 Inspecting for completeness of the work performed.

D. Supervisor's Preliminary Visual Inspection

After the cleaning is completed, the supervisor should visually evaluate the entire area subject to clearance (including work areas, worker passageways and storage areas) to ensure that all work has been completed and all visible dust and debris has been removed (see Figure 14.9). The supervisor's preliminary inspection does not replace the independent visual assessment and dust testing conducted by the clearance examiner. If the clearance examiner's visual assessment results are unsatisfactory, dust testing is postponed until identified surfaces are recleaned and/or retreated. This process makes it cost effective to have the supervisor perform a preliminary visual inspection.

E Surface Painting or Sealing of Non-Floor Surfaces

The next step of preparing for clearance (or cleaning verification) 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 painted are exempt from the painting provision.

Painters should use the following lead-safe work practices:

- ◆ Using "drop cloths," which should be disposable, impermeable sheeting – not cloth,
- ◆ Cleaning their work tools before bringing them into the clearance area, and
- ◆ Ensuring no dust is tracked in from outside the clearance area.

F. Sealing Floors

The next step before clearance is to seal all hard-surface floors that do not already have an intact, nonporous coating. Sealed surfaces are easier for residents to clean and maintain over time than those that are not sealed. Wooden floors should be sealed with clear polyurethane or painted with deck enamel or durable paint. Vinyl tile, linoleum, and other similar floors should be sealed with an appropriate floor wax (or equivalent product). 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.

Workers applying floor sealants or coverings should take care to wipe clean tools brought into the work area and to avoid tracking in dust from outside the clearance area.

G. Final Wet Cleaning, EPA Cleaning Verification, and Possible Pre-Clearance Dust Testing

Even if painters and floor covering workers use lead-safe work practices, lead-contaminated dust may still migrate into previously cleaned areas. Therefore, it is recommended that the final step before the clearance examination is to wet clean all horizontal surfaces one more time (see Figures 14.10 through 14.13).

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 wood work, and so on, and work down to the floor. Do every inch of the window, especially the window trough.



Courtesy: Alice Hamilton Occupational Health Center

FIGURE 14.10 The HEPA Vacuum-Wet Wash-HEPA Vacuum Cycle Helps Meet Clearance Standards.

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 14.11 Wet Cycle Requires Washing All Surfaces with Suitable Detergents.

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 no bucket #1 for more detergent solutions and continue mopping. Repeat.

Use the third bucket for rinsing the floor.

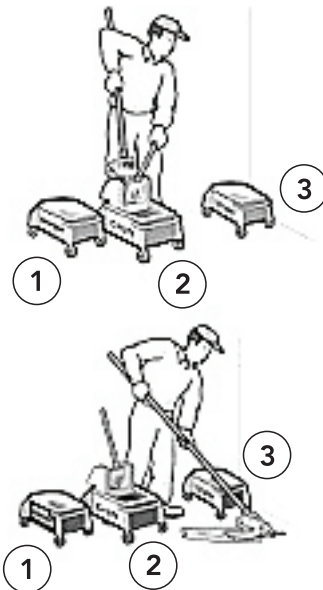


FIGURE 14.12 Use a Three-Bucket System and Then HEPA Vacuum Again to Minimize Recontamination.

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.



FIGURE 14.13 HEPA vacuum all surfaces a final time.

Under EPA's Renovation, Repair and Painting rule, after the renovation has been completed, the firm must clean the work area until no dust, debris or residue remains (see Appendix 6). The post-renovation cleaning verification requirements must be performed by a certified renovator. If the certified renovator directs the other workers to perform the work practices, the certified renovator must be at the work site during cleaning of the work site. For more information on EPA's RRP rule and the cleaning it requires, see www.epa.gov/lead/pubs/renovation.htm.

At this point in the process, supervisors of work for which achievement of clearance is known to be difficult may wish to consider preliminary dust testing before requesting the clearance examination. Factors that tend to be associated with clearance failure are (1) high levels of lead in dust and paint before the work began, (2) hard floor and window surfaces that are not smooth and cleanable, and (3) high-dust work in rooms from which furniture has not been removed (NCHH, 2004).

Methods exist for reliably screening wipe samples on-site instead of in a fixed laboratory. These include portable X-ray fluorescence (XRF) analysis and anodic stripping voltammetry (ASV) (Ashley 2001; EPA, 2002b; Clark, 2002) or potentiometric stripping analysis (PSA). These methods may provide testing results much more quickly than fixed laboratory analysis, because transportation of samples is not necessary and handling time is reduced. Note that analysis of samples taken from target housing of pre-1978 child-occupied facilities must be conducted by a laboratory, whether fixed-site or mobile, recognized by the Environmental Protection Agency (EPA) under its National Lead Laboratory Accreditation Program (NLLAP) (<http://www.epa.gov/lead/pubs/nllap.htm>).

Any person who is trained and otherwise qualified to operate the XRF instrument or use the ASV method may use these methods to conduct *preliminary* dust testing to determine whether the clearance area is clean and ready for the clearance examination. A person conducting a preliminary screen does not have to be a technician working for an NLLAP-recognized laboratory; the sample may be collected by the contractor or the owner, and given to the laboratory for analysis. Owners and contractors may wish to use such screening tests to minimize the likelihood of clearance failure. Federal and State regulations on the use of devices with radioactive elements (i.e., some XRF analyzers) must be observed (see Chapter 7, section VII.A).

H. Clearance

The clearance examination should take place more than 1 hour after the final cleaning. This ensures that any airborne lead particles stirred up by the cleaning have settled. Clearance is usually performed after the sealant is applied to the floor. See Chapter 15 for information on clearance examination procedures. For cleaning verification, a waiting period is not required for the initial wipe, nor after the first failed wipe, but a 1-hour waiting period is required after the second failed wipe before the work area is released from the project.

I. Recleaning After Clearance Failure

If the area fails the clearance examiner's visual assessment or clearance dust sampling tests, all surfaces represented by the failing clearance dust wipe samples must be recleaned. Failure is an indication that the cleaning has not been successful. If the surfaces are smooth, a wet wash should be used. If the surfaces are rough, a vacuum, wet-cleaning, vacuum cycle is recommended. If the failing surfaces include carpeting, the decision must be made whether to try to clean the carpet or to dispose of it. See Section V.B.2 of Chapter 11 for guidance. Care should be exercised during the recleaning of "failed" surfaces or components to avoid recontaminating "cleared" surfaces or components.

References

Ashley, 2001. Ashley, K., Wise, T.J., Mercado, W., Parry D.B., Ultrasonic extraction and field-portable anodic stripping voltammetric measurement of lead in dust wipe sample. *Journal of Hazardous Materials*, 83: 41-50, 2001.

California Department of Health Services, 2004. Public Health Institute for California Department of Health Services, Childhood Lead Poisoning Prevention Branch and Environmental Health Laboratory Branch, "Evaluation of Household Vacuum Cleaners in the Removal of Settled Lead Dust from Hard Surface Floors," Final Report to U.S. Department of Housing and Urban Development, 2004.

CMHC, 1992. Canada Mortgage and Housing Corporation, Saskatchewan Research Council Report, *Effectiveness of Cleanup Techniques for Leaded Paint Dust*, Saskatoon, Saskatchewan, Canada (also see Figley, 1994). (<http://www.cmhc-schl.gc.ca/publications/en/rh-pr/tech/92-203.pdf>)

Clark, 2002. Clark, C.S., "Development of a Rapid On-Site Method for the Analysis of Dust Wipes Using Field Portable X-Ray Fluorescence," prepared for the U.S. Department of Housing and Urban Development, January, 2002.

Dixon, 2004. Sherry Dixon, Jonathan Wilson, Paul Succop, Mei Chen, Warren Galke, William Menrath, and C. Clark, "Residential Dust Lead Loading Immediately After Intervention in the HUD Lead Hazard Control Grant Program," *Journal of Occupational and Environmental Hygiene*, 1: 716 – 724.

EPA, 1997a. U.S. Environmental Protection Agency, *Laboratory Study of Lead-Cleaning Efficacy*, March 1997 (EPA 747-R-97-002).

EPA, 1998. U.S. Environmental Protection Agency, *Lead-Cleaning Efficacy Follow-Up Study*, October 1998 (EPA 747-R-98-008).

EPA, 2002b. U.S. Environmental Protection Agency, The Environmental Technology Verification Program (ETV), Verification Statements EPA-VS-SCM-50, 51, 52, 53 and 54. Prepared by Oak Ridge National Laboratory, Oak Ridge, Tennessee, August, 2002.

Ewers, 1994. Ewers, L., S. Clark, W. Menrath, P. Succop, and R. Bornschein, "Clean-Up of Lead in Household Carpet and Floor Dust," *Journal of the American Industrial Hygiene Association*, 55(7):650-7, July, 1994.

Lewis, 2006. Roger D. Lewis, Sridhar Condoor, Joe Batek, Kee Hean Ong, Denis Backer, David Sterling, Jeff Siria, John J. Chen, and Peter Ashley, "Removal of Lead Contaminated Dusts from Hard Surfaces," *Environ. Sci. Technol.*, 40, 590 -594, 2006. <http://pubs.acs.org/doi/abs/10.1021/es050803s>.

Lewis, 2012. Lewis R.D., Ong, K.H., Emo, B, Kennedy, J., Brown, C.A., Condoor, S. and Thummalakunta, L. Do New Wipe Materials Outperform Traditional Lead Dust Cleaning Methods? *Journal of Occupational and Environmental Hygiene*, 9:8 524-533, August 2012. <http://www.tandfonline.com/doi/abs/10.1080/15459624.2012.695975>

NCHH, 2004. National Center for Healthy Housing, and University of Cincinnati Department of Environmental Health, *Evaluation of the HUD Lead-Based Paint Hazard Control Grant Program: Final Report*, prepared for the U.S. Department of Housing and Urban Development, Washington, DC, May 1, 2004.

Rich, 2002. Rich, David Q., G.G. Rhoads, L. Yiin, J. Zhang, Z. Bai, J.L. Adgate, P.J. Ashley and P.L. Liroy, "Comparison of Home Lead Dust Reduction Techniques on Hard Surfaces: The New Jersey Assessment of Cleaning Techniques Trial," *Environmental Health Perspectives*, 110(9): 889-893, September, 2002.

Rupp, 2003. Rupp, R. and R. Zatzke, "Comments on Proposed Revisions to Chapter 14 of the HUD *Guidelines*, Unpublished memorandum, May 8, 2003.

White, 2003. White, K. and G. Dewalt, Unpublished comments on proposed revisions to Chapter 14 of the HUD *Guidelines*, May 2003.

Yiin, 2002. Yiin, Lih-Ming, F.F. Rhoads, D.Q. Rich, J. Zhang, Z. Bai, J.L. Adgate, P.J. Ashley and P.J. Liroy, "Comparison of Techniques to Reduce Residential Lead Dust on Carpet and Upholstery: The New Jersey Assessment of Cleaning Techniques Trial," *Environmental Health Perspectives*, 110(12): 1-5, December, 2002.