NBSIR 73-242

# Pilot Demonstration of Lead Based Paint Hazard Elimination Methods

Report on Field Study No. 1

T. H. Boone, T. R. Ray, W. G. Street

Center for Building Technology
Institute for Applied Technology
National Bureau of Standards
Washington, D. C. 20234

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Final Report

Prepared for
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U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary

NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

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## ABSTRACT

This report describes the elimination of the potential ingestion hazard of lead bearing paints in a one bedroom apartment using materials and procedures that are undergoing laboratory and field evaluation by the National Bureau of Standards (NBS). Paint removal was used to eliminate the hazard from some surfaces and two nonhazardous membrane type coverings were installed as barrier materials over the residual leaded paint on other surfaces. The preparation and refinishing of the interior surfaces are described and work rates and cost data are presented.

This pilot demonstration is the first of a series of studies that will be used to determine the merits of various lead based paint hazard elimination methods when applied to actual housing conditions.

Final recommendations for further use of materials and systems, described in this report, are not presented due to the preliminary nature of this work. The completion of the projected series of demonstrations and the long term evaluation of the in-use performance of the materials and systems will be required before final recommendations can be made.

Key Words: Cost analysis; hazard elimination; housing; lead based paint; materials; surface preparation; surface refinishing

## SI Conversion Units

The conversion factors and units contained in this report are in accordance with the International System of Units (abbreviated SI for Systeme International d'Unites). The SI was defined and given official status by the 11th General Conference on Weights and Measures which met in Paris in October 1960. For assistance in converting U.S. customary units to SI units, see ASTM E 380, ASTM Standard Metric Practice Guide, available from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103. The conversion factors for the units found in this Standard are as follows:

Length

1 in = 0.0254* meter

1 ft = 0.3048* meter

1 mil = 0.001* in

Area

1 $in^2$ = 6.4516* x $10^{-4}$ $meter^2$

1 $ft^2$ = 0.9290 $meter^2$

Volume

1 $in^3$ = 1.638 x $10^{-5}$ $meter^3$

1 liter = 1.000* x $10^{-3}$ $meter^3$

Mass

1 grain = 6.479 x $10^{-5}$ kilogram

1 ounce-mass (avoirdupois) = 2.834 x $10^{-2}$ kilogram

1 pound-mass (avoirdupois) = 0.4535 kilogram

Pressure or Stress (Force/Area)

1 inch of mercury (60°F) = 3376 $newton/meter^2$

1 $pound\text{-}force/inch^2$ (psi) = 6894 $newton/meter^2$

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* Exactly

Energy

1 inch-pound-force (in-lbf) = 0.1130 joule

Plane Angle

1 degree (angle) = $1.745 \times 10^{-2}$ radian

Power

1 watt = $1.000^{*} \times 10^{7}$ erg/second

Temperature

°C = 5/9 (Temperature °F - 32)

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* Exactly

Pilot Demonstration of Lead Based Paint Hazard Elimination Methods
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## 1. INTRODUCTION

Lead poisoning resulting from the ingestion of lead based paint is a serious illness and is now recognized as a major pediatric disease [1]*. In January 1971, Congress enacted the "Lead Based Paint Poisoning Prevention Act" (PL 91-695) to provide federal assistance to help eliminate this disease. Title III of this Act gives the Department of Housing and Urban Development (HUD) responsibility for demonstrating methods that can be used to make leaded paint inaccessible to children.

The Center for Building Technology (CBT) of the National Bureau of Standards (NBS) is currently under an interagency agreement with HUD to provide technical support and research on the lead based paint poisoning problem. One of CBT's tasks is to demonstrate methods for the elimination of the lead paint poisoning hazard in existing dwelling units either by removal of the lead based paint or by providing a serviceable nonhazardous barrier to the existing paint.

The first pilot demonstration, under the direction of CBT's Lead Based Paint Poisoning Project was carried out in Washington, D.C.

A specification was prepared and a contract awarded for the implementation of the following six hazard elimination methods:

a. Repainting of ceiling and closet surfaces which contain lead based paint.

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* Figures in brackets indicate the literature references at the end of the paper.

b. Installing metal covers over painted radiators.

c. Removal of lead based paint from walls, doors, trim, exposed steam pipes and windows by means of chemical paint removers and scraping, followed by repair where necessary and repainting.

d. Complete removal and replacement of wood base molding covered with lead based paint.

e. Covering of wall surfaces, coated with lead based paint, with adhesive bonded, gypsum impregnated, jute fabric membrane.

f. Covering of painted wall surfaces and wood trim containing lead, with adhesive bonded, fabric reinforced, vinyl coated membrane.

Final recommendations for further use of materials and systems, described in this report, are not presented due to the preliminary nature of this work. The completion of the projected series of demonstrations and the long term evaluation of the in-use performance of the materials and systems, will be required before such recommendations can be made.

## 2. GENERAL DESCRIPTIONS

### 2.1. DWELLING UNIT

The dwelling unit selected for this field demonstration was an unoccupied one-bedroom corner apartment on the first floor of a two-story masonry structure which is part of a row of similar units. The unit, 716 Langston Terrace, is located near the intersection of 21st and G Streets, N.E., Washington, D.C. The Langston Terrace multi-family complex was constructed in 1937 and is now maintained by the National Capital Housing Authority (NCHA). Figure 1 is a photograph of the unit's exterior and figure 2 is a sketch of the floor plan.

Figure 1. Pilot demonstration. One-bedroom corner apartment on first floor of a two story masonry structure at 716 Langston Terrace, N.E., Washington, D.C.

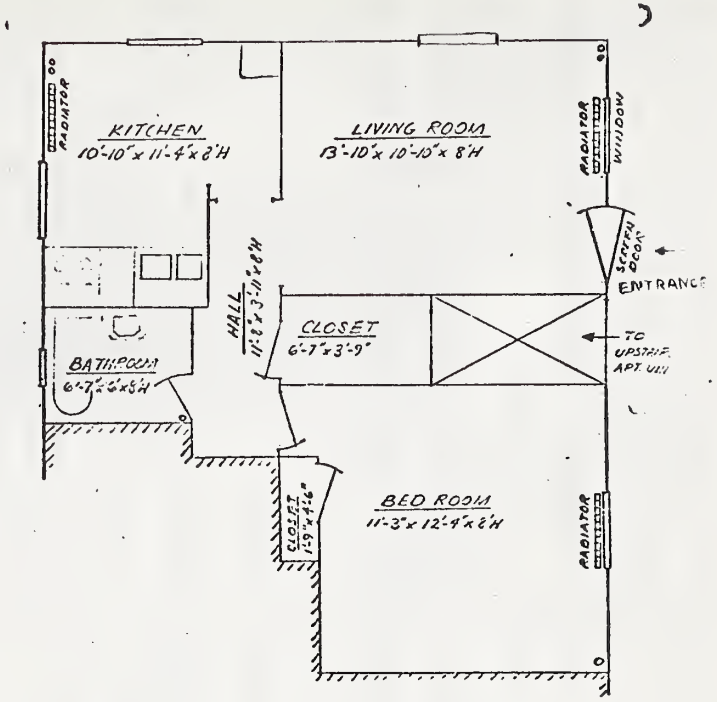


Figure 2. Floor Plan - Pilot Demonstration

Table 1 lists the surface materials; the conditions of the surfaces and the lead content present in each surface recorded in milligrams per square centimeter ($mg/cm^2$) as measured with a portable X-ray fluorescence (XRF) instrument. A photograph of this instrument in use is presented in figure 3. Rasberry [2] reported on a number of portable XRF lead detectors and Spurgeon [3] thoroughly investigated the model used in this demonstration.

2.2. MATERIALS AND APPLICATION

A. Water Wash Type Paint Remover: A paint remover was applied by brush to the old paint on kitchen walls, all window frames, all exterior and interior doors and exposed steam pipes. The loosened paint was scraped off with a wide bladed putty knife and water washed with sponges and rags. This procedure was repeated as necessary to remove the multiple layers of paint until plaster, wood or metal was exposed. Figures 4, 5, 6 and 7 are photographs taken during various phases of this surface preparation work.

Steel wool was used on the metal sills and frames of the windows and steam pipes after scraping.

The paint remover contained methylene chloride, mineral spirits, methanol and triethyl ammonium phosphate. Methylene chloride and methanol are hazardous when they are ingested or their vapors are inhaled. Paint removers of this type are considered "flammable".

| AREA | | MATERIALS | CONDITIONS | XPF READINGS ($mg/cm^2$) 1/ Range | Aver. |
|---|---|---|---|---|---|
| LIVING ROOM | Walls | Painted plaster | Generally good: some loose and bulging plaster under windows and behind radiator. | 0.1 to 1.8 | 1.2 |
| | Ceiling | Painted concrete | Good | -- | -- |
| | Floor | Asphalt tile | Severely indented and cracked | -- | -- |
| | Doors | Painted wood exterior door | Cracked paint inside, cracked and weathered paint outside | 9.8 to 10.2 | 10.0 |
| | | Painted wood exterior screen door | Cracked paint inside, peeling | 4.0 to 5.2 | 4.6 |
| | Windows | Painted metal casement | Cracked paint, rusted | 0.4 to 1.3 | 0.9 |
| | Base Molding | Painted wood | Good | 0.8 to 1.6 | 1.3 |
| | Closet | Painted plaster and wood shelves | Good | -- | -- |
| | Radiator, | Painted metal | Paint chipped and peeling, rusted | -- | -- |
| | Steam Pipes | Painted metal | Paint chipped and peeling, rusted | -- | -- |
| KITCHEN | Walls | Painted plaster | Peeling paint, cracked loose bulging plaster | 0.9 to 4.6 | 3.0 |
| | Ceiling | Painted concrete | Good | -- | -- |
| | Floor | Linoleum | Severely indented and worn | -- | -- |
| | Windows | Painted metal casement | Cracked paint, rusted | 0.7 to 1.1 | 0.9 |
| | Base Molding | Painted wood | Good | 0.9 to 1.6 | 1.4 |
| | Cabinets | Painted wood | Good | -- | -- |
| | Radiator, | Painted metal | Paint chipped and peeling, rusted | -- | -- |
| | Steam Pipes | Painted metal | Paint chipped and peeling, rusted | -- | -- |
| BEDROOM | Walls | Painted plaster | Generally good, some loose and bulging plaster behind radiator | 1.0 to 2.4 | 1.9 |
| | Ceiling | Painted concrete | Generally good, some peeling paint | -- | -- |
| | Floor | Asphalt tile | Severely indented and cracked | -- | -- |
| | Doors | Painted wood | Good | 6.3 to 7.0 | 6.8 |
| | Window | Painted metal casement | Cracked paint, rusted | 0.8 to 1.1 | 0.9 |
| | Base Molding | Painted wood | Good | 0.8 to 1.0 | 0.9 |
| | Closet | Painted plaster walls, unfinished concrete floor | Good | 0.8 to 1.5 | 1.1 |
| | Radiators, | Painted metal | Paint chipped and peeling, rusted | -- | -- |
| | Steam Pipes | Painted metal | Paint chipped and peeling, rusted | -- | -- |
| BATHROOM | Walls | Painted plaster except for Ceramic wall tile 20 in. above tub | Fair, slight peeling paint at four locations | 1.0 to 2.0 | 1.8 |
| | Ceiling | Painted concrete with small painted wood utility drop ceiling box. | Good | -- | -- |
| | Floor | Ceramic tile | Good | -- | -- |
| | Door | Painted wood | Good | 6.2 to 6.5 | 6.3 |
| | Window | Painted metal casement | Cracked paint, rusted | 0.0 to 1.8 | 0.9 |
| | Steam Pipe | Painted metal | Paint chipped and peeling, rusted | -- | -- |
| HALLWAY | Walls | Painted plaster | Good | 1.5 to 2.1 | 1.9 |
| | Ceiling | Painted concrete | Good | -- | -- |
| | Floor | Asphalt tile | Fair | -- | -- |
| | Closet | Painted wood door | Good | 6.2 to 6.4 | 6.3 |
| | Base Molding | Painted wood | Good | 0.9 to 1.1 | 1.0 |

Table 1. Description and Conditions of Original Surfaces. Pilot Demonstration

1/ -- XRF Readings not taken.

Figure 3. Measuring lead content in painted surfaces with Portable X-Ray Fluorescent instrument.

Figure 4. Scraping of old paint loosened by chemical paint remover on exterior door.

Figure 5. Plaster wall in kitchen during removal of old paint. Note the good condition of ceiling paint over concrete.

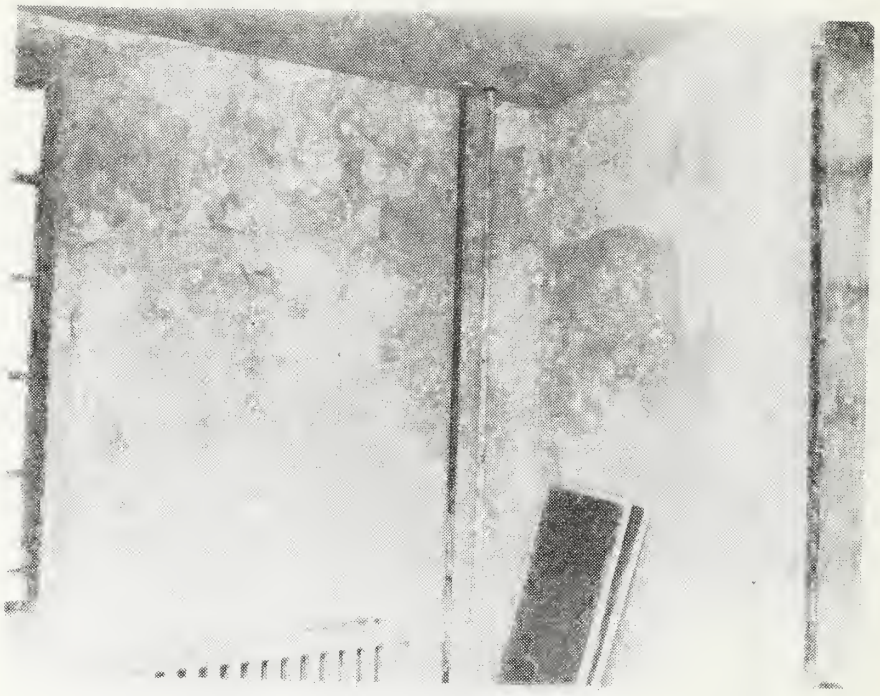

Figure 6. Metal window frame and section of left steam pipe after removal of paint before buffing with steel wool.

Figure 7. Plaster wall in kitchen after removal of old paint and plaster repair in lower corner.

Although the hazards involved in the use of solvent-type paint removers usually limit their use to small areas, the use of this system was justified for the treatment of large areas of this dwelling unit since it was unoccupied, well ventilated, and no open flames were used.

B. Prefinished Covering Materials: Two covering products were used to provide both a barrier over leaded paints and a final finish, on the wall surfaces in the living room, bedroom, hallway and bathroom. These painted plaster wall surfaces required no preparation before applying the adhesives and the prefinished covering materials. Loose paint and plaster under the windows in the living room and bedroom were removed and damaged areas were patched and smoothed. Figure 8 shows the living room walls prior to application of the covering material.

A wall covering system consisting of jute fabric impregnated with uncrystallized gypsum was applied with a water-base adhesive in a wall-paper manner over the walls in the living room, bedroom and hallway.

The NBS laboratory evaluations of this covering system indicated that it would have good adhesion characteristics on walls in normally dry areas and could be used to bridge minor voids in the walls being covered. Also, the fire related properties were considered acceptable when the system is used over non-combustible substrates such as plaster. Although the membrane is considered acceptable with regard to impact resistance, properties such as abrasion and scratch resistance and washability are less than acceptable based on laboratory evaluations. The textured nature of the product, however, tends to conceal these latter types of damages. The surface can be coated with paints after installation, if desired. The use of the jute fabric impregnated gypsum membrane was

Figure 8. Living room walls in original condition. Window frames have been painted with 1 coat rust inhibitive primer.

considered justifiable for covering noncombustible smooth surface substrates in normally dry areas. This material used in conjunction with a high strength adhesive, was chosen because of laboratory tests which indicated its ability to resist mechanical abuse such as scratch, puncture and impact. The good bonding of this system to painted surfaces will help to keep the covering in place as a barrier to the leaded paint beneath it.

The bathroom wall surfaces, including the horizontal wood trim four feet above the finish floor, were covered with a fabric reinforced, vinyl coated membrane applied with a mildew-resistant adhesive. This vinyl wall covering was stated by the manufacturer to meet the requirements of Federal Specification CCC-W-408, Type I, Class 2 material.

The laboratory evaluations of this type of covering indicated that this material is potentially acceptable for use in bathrooms if the adhesive selected is moisture resistant and the underlying substrate is smooth, clean and sound.

The three steam radiators in this demonstration unit presented a particular problem. They were covered with many layers of old paint that could not be reached without disconnnecting pipes and moving each unit away from the wall. The old pipe connection unions were in such condition that breaking the union could lead to major pipe replacement and refitting. The solution chosen for this condition was to first

cover the walls behind the radiators with asbestos cement board and thus prevent continued flaking of plaster and paint and then to cover the radiators with factory pre-finished metal radiator enclosures. The small openings at the floor and on the face of the cover should prevent access to the remaining lead paint on the radiators as can be seen in figure 9.

C. Paints: Paint coatings containing not more than 0.5% of lead by residual weight were chosen to refinish those walls, metal work and woodwork where the old paint was removed. Undercoat primers for plaster and wood were specified.

A rust inhibitive primer was selected for all metal work before application of the finish coat, which was a high heat resistant paint intended for exposed steam pipes. This system of coatings along with weather resistant paint for the exterior doors should provide tight painted surfaces for a reasonable period of time under normal usage.

The surfaces from which the lead based paint was removed as described in the previous section A, Water Wash Paint Remover, were repainted as follows. [The percent lead by weight in the applied paint, is presented in parentheses.].

1. Kitchen walls, interior wood doors, and shelves, as shown in figure 10.

    1 coat alkyd enamel undercoat (0.005% lead)

    1 coat alkyd semi-gloss enamel (0.25% lead)

2. Exterior door, exterior screen door and frames, as shown in figure 11.

    1 coat oil base exterior primer (0.38% lead)

    1 coat oil base gloss exterior paint (0.38% lead)

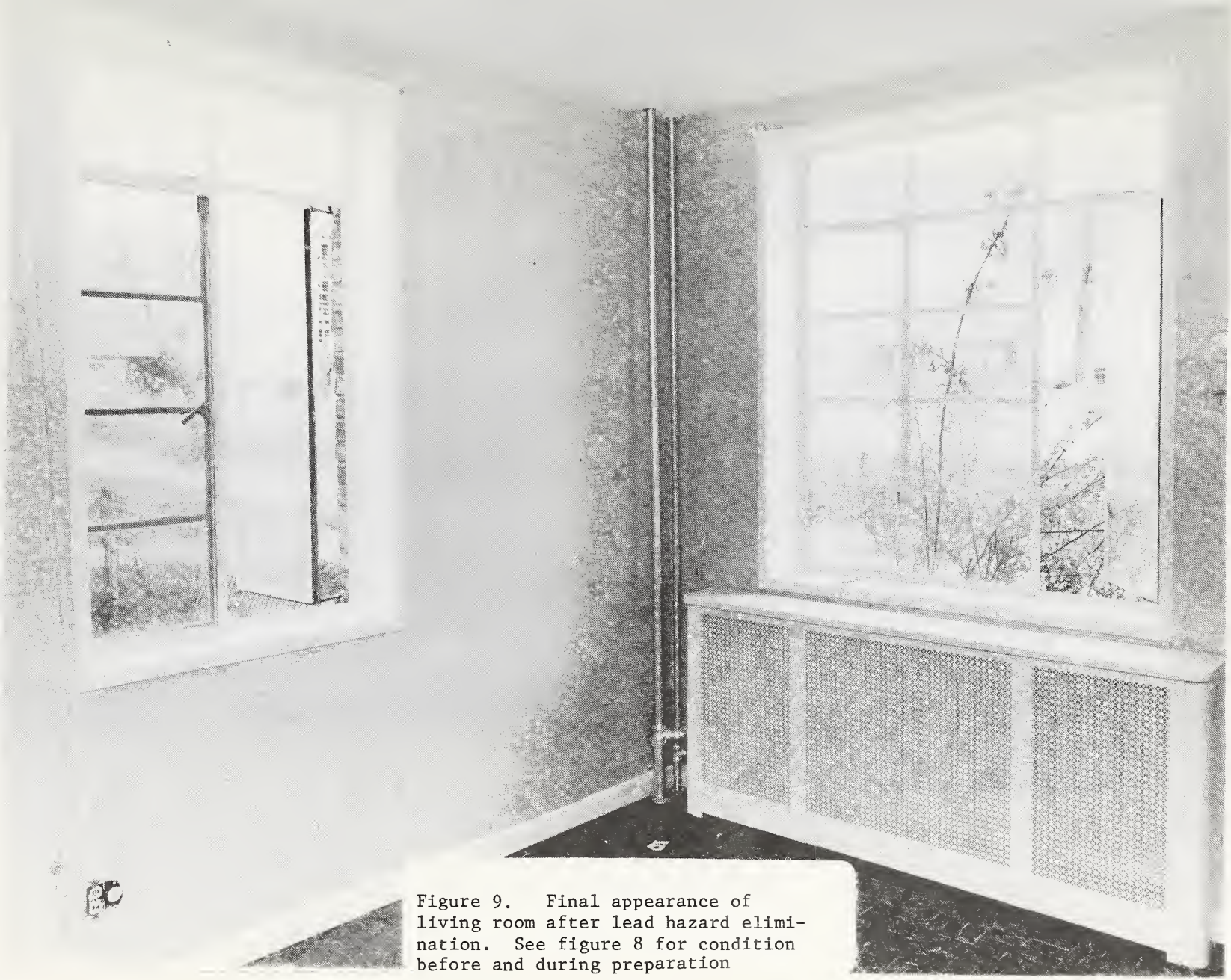

Figure 9. Final appearance of living room after lead hazard elimination. See figure 8 for condition before and during preparation

Figure 10. Re-finished plaster walls, shelving and metal window in kitchen.

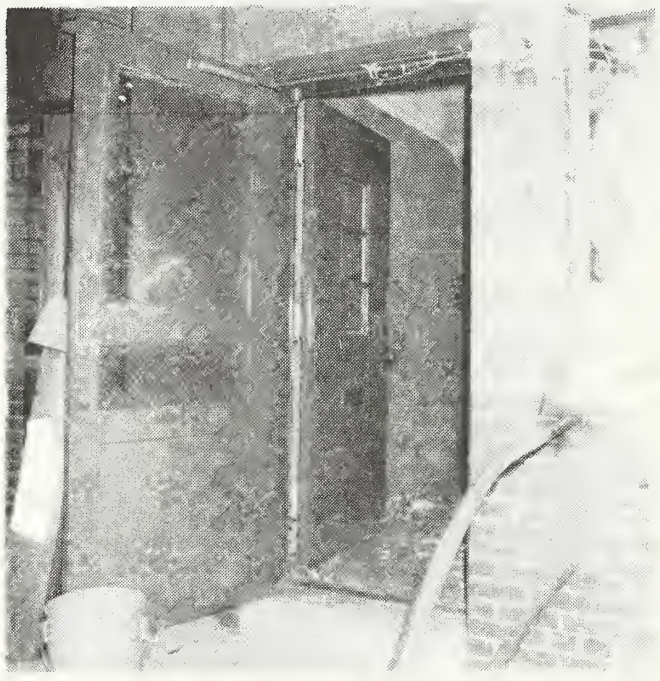

Figure 11. Re-finished wood exterior door, screen door and frame.

3. Windows and interior metal door frames, as shown in figure 12.

1 coat rust inhibitive primer (0.002% lead)

1 coat alkyd semi-gloss enamel (0.25% lead)

4. Metal steam pipes, as shown in figure 13.

1 coat rust inhibitive primer (0.002% lead)

1 coat aluminum oil base paint (0.001% lead)

The ceiling surfaces and closet walls from which the tightly adhering original paint was not removed, were covered as follows:

1 coat vinyl latex flat paint (0.003% lead)

D. Wood Base Molding: New wood base molding was used to cover and hold down the bottom edges of the newly installed wall covering.

The replacement wood base molding was painted as follows:

1 coat alkyd enamel undercoat (0.005% lead)

1 coat alkyd semi-gloss enamel (0.25% lead)

2.3. CONTRACTOR

All work, with the exception of the installation of new floor tiles was performed by one contractor. This union contractor had previous experience with all of the materials specified and had refinished old dwelling units.

The contractor was asked to provide:

a. Information on difficulties encountered in material use, unsuitable materials or delays due to job conditions and the reasons for such problems.

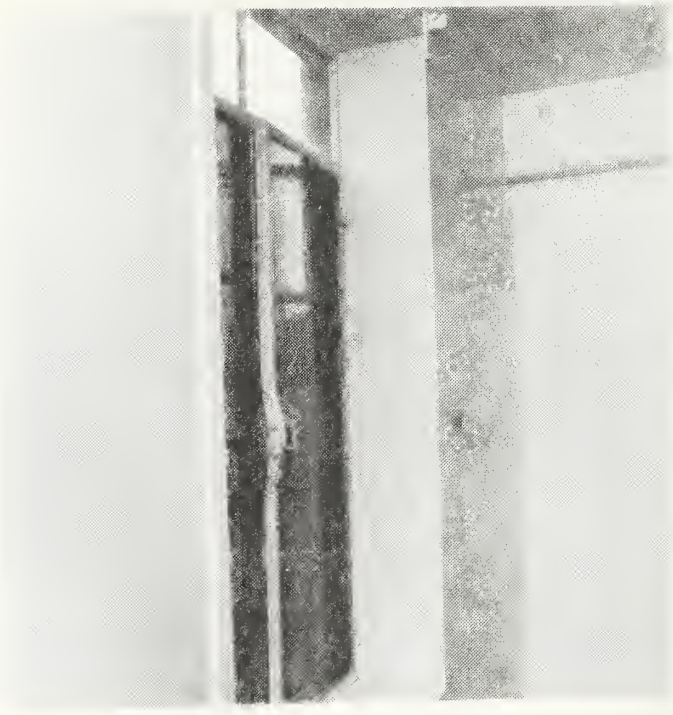

Figure 12. Re-finished plaster walls, metal window and concrete ceiling in kitchen.

Figure 13. Metal steam pipes in kitchen coated with 1 coat rust inhibitive primer and 1 coat heat resistant aluminum paint.

b. Type of skills used in performing the work.

c. Recommendations as to types of materials and/or variations in application for similar future work.

d. Cost breakdowns for the work.

A summary of the contractors responses to items a., b., and c. above are given in section 4.1. of this report.

The cost analysis presented in detail in section 5 of this report is based only in part on information provided by the contractor in response to item d., above. The cost collection formats provided to the contractor to assist him in preparing cost breakdowns required a far more careful surveillance of the job than the contractor carried out.

## 3. IMPLEMENTATION OF DELEADING METHODS

### 3.1. PREPARATION AND PRE-TREATMENT OF SURFACES

The preparation and pre-treatment work done on surfaces and the applicable x-ray fluorescence (XRF) measurements made after the removal of the old paint and prior to refinishing are presented in table 2.

The removal of leaded paint by means of chemical solvents and scraping was used in several areas of the dwelling unit that presented accessible hazards. This system was used to remove several layers of old leaded paint from plaster surfaces in the kitchen where there were large areas of blistered and peeling paint which would have been easily accessible to a young child.

| AREA | | WORK DONE | XRF READINGS ($mg/cm^2$) 1/ Range | Aver. |
|---|---|---|---|---|
| LIVING ROOM | Walls | Slight repair of plaster under windows. Old paint not removed | 0.1 to 1.8 | 1.2 |
| | Ceiling | No repair, old paint not removed | -- | -- |
| | Floor | None | -- | -- |
| | Doors | Old paint removed with remover and scraping | -- | -- |
| | Windows | Old paint removed with remover, scraping and steel wool | 0.0 to 1.0 | 0.6 |
| | Base molding | Completely removed | -- | -- |
| | Closet | No repair. Old paint not removed | -- | -- |
| | Radiators | Loose peeling paint removed | -- | -- |
| | Pipes | Old paint removed with paint remover, scraping and steel wool | -- | -- |
| KITCHEN | Walls | Old paint removed with remover and scraping | 0.2 to 4.6 | 2.0 |
| | Ceiling | No repair, old paint not removed | -- | -- |
| | Floor | None | -- | -- |
| | Windows | Old paint removed with remover, scraping and steel wool | 0.4 to 0.7 | 0.5 |
| | Base Molding | Completely removed | -- | -- |
| | Cabinets | No repair, old paint not removed | -- | -- |
| | Radiators | Loose, peeling paint removed | -- | -- |
| | Pipes | Old paint removed with remover, scraping and steel wool | -- | -- |
| BEDROOM | Walls | Slight repair of plaster under window. Old paint not removed | 1.0 to 2.4 | 1.9 |
| | Ceiling | Small crack repaired, old paint not removed | -- | -- |
| | Floor | None | -- | -- |
| | Doors | Old paint removed with remover and scraping | -- | -- |
| | Window | Old paint removed with remover, scraping and steel wool | 0.0 to 0.8 | 0.4 |
| | Base Molding | Completely removed | -- | -- |
| | Closet | No repair, old paint not removed | -- | -- |
| | Radiators | Loose, peeling paint removed. | -- | -- |
| | Pipes | Old paint removed with paint remover, scraping and steel wool. | -- | -- |
| BATHROOM | Walls | Slight repair of plaster in few locations. Old paint not removed | 1.0 to 2.0 | 1.8 |
| | Ceiling | No repair, old paint not removed | 1.0 to 2.0 | 1.8 |
| | Floor | None | -- | -- |
| | Door | Old paint removed with remover and scraping | -- | -- |
| | Window | Old paint removed with remover, scraping and steel wool | 0.0 to 0.6 | 0.3 |
| | Steam Pipe | Old paint removed with remover, scraping and steel wool | -- | -- |
| HALLWAY | Walls | No repair, old paint not removed | 1.5 to 2.1 | 1.9 |
| | Ceiling | No repair, old paint not removed | -- | -- |
| | Floor | None | -- | -- |
| | Door | Old paint removed with remover and scraping | -- | -- |
| | Closet | No repair, old paint not removed | -- | -- |
| | Base Molding | Completely removed | -- | -- |

Table 2. Preparation and Pre-Treatment of Surfaces. Pilot Demonstration

1/ -- XRF readings not taken.

Other surfaces, readily accessible to children, which were coated with tightly adhering lead based paint were also selected for paint removal by chemical softening and scraping. These areas included interior and exterior doors, window frames, etc. which were within the reach of children and of a chewable configuration.

3.2. REFINISHING OF SURFACES

The final refinishing materials used on each surface and the applicable x-ray fluorescence (XRF) measurements made after completion of the refinishing work are shown in table 3. The negative readings recorded in table 3 are valid and result from a combination of factors associated with calibration and standardization of the XRF instrument according to the manufacturer's recommendation. The negative readings can be adjusted to true positive values by comparison with standardization curves [3]. This was not done for this work because of small corrections involved and the fact that the negative readings indicated the absence or extremely small presence of lead, believed to be below the level of 1 $mg/cm^2$, which was our primary concern. It is recommended that future measurements be corrected according to a standardization curve for the particular instrument.

4. OBSERVATIONS AND COMMENTS

4.1. ADVANTAGES AND DISADVANTAGES OF METHODS

A. Lead Paint Removal: The water wash paint removal system worked satisfactorily (although it was quite time consuming) on the metal sills and frames of the casement windows. Some ineffectiveness of the liquid paint remover was noted because of rapid evaporation of solvents caused by heat in the steam pipe.

The removal of the old lead based paint from the damaged, loose and spot repaired plaster walls in the kitchen was time consuming and

| AREA | | MATERIALS USED | | XRF READINGS ($mg/cm^2$) 1/ Range | Aver. |
|---|---|---|---|---|---|
| LIVING ROOM | Walls | Covered with jute fabric/gypsum membrane | | -0.4 to 0.5 | -0.1 |
| | Ceiling | Painted 1 coat flat latex paint | | -- | -- |
| | Floor | New asphalt tile installed by NCHA | | -- | -- |
| | Doors | Painted 1 coat oil base exterior primer, and 1 coat oil base gloss exterior paint | Door | 2.4 to 6.2 | 4.1 |
| | | | Screen | 3.9 to 4.3 | 4.1 |
| | Windows | Painted 1 coat rust inhihitive primer, and 1 coat alkyd semi-gloss enamel | | -0.5 to 0.1 | -0.2 |
| | Base Molding | New wood molding painted 1 coat alkyd enamel undercoat and 1 coat alkyd semi-gloss enamel | | 0.7 to 1.1 | 1.0 |
| | Closet | Painted 1 coat alkyd semi-gloss enamel | | -- | -- |
| | Radiators | Metal radiator cover/baked enamel finished | | -0.9 to -0.1 | -0.5 |
| | Steam Pipes | 1 coat rust inhibitive primer and 1 coat aluminum oil base paint on pipes | | -- | -- |
| BEDROOM | Walls | Covered with jute fabric/gypsum membrane | | -1.5 to 0.3 | -0.5 |
| | Ceiling | Painted 1 coat flat latex paint | | -- | -- |
| | Floor | New asphalt tile installed by NCHA | | -- | -- |
| | Doors | Painted 1 coat alkyd enamel undercoat and 1 coat alkyd semi-gloss enamel | | 2.4 to 3.6 | 3.1 |
| | Window | Painted 1 coat rust inhibitive primer and 1 coat alkyd semi-gloss enamel | | -0.6 to -0.2 | -0.4 |
| | Base Molding | New wood molding painted 1 coat alkyd enamel undercoat and 1 coat alkyd semi-gloss enamel | | -0.1 to 1.3 | 0.7 |
| | Closet | Painted 1 coat flat latex paint | | -- | -- |
| | Radiator | Metal radiator cover/baked enamel finish | | -0.9 to 0.1 | -0.5 |
| | Steam | 1 coat rust inhibitive primer and 1 coat aluminum oil base paint on pipes | | -- | -- |
| KITCHEN | Walls | Resurfaces with white coat plaster, 1 coat alkyd enamel undercoat, and 1 coat alkyd semi-gloss enamel | | -1.2 to 3.2 | 0.6 |
| | Ceiling | Painted 1 coat flat latex paint | | -- | -- |
| | Floor | New asphalt tile installed by NCHA | | -- | -- |
| | Door | -- | | -- | -- |
| | Windows | Painted 1 coat rust inhibitive primer and 1 coat alkyd semi-gloss enamel | | -0.6 to 0.5 | 0.1 |
| | Base Molding | New wood molding painted 1 coat alkyd enamel undercoat and 1 coat alkyd semi-gloss enamel | | 0.5 to 1.3 | 1.7 |
| | Cabinets | Painted 1 coat alkyd semi-gloss enamel | | -- | -- |
| | Radiator | Metal radiator cover/baked enamel finish | | -0.9 to 0.1 | -0.5 |
| | Steam Pipes | 1 coat rust inhibitive primer and 1 coat aluminum oil base paint on pipes | | -- | -- |
| BATHROOM | Walls | Covered with vinyl membrane | | 0.6 to 2.4 | 1.4 |
| | Ceiling | Painted 1 coat flat latex paint | | -- | -- |
| | Floor | None | | -- | -- |
| | Door | Painted 1 coat alkyd enamel undercoat and 1 coat alkyd semi-gloss enamel | | 2.4 to 3.6 | 3.1 |
| | Window | Painted 1 coat rust inhibitive primer and 1 coat alkyd semi-gloss enamel | | -0.2 to 0.5 | 0.2 |
| | Steam Pipe | Painted 1 coat rust inhibitive primer and 1 coat aluminum oil base paint | | -- | -- |
| HALLWAY | Walls | Covered with jute fabric/gypsum membrane | | -0.3 to 0.0 | -0.1 |
| | Ceiling | Painted 1 coat flat latex paint | | -- | -- |
| | Floor | New asphalt tile by NCHA | | -- | -- |
| | Door | Painted 1 coat alkyd enamel undercoat and 1 coat alkyd semi-gloss enamel | | 2.4 to 3.6 | 3.1 |
| | Closet | Painted 1 coat flat latex paint | | -- | -- |
| | Base Molding | New wood molding painted 1 coat alkyd enamel undercoat and 1 coat alkyd semi-gloss enamel | | 0.1 to 0.3 | 0.2 |

Table 3. Description of Re-Finished Surfaces. [illegible] Demonstration

1/ -- XRF readings not taken.

created additional problems. Much of the plaster was loosened from the wall or was badly scratched by the scraping operation which followed the paint remover application (as can be seen in figures 5, 6, and 7). Preparation of the kitchen walls with a white coat of plaster was required prior to painting.

On the basis of his experience the contractor stated his opinion that:

1. Chemical paint removers excel on smooth, hard, (i.e. metal) painted surfaces in stripping thoroughness, saving in worker time and effort as compared to blow-torch removal techniques;

2. In the case of the kitchen plaster walls, time and labor costs could have been reduced by just removing the loose paint, repairing damaged areas, and covering with medium to heavy-weight vinyl wall covering, and;

3. Another alternative for cost reduction would have been to apply gypsum dry wall with adhesive over the cleaned and scraped kitchen plaster wall. When ready to receive paint, he estimated that this method could have been applied at an approximate cost $.50 per square foot as compared with $1.42 per square foot for paint removal and plastering.

B. Replacement Systems: Although no direct cost comparison data were available, the contractor believed that the lightweight interior doors could have been replaced with new doors and painted at a lower cost then removing paint and repainting the old doors. In contrast, he felt that complete replacement and painting of interior door frames, heavy exterior doors, and windows and window frames would have increased costs.

As an alternative to wood baseboard replacement and painting he suggested that a less expensive treatment would have been to install a vinyl molding after removal of the old wooden baseboards.

C. Prefinished Covering Materials: Work including: minor repairs made on the painted plaster walls in the living room, bedroom, bathroom and hallway; adhesive application and placing of the covering was accomplished effectively by two skilled wallpaper hangers in one day. The workers stated that the gypsum impregnated jute fabric material was easy to handle and to apply. The final appearance of the covered walls is considered quite attractive.

D. Repainting Systems: The appearance of repainted surfaces was dependent on the degree of surface preparation. Well prepared metal sills and frames of the windows took on a like-new appearance after painting. Painting of the exterior wood doors and kitchen plaster walls, however, did not hide surface irregularities which remained after surface preparation.

## 4.2. REDUCTION OF LEAD BASED PAINT HAZARD

One quantitative measure of the effectiveness of a lead based paint hazard elimination system is the decrease of the lead content resulting from the implementation of the particular method. Obviously this criterion does not apply to covering systems where the original lead paint is not removed from the surface. The effectiveness of covering systems will depend on their performance, their resistance to puncture and wear, and their tight adherence to the lead containing surface over a period of time.

Table 4 presents a comparison of the lead contents measured by the portable XRF in $mg/cm^2$ on typical surfaces in the pilot dwelling unit. It is interesting to note that lower lead levels were measured for every surface treated including those that were covered with membrane type systems. Since the lead containing paint was not removed from the living room, bedroom, bathroom, and hallway wall surfaces it is believed that this reduction was caused by attenuation of the x-rays by the covering material. This reduction is particularly noticeable on areas covered with the gypsum impregnated, jute fabric membrane.

Fairly substantial reductions in lead content were observed on the kitchen walls (3.0 $mg/cm^2$ to 0.6 $mg/cm^2$) and metal window frames (0.9 $mg/cm^2$ to 0.2 $mg/cm^2$ or less) from which the original lead based paint was removed. In these cases the original paint had been applied to hard, impervious surfaces. Application of the paint remover followed by scraping and washing removed virtually all of the old leaded paint. By contrast, it can be noted that the reduction of lead content on both exterior and interior wooden doors was measurably less than for the kitchen walls, and metal window frames. This difference was probably caused by the old leaded paint which penetrated into the porous wood fibers and was not leached out by the paint remover solvent and scrape operation.

These results suggest that where maximum removal of the lead paint hazard on wooden surfaces is desired, complete replacement may be the preferred solution. It can be argued, however, that lead pigments absorbed into wood fibers do not present a serious hazard especially when a tightly adhered non-leaded finish coat of paint is applied over them since the residual leaded paint is virtually inaccessible to a child.

| Surface | | Preparation and/or Refinishing of Surface | Lead Content Average XRF Readings ($mg/cm^2$) Before Preparation and/or Refinishing | After Refinishing |
|---|---|---|---|---|
| INTERIOR | | | | |
| Living Room | Walls | Slight plaster repaired - old paint not removed Covered with jute fabric/gypsum | 1.2 | -0.1 |
| | Base Molding | Installed new wood base molding. One coat alkyd enamel primer, one coat alkyd enamel | 1.3 | 1.0 |
| | Windows | Old paint removed. One coat rust inhibitor primer, one coat alkyd enamel | 0.9 | - .02 |
| Bedroom | Walls | Slight plaster repaired - old paint not removed Covered with jute fabric/gypsum | 1.9 | -0.5 |
| | Base Molding | Installed new wood base molding. One coat alkyd enamel primer, one coat alkyd enamel | 1.9 | 0.7 |
| | Windows | Old paint removed. One coat rust inhibitor primer, one coat alkyd enamel | 0.9 | -0.4 |
| | Door | Old paint removed. One coat alkyd enamel primer, one coat alkyd enamel | 6.8 | 3.1 |
| Kitchen | Walls | Old paint removed. Re-surfaced with white coat plaster. One coat alkyd enamel primer, one coat alkyd enamel | 3.0 | 0.6 |
| | Base Molding | Installed new wood base molding. One coat alkyd enamel primer, one coat alkyd enamel | 1.4 | 0.7 |
| | Windows | Old paint removed. One coat rust inhibitor primer, one coat alkyd enamel | 0.9 | 0.1 |
| Bathroom | Walls | Plaster repaired. Old paint not removed. Covered with vinyl membrane | 1.8 | 1.4 |
| | Window | Old paint removed. One coat rust inhibitor primer, one coat alkyd enamel | 0.9 | 0.2 |
| | Door | Old paint removed. One coat alkyd enamel primer, one coat alkyd enamel | 6.3 | 3.1 |
| Hallway | Walls | No repair. Old paint not removed. Covered with jute fabric/gypsum | 1.9 | -0.1 |
| | Base Molding | Installed new wood base molding. One coat alkyd enamel primer, one coat alkyd enamel | 1.0 | 0.2 |
| | Closet Door | Old paint removed. One coat alkyd enamel primer, one coat alkyd enamel | 6.3 | 3.1 |
| EXTERIOR | | | | |
| | Front Door | Old paint removed. One coat oil base exterior primer, one coat oil base exterior paint | 10.0 | 4.1 |
| | Front Screen Door | Same as Front Door | 4.6 | 4.1 |

Table 4. Comparison of Lead Content on Typical Surfaces Before and After Deleading

## 5. COST ANALYSIS

The labor and material costs and work rate data for the dwelling unit for both preparation and refinishing work done on the kitchen walls, windows and doors, and the wood base molding are presented in table 5. Because little or no surface preparation was required on the ceilings before the application of the one coat of paint, and, on the living room, hallway, bedroom and bathroom walls before application of the membrane coverings, only data on refinishing those surfaces is provided. The information is based on a cost breakdown provided by the contractor, verification of material costs by the distributor, and spot checks on material usage and man-hours by the NBS Lead Based Paint Poisoning Project staff.

The labor furnished for the job consisted of one painter, one painter's helper and two wallpaper hangers. Two additional supporting personnel, carried by overhead costs, were an estimator-timekeeper and a clerk. The labor rate used in table 5 is based on an average hourly rate per man of $11.71 and includes profit, overhead, Federal Insurance Contributions (FICA), Federal Unemployment Tax (FUTA), and insurance and welfare fund.

Slightly more than 50% of the 20 man-days spent on this unit was utilized in removing paint from the kitchen walls, six windows, and six doors, and is reflected in the cost of surface preparation shown in table 5.

| Item | Surface Preparation | | | | Surface Refinishing | | | | Total $/sq ft | Summary of Work Performed |
|---|---|---|---|---|---|---|---|---|---|---|
| | Labor[1] $/sq ft | Matl. $/sq ft | Sub Total $/sq ft | Work Rate sq ft/ man-hr | Labor[1] $/sq ft | Matl. $/sq ft | Sub Total $/sq ft | Work Rate sq ft/ man-hr | | |
| Kitchen Walls | 1.32 | 0.10 | 1.42 | 9 | 0.17 | 0.03 | 0.20 | 71 | 1.62 | Old paint removed. Plaster wall repaired. 1 coat enamel undercoat and 1 coat enamel finish |
| Windows, Doors, Shelves, Cabinets | 0.92 | 0.10 | 1.02 | 13 | 0.41 | 0.04 | 0.45 | 29 | 1.47 | Old paint removed. 1 coat undercoat and 1 coat enamel finish |
| Wood Base Molding | 0.59* | 0.30* | 0.89* | 20* | 0.10* | 0.01* | 0.11* | 107* | 1.00* | Old wood base removed. New wood base installed. 1 enamel undercoat and 1 enamel finish coat. |
| Ceilings, Closets | - | - | - | - | 0.08 | 0.02 | 0.10 | 143 | 0.10 | 1 coat flat latex. |
| Living, Bedroom, Hall Walls | - | - | - | - | 0.26 | 0.45 | 0.71 | 45 | 0.71 | Jute fabric/gypsum impregnated covering. |
| Bathroom Walls | - | - | - | - | 0.39 | 0.34 | 0.73 | 30 | 0.73 | Vinyl wall covering. |

1/ Includes hourly rate, welfare fund, 11% insurance, 15% overhead, 10% profit, and 6% FICA plus FUTA.

* Wood Base Molding cost and work-rate data are presented in $/lin. ft. and lin. ft./man-hr. respectively.

Table 5. Cost Analysis and Work-Rate Data for Pilot Demonstration Unit No. 1

It is also interesting to note in table 5 that the labor cost incurred for paint removal from the kitchen walls is higher than for interior windows and doors. This seemingly inconsistent result is attributed to the additional labor required to patch, replaster, and smooth the wall surfaces, an operation not required for the interior windows (except for one sill) and doors. The total cost per square foot for the various methods of flat surface preparation and refinishing ranked as follows (from highest cost to lowest cost):

1. Paint removal and repainting of kitchen walls.
2. Paint removal and repainting interior windows, doors, cabinets and shelves.
3. Installation of vinyl wall covering in bathroom with considerable trimming required.
4. Installation of jute fabric/gypsum membrane covering on flat surfaces.
5. Repainting only over existing painted ceiling.

Table 6 presents a comparison of the total refinishing costs as derived from the cost data submitted by the contractor with costs that would be estimated using Means 1/. As can be noted from the last two columns of this table, total costs for the various refinishing methods are in good agreement.

A summary of the refinished areas in the dwelling unit is provided in table 7.

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1/ "Building Construction Data - 1973 Edition", published by Robert S. Means Company, Inc.

| Item | Estimated/Means 1973 Edition | | | Estimated Refinish Cost Unit No. 1 $/sq ft | Remarks |
|---|---|---|---|---|---|
| | Labor[1/] $/sq ft | Material[1/] $/sq ft | Total Refinish Cost $/sq ft | | |
| Kitchen Walls | .11 | .04 | .15 | .20 | One coat enamel primer<br>One coat enamel |
| Wood Base Molding | .08* | .03* | .11* | .11* | One coat enamel primer<br>One coat enamel |
| Living, Bedroom, Hall Walls | .19 | .56 | .75 | .71 | Jute fabric/gypsum impregnated covering |
| Bathroom Walls | .31 | .38 | .69 | .73 | Vinyl wall covering |

1/ Adjusted by +25% for overhead, profit, etc.

* Wood Base Molding cost data are presented in $/lin. ft.

Table 6. Comparison of Surface Refinishing Costs

Table 7. Summary of Refinished Areas for Pilot Demonstration Unit No. 1

| | Sq ft |
|---|---|
| **I. Painting** | |
| A. One coat vinyl latex | |
| 1. Living room ceiling | 150 |
| 2. Bedroom ceiling | 140 |
| 3. Kitchen ceiling | 80 |
| 4. Bathroom ceiling | 40 |
| 5. Hall ceiling | 40 |
| 6. Closets | |
| a. Bedroom (walls and ceiling) | 110 |
| b. Hall (walls, ceiling and floor) | 155 |
| Total (one coat) | 715 |
| B. One coat enamel finish | |
| 1. Bedroom closet shelving | 15 |
| 2. Hall closet shelving | 15 |
| Total (one coat) | 30 |
| C. One coat enamel undercoat and one coat enamel finish [1/] | |
| 1. Kitchen walls | 355 |
| 2. Kitchen wall cabinets | 90 |
| 3. Bathroom cabinet | 15 |
| 4. Doors (wood doors with metal frames) | 330 |
| 5. Windows (steel casement) | 120 |
| Total (one coat) | 910 |
| Total (two coats) | 1820 |
| **II. Wall Coverings** | |
| A. Vinyl | |
| 1. Bathroom | 122 |
| B. Jute fabric/gypsum | |
| 1. Living room | 181 |
| 2. Bedroom | 303 |
| 3. Hall | 128 |
| Total | 734 |

1/ In addition to the following, 160 linear feet of wood baseboard (3" high) received one coat enamel undercoat and one coat enamel finish.

## 6. REFERENCES

[1] Gilsinn, J., "Estimates of the Nature and Extent of Lead Paint Poisoning in the United States", National Bureau of Standards Technical Note 746, (December 1972).

[2] Rasberry, S. D., "Investigation of Portable X-Ray Fluorescence Analyzers for Determining Lead on Painted Surfaces", Applied Spectroscopy, Volume 27, Number 2, 102, (1973).

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FORM NBS-114A (1-71)

| U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET | 1. PUBLICATION OR REPORT NO. NBSIR 73-242 | 2. Gov't Accession No. | 3. Recipient's Accession No. |
|---|---|---|---|

4. TITLE AND SUBTITLE

Pilot Demonstration of Lead Based Paint Hazard Elimination Methods. Report on Field Study No. 1

5. Publication Date

6. Performing Organization Code


7. AUTHOR(S)
Thomas H. Boone, Theodore R. Ray, William G. Street


8. Performing Organization
NBSIR 73-242


9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234


10. Project/Task/Work Unit No.
4608400

11. Contract/Grant No.
IAA-H-34-71

12. Sponsoring Organization Name and Address

Office of Policy Development and Research
Department of Housing and Urban Development
Washington, D.C. 20410

13. Type of Report & Period Covered
Final

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)


This report describes the elimination of the hazard of lead bearing paints in a one bedroom apartment using materials and procedures that are undergoing laboratory and field evaluation by the National Bureau of Standards (NBS). Paint removal was used to eliminate the hazard from some surfaces and two nonhazardous membrane type coverings were installed as barrier materials over the residual leaded paint on other surfaces. The preparation and refinishing of the interior surfaces are described and work rates and cost data are presented.

This pilot demonstration is the first of a series of studies that will be used to determine the merits of various lead based paint hazard elimination methods when applied to actual housing conditions.

Final recommendations for further use of materials and systems, described in this report, are not presented due to the preliminary nature of this work. The completion of the projected series of demonstrations and the long term evaluation of the in-use performance of the materials and systems will be required before final recommendations can be made.



17. KEY WORDS (Alphabetical order, separated by semicolons)
Cost analysis; hazard elimination; lead based paint; housing; lead based paint; materials; surface preparation; surface refinishing


18. AVAILABILITY STATEMENT

[x] UNLIMITED.

[ ] FOR OFFICIAL DISTRIBUTION. DO NOT RELEASE TO NTIS.

19. SECURITY CLASS (THIS REPORT)
UNCLASSIFIED

21. NO. OF PAGES

20. SECURITY CLASS (THIS PAGE)
UNCLASSIFIED

22. Price