

National Center for HEALTHY HOUSING



Technical Assistance Brief: Assessing Lead-Based Paint Hazard Control Treatment Post-Remediation

Purpose

This technical assistance brief provides state and local childhood lead poisoning prevention programs with a method of assessing the lead safety of housing units at least one year after lead hazard control treatment. Options for more vigorous evaluations which include pre-remediation data for comparison are also provided to examine the overall impact of treatment from pre-remediation to at least one year post-remediation.

Background

Through visual assessment of paint condition, dust lead testing, or both, programs can assess the lead safety of housing units at a specific interval after lead hazard control treatment. Collection and analysis of post-remediation information will inform, in general, how long housing units remain lead-safe and protective for the children residing in them. More

specifically, post-remediation assessment can assist programs in better understanding the:

- Effectiveness of work specifications (i.e., are certain surfaces or housing components breaking down more quickly than others?);
- Importance of maintenance and housekeeping; and
- Contribution of dust lead tracked in from outside sources, yielding unsafe floor dust levels.

Assessing the lead safety of housing units at least one year post-remediation can also inform the limitations and requirements of initiatives such as a lead-safe housing registry or certificate of occupancy program to assure that the housing units are, in fact, lead-safe as marketed. Communities can also use this information to quantify the number of housing units that are made and remain lead-safe over time.

Options

The following options provide programs with a variety of post-remediation assessment methods from which to choose based on their program needs, available data, and evaluation expertise:

Option 1. Post-Remediation Visual Assessment of Paint Condition

This is the simplest approach to assessing treatment stability (paint condition). As the advantage of this visual assessment option is its relative simplicity, this approach provides a perfect starting point for programs beginning to look at how their hazard control treatments are holding up after remediation. You can gain many insights by examining the number and extent of hazards found post-remediation and sharing and discussing these results with your program staff, rental property owners, contractors, and community leaders.

Post-remediation visual assessment can be conducted without comparing it to an initial or pre-remediation inspection. However, if the necessary data and staff capacity are available, inclusion of pre-remediation data would allow programs to quantify relative improvement of housing units served (see Option 3).

Option 2. Examination of Post-Remediation Dust Lead Loading

Collecting post-remediation dust lead loading data can provide meaningful information on the dust lead levels after remediation, the contribution of lead sources both inside and outside the home remaining after the remediation to dust lead loadings, and the true nature of lead hazards accessible to young children. Dust lead loadings on floors may contribute with an understanding of the effect of track-in from the outdoors, while dust lead loadings on sills may contribute to an understanding of dust lead blow-in from the exterior. If possible, programs examining post-remediation dust lead loadings should also follow the steps to perform a visual assessment of paint condition as described under Option 1 during the post-remediation visit to provide a more thorough examination of both paint condition and dust lead loadings.

The primary advantage to this approach is that it is quantifiable and less subjective than the visual assessment method. Comprehensively assessing

the condition of housing units post-remediation is an important step in accurately characterizing and understanding the true lead safety of housing units over time. Programs are encouraged to visually assess and collect these dust samples from *as many* dwellings and at as many time intervals at possible, so they have data from a sufficient quantity of units to assess temporal trends in dust lead reloading and the accessibility of dust lead hazards to young children.

Options 3 and 4. Comparison of Pre- and Post-Remediation Data

If your program collects pre-remediation data in the form of visual assessments and/or dust lead data, comparing your pre-remediation data with post-remediation data will enable a more robust evaluation by providing information on both how pre-remediation conditions impact post-remediation conditions and how housing units have changed from pre-remediation. Option 3 is analysis of visual assessment of paint condition data, while Option 4 is analysis of dust lead data. Use Option 3 to assess treatment stability and quantify relative improvement in paint conditions of housing units served. Use Option 4 to assess the overall effectiveness of the housing interventions, which is best measured by dust lead levels.

Programs comparing pre- and post-remediation visual assessments who do not have pre-remediation dust lead loadings should still follow the steps described under Option 2 and collect dust lead data during the post-remediation visit to have a more quantifiable and less subjective evaluation method.

Programs comparing pre- and post-remediation dust lead loadings who do not have pre-remediation visual assessment data should still follow the steps described under Option 1, “Post-Remediation Visual Assessment of Paint Condition,” during the post-remediation visit to provide a more complete comparison of both paint condition and dust lead levels at pre- and post-remediation.

General Rules

Regardless of which option is chosen as the post-remediation assessment approach, the following list of general rules should be considered:

1. Assess a minimum of 25-30 housing units for meaningful results, using random sampling to select housing units if feasible. When deciding which housing units to include for post-remediation assessment, consider important

factors that might influence the outcome of the assessment. These factors might include:

- a. **The different types of individuals who may have conducted the remediation** (e.g., contractor, property owner): Do you want to include only units treated by the same type of remediator or those treated by different types of remediators?
 - b. **The types of treatments provided:** Did your program change its protocols so that some units had a different treatment intensity than others?
 - c. **The length of time since the homes were first treated:** Do you want to evaluate units treated in the early stages of your program (when the program was still evolving) or units treated after the program was running more routinely?
 - d. **The location of units:** Do you want to select randomly from all units that have been inspected and cleared through your program regardless of their geographic location or focus on specific target areas?
2. If you want to assess work quality, treatment failure rate, and dust lead loadings after remediation, we recommend a post-remediation assessment time frame of one year. If you want to look at treatment longevity, we recommend a post-remediation assessment time frame of three years.
 3. Before you design your post-remediation assessment protocols, formulate the questions you want to answer and prepare protocols to answer these questions.
 4. Be sure to document and share results with your program staff in order to identify new questions that need to be pursued and document any lessons learned to inform policy changes.
 5. To ensure that post-remediation data become part of your routine program evaluation and are not considered research data (entailing HIPAA and IRB requirements), programs need to require property maintenance as a part of their clearance reports and funding requirements.
 6. It is strongly preferred that visual assessments are conducted and/or dust lead samples are collected as close as possible to the post-remediation time periods (i.e., anniversary of treatment completion, same season of the year) in each dwelling.

Useful Terms

PRE-REMEDICATION:

Refers to the period before lead hazard control treatment activities occurred in a housing unit.

POST-REMEDICATION:

Refers to the period after lead hazard control treatment activities occurred in a housing unit.

TIME INTERVAL:

Designated period of time between lead hazard control treatment activities and post-remediation data collection that the program conducting the evaluation has determined to utilize. We recommend a time interval of no less than 12 months for any post-remediation assessment and no less than 36 months for assessments of the longevity of hazard control treatments.

ARITHMETIC MEAN:

Mathematical average of a set of numbers using their sum (e.g., the arithmetic mean of three numbers is equal to the sum of those numbers divided by three).

GEOMETRIC MEAN:

Mathematical center of a set of numbers defined as the n th root of the product of the n numbers (e.g., the geometric mean of three numbers is equal to the cube root of the product of those three numbers).

7. If including pre-remediation data, it may help reduce variability if the same inspector who conducted the pre-remediation inspection also conducts the follow-up visits.
8. Prior to the post-remediation assessment visit, contact each resident, explaining the need to conduct a follow-up visit to the dwelling and describing what will occur during the visit. If the resident is willing, schedule a home visit. If the property is rented, consider informing the rental property owner about the upcoming visit. Cold calling and asserting the need of the program to reassess the unit is also an acceptable method.
9. Following the post-remediation assessment visit, communicate the results of the visual assessment and dust lead samples to the property owner and residents. **Programs will need to determine how to work with property owners if new hazards are identified that are accessible to young children.** Options include providing

information to the property owner, attempting to work voluntarily with property owners to fix the new lead-based paint hazards, or using enforcement mechanisms if available. It is important to remember that, in most cases, these housing units have had an expectation of ongoing maintenance communicated and have local and state building and health code requirements.

10. Data collection quality control is critical to program success and must be considered at every visit. Make every effort to use the same visual assessment and/or dust collection procedures at each visit to the dwelling. Review all completed forms for completeness and consistency and reconcile any missing data and apparent inconsistencies with the field inspector before analyzing any data.
11. Options 3 and 4 of this document describe analysis of changes from pre-remediation to at least 12 months post-remediation. It may also be of interest to analyze changes from clearance dust lead sampling to a later post-remediation sampling time, but that analysis should supplement and not replace options 3 and 4.
12. The federal hazards standards are 10 µg/ft² for floors and 100 µg/ft² for window sills (US EPA 2019). There is no federal hazard standard for window troughs but there is a federal clearance standard of 400 µg/ft² (US EPA 2020).*

Limitations and Assumptions

Before choosing an approach and beginning a post-remediation assessment, the following limitations and assumptions should be considered:

1. These approaches are basic examples of things to consider and assess – not *everything* one could or should consider. The data will not be perfect and are may be questioned but will still have valuable things to share. Be prepared to defend your analysis and choices.

2. There is a chance that your program's protocols for performing visual assessments and/or dust lead sampling have changed over the period from pre-remediation to post-remediation. If your protocols have changed, you may choose to analyze the effect of that change. For example, if you previously collected windowsill dust samples in four rooms but dropped the living room, you would use homes with data collected before the change to compare dust leads in the three rooms in the new protocols to the living room.
3. The options presented below assume the use of only one designated post-remediation time interval at a period greater than 12 months post-remediation. You may have more data for more than one post-remediation time interval. The options can be modified to include comparisons from several designated post-remediation periods to evaluate the longevity of hazard control interventions and better assess the lead safety of housing units over time.
4. These options assume the availability of data for a minimum of 25-30 housing units.

Use the flowchart on the next page to help you determine which approach you should use. TIP: If possible, use dust lead data rather than, or in addition to, visual assessments and include a pre-remediation comparison if you can!

* U.S. EPA, 2019. *Review of the Dust-Lead Hazard Standards and the Definition of Lead-Based Paint, Code of the Federal Regulations Title 40 Part 745*. U.S. EPA, Washington, DC.

U.S. EPA, 2020. *Review of Dust-Lead Post Abatement Clearance Levels, Code of the Federal Regulations Title 40 Part 745*. U.S. EPA, Washington, DC.

Figure out which option to choose by answering a few simple questions.

Begin here

Do you have, or are you able to collect, at least one year post-remediation data for a minimum of 25-30 housing units?

NO

YES

STOP.
You do not have adequate post-remediation data to complete this assessment.

Is your pre- and post-remediation data visual assessments, dust lead loadings, or both?

Visuals

Dust Loads

Both

Use Option 3 to assess changes in visually assessed paint conditions from pre-remediation to post-remediation.

Use Option 4 to compare dust lead levels pre-remediation with post-remediation.

Use Option 4 with the dust lead data for a more robust evaluation.

Do you have pre-remediation data for the same housing units and want to include a comparison from pre- to post-remediation in this assessment?

YES

NO

Use Option 1 to assess treatment stability of the housing interventions.

Is your post-remediation data in the form of visual assessments, dust lead loadings, or both?

Visuals

Dust Loads

Both

Use Option 2 to assess post-remediation dust lead loads.

Use both Option 2 with the dust lead data and Option 1 with visual assessment of paint condition data for a more robust evaluation.

Conducting the Assessment

Once you have determined which assessment option best fits both your evaluation goals and data availability and you have considered the general rules for any post-remediation approach, you can undertake the option of your choice using the steps outlined below along with the referenced attachments and additional materials:

Option 1. Post-Remediation Visual Assessment of Paint Condition

Step 1: Post-Remediation Visual Assessments.

Remediated housing units can be assessed at a designated time interval at least 12 months post-remediation. Revisit the dwelling and conduct a visual assessment of paint condition, using your program's protocols or the visual assessment template provided in Attachments B.1-B.3. Inspect the paint condition on all surfaces, including those that were treated, those not in need of treatment, or those with hazards determined to be *de minimus*.

Step 2: Data Analysis.

Once you have post-remediation data, you can describe the hazards identified post-remediation using the following steps:

- a. Document the number of hazards and the extent of deteriorated paint at the designated post-remediation time interval using the data entry template (B Attachments). The data entry template can also be used to combine the results of all housing units reassessed. Accompanying instructions provide a detailed description of the types of statistics you could use to quantify post-remediation visual assessment alone, such as the total number, average, and range of rooms with non-intact paint on specific components; the range and percentage of rooms with non-intact paint on specific components; and the average percentage of replacement windows per unit.
- b. Importantly, describe the types of hazards found at the post-remediation time interval. Use your work specifications and the paint inspection information to determine whether hazards were found on surfaces that were treated, surfaces not in need of treatment, or surfaces with hazards determined to be *de minimus*. Consider the implications for your protocols and future remediation specifications.

Step 3: Notification.

Communicate the results of the visual assessment to the property owner and residents.

Option 2. Examination of Post-Remediation Dust Reloading Since Clearance

Step 1: Post-Remediation Dust Sampling.

Remediated housing units can be assessed at a designated time interval at least 12 months post-remediation. Following your program's dust lead sampling protocol, collect post-remediation samples from the same locations that were sampled at clearance. Another option is to collect dust lead samples per the template and protocol provided in Attachments C.1-C.3.

Step 2: Sample Analysis.

Send dust samples to a laboratory recognized under EPA's National Lead Laboratory Accreditation Program, if possible use the same laboratory to analyze samples collected on previous visits.

Step 3: Data Analysis.

- a. For each housing unit, calculate the average (arithmetic mean) dust lead loading for each type of surface sampled (e.g., windowsill, floor, window trough*) at post-remediation. Determine the percentage of housing units with:
 - Floor dust lead hazards (i.e., housing unit average floor dust lead loading of 10 µg/ft² or higher);
 - Windowsill dust lead hazards (i.e., housing unit average windowsill dust lead loading of 100 µg/ft² or higher); and/or
 - Floor or windowsill dust lead hazards (i.e., either housing unit average floor dust lead loading of 10 µg/ft² or higher or housing unit average windowsill dust lead loading of 100 µg/ft² or higher).
- b. For each type of surface sampled (e.g., windowsill, floor window trough) at the post-remediation time period calculate the geometric mean (GM) dust lead loading across all housing units. Example GM calculations and a sample data analysis are provided in the C Attachments. Compare the post-remediation GM dust lead loadings with hazard standards.

Note: We calculate arithmetic means within a housing unit (Step 3a) to be consistent with the measures used to set federal hazard standards for specific

* There is no federal hazard standard for window troughs, but there is a federal clearance standard of 400 µg/ft².

units. When examining data across multiple housing units (Step 3b), we use geometric means because they are the best measure to use when examining the center of the distribution of dust lead loadings across multiple units.

Step 4: Notification.

Provide written reports of dust lead measurements to all participating households and the owners of the dwellings along with information on paint condition.

Option 3. Comparison of Pre- and Post-Remediation Visual Assessments

Step 1: Post-Remediation Visual Assessments.

Remediated housing units can be assessed at a designated time interval at least 12 months post-remediation, and the resulting data can be compared to that collected during pre-remediation visits. Using the same procedures implemented during the initial pre-remediation risk assessment (if possible), conduct a visual assessment of current paint conditions. If your program's protocols have changed, you can use your current protocols or the visual assessment template provided in Attachments B.1-B.3. Inspect the paint condition on all surfaces, including those that were treated, those not in need of treatment, or those with hazards determined to be *de minimus*.

Step 2: Data Analysis.

Once you have pre-remediation and post-remediation data, you can quantify the reoccurring or new hazards identified by comparing the hazards identified at pre-remediation with those identified at post-remediation using the following steps:

- a. Document the number and the extent of lead-based paint hazards at each period (pre- and post-remediation) using the data entry template provided in the B Attachments. The data entry template can also be used to combine the results of all housing units reassessed. Accompanying instructions provide a detailed description of the types of statistics you could use to quantify post-remediation visual assessments, such as the total number, average, and range of rooms with non-intact paint on specific components; the range and percentage of rooms with non-intact paint on specific components; and the average percentage of replacement windows per unit.
- b. Importantly, describe the types of hazards found at the post-remediation time interval. Use your work specifications and the paint inspection information

to determine whether hazards were found on surfaces that were treated, surfaces not in need of treatment, or surfaces with hazards determined to be *de minimus*. Consider the implications for your protocols and future remediation specifications.

Step 3: Notification.

Communicate the results of the post-remediation visual assessment to the property owner and residents.

Option 4. Comparison of Pre- and Post-Remediation Dust Lead Loadings

Step 1: Post-Remediation Assessment.

Remediated housing units can be assessed at a designated time interval at least 12 months post-remediation, and the resulting data can be compared to that collected during pre-remediation visits. Following your program's dust lead sampling protocol, revisit the dwelling and collect samples from the same locations that were sampled pre-remediation. Another option is to collect dust lead samples per the template and protocol provided in Attachments C.1-C.3.

Step 2: Sample Analysis.

Send dust samples to a laboratory recognized under EPA's National Lead Laboratory Accreditation Program; if possible, use the same laboratory to analyze samples post- and pre-remediation.

Step 3: Data Analysis.

- a. For each housing unit, calculate the average (arithmetic mean) dust lead loading for each type of surface sampled (e.g., windowsill, floor, window trough*) and at each interval (pre- and post-remediation). Determine the percentage of housing units at pre- and post-remediation with:
 - Floor dust lead hazards (i.e., housing unit average floor dust lead loading of 10 µg/ft² or higher)
 - Windowsill dust lead hazards (i.e., housing unit average windowsill dust lead loading of 100 µg/ft² or higher)
 - Floor or windowsill dust lead hazards (i.e., either housing unit average floor dust lead loading of 10 µg/ft² or higher or housing unit average windowsill dust lead loading of 100 µg/ft² or higher)

* There is no federal hazard standard for window troughs, but there is a federal clearance standard of 400 µg/ft².

- b. For each type of surface sampled (e.g., windowsill, window trough, floor) and each time period (pre- and post-remediation), calculate the geometric mean (GM) dust lead loading (across all housing units). Example GM calculations and a sample data analysis are provided in the C Attachments.
- c. Calculate the percent change by comparing the post-remediation GM dust lead loadings with the pre-remediation GM dust lead loading and with hazard standards to see the extent to which dust has re-accumulated. See example GM calculations and a sample data analysis in the C Attachments.

Note: We calculate arithmetic means within a housing unit (Step 3a) to be consistent with the measures used to set federal hazard standards for specific units. When examining data across multiple housing units (steps 3b and 3c), we use geometric means because they are the best measure to use when examining the center of the distribution of dust lead loadings across multiple units.

Step 4: Notification.

Provide written reports of post-remediation dust lead measurements and paint hazards to all participating households and the owners of the dwellings.

Attachments

- A. Example: geometric mean calculation
- B. Visual: methods; templates in Word and Excel
 - B.1. Suggested Methods for Analyzing Visual Assessment Data of Paint Condition and Windows at Baseline and Post-Remediation Time Intervals
 - B.2. Word template: Visual Inspection of Paint Condition and Window Replacements
 - B.3. Excel template: Visual Inspection of Paint Condition and Window Replacements
- C. Dust: methods; templates in Word and Excel
 - C.1. Suggested Methods for Analyzing Dust Lead Sampling Data at Baseline and Post-Remediation Time Intervals
 - C.2. Word template: Dust Sample Collection
 - C.3. Excel template: Dust Sample Collection

Attachment A is included on the following page. All B and C attachments can be accessed and downloaded from <https://nchh.org/tools-and-data/technical-assistance/nys-clpppp>.

Technical Assistance Brief

Assessing Lead-Based Paint Hazard Control Treatment Post-Remediation

For additional resources, please visit:

<https://nchh.org/tools-and-data/technical-assistance/nys-clpppp/>

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Attachment A

Example: Geometric Mean Calculation

The geometric mean, percentage of results equal to or above 10 µg/dL, and percentage of results equal to or above 5 µg/dL of a set of blood lead level (BLL) data can be calculated as follows:

1. Enter BLL data into column A of an Excel spreadsheet. (In this example, data begins in cell A2 and ends in cell A10; adjust accordingly based on your final range.)
2. Enter the following three formulas into a separate column in the same Excel spreadsheet:
 - (a) =GEOMEAN(A2:A10)
 - (b) =COUNTIF(A2:A10,">=10")/COUNT(A2:A10)
 - (c) =COUNTIF(A2:A10,">=5")/COUNT(A2:A10)

Note: Do not copy/paste these formulas into your Excel spreadsheet or Excel will recognize the text as plain text rather than a formula; instead, type them (with your specific cell ranges) directly into Excel.

Note: The geometric mean can only be calculated if all values are above zero. If the dust lead loading value reported by your laboratory was less than the detection limit or equal to 0, then you should replace that value with the detection limit divided by the square root of two before calculating the geometric mean.

3. The results, using the example data above:
 - (a) 1.62 µg/dL = geometric mean
 - (b) 11.11% = percentage of BLLs ≥ 10 µg/dL
 - (c) 33.33% = percentage of BLLs ≥ 5 µg/dL

The Excel function GEOMEAN calculates the geometric mean of a specified range of cells. For example, if you want to find the geometric mean of cells A2 to A10, you would type into the cell: =GEOMEAN(A2:A10). The resulting value is 1.62.

The Excel function COUNT calculates the number of non-missing numeric values from a specified range of cells. For example, if you want to find the number of non-missing values in cells A2 to A10 you would type into the cell: =COUNT(A2:A10). The resulting value is 9.

The Excel function COUNTIF calculates the number of cells in the specified range (where you want to look) that meet the specified criteria (what you want to look for). For example, if you want to look in cells A2 to A10 for values ≥5, you would type into the cell =COUNTIF(A2:A10,">=5"). The resulting value is 3.

Example Data

BLL
3.0
4.4
5.1
3.2
5.7
10.2
0.1
0.2
0.3