The Connecticut Agricultural Experiment Station, New Haven

Lead Content of Paint in Connecticut Homes

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SUMMARY

The lead content in 292 paint chip samples from 48 older dwellings in Hamden, North Haven and New Haven, Connecticut was determined. Over half of the samples contained more than 0.5% Pb, and almost 20% contained more than 10% Pb. In 46 of the dwellings (96%), at least one sample contained more than 0.5% Pb, and about half of the dwellings had at least one sample greater than 10% Pb. The samples were classed by location. Exterior surfaces contained the highest lead contents. For interior surfaces, high lead levels are much more likely on window trims than on ceilings, walls, interior door surfaces, and to a lesser extent, on door trims and baseboards.

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Prior to the mid 1900's, lead (Pb) salts were used extensively for pigments in paints. Indeed, until the late 19th Century, and for two thousand years before that, white lead ($2PbCO_3 \cdot Pb(OH)_2$) was the only known white pigment (Toch, 1925). Other common lead salts used in paints included lead sulfate ($PbSO_4$), litharge yellow (PbO), red lead (Pb_3O_4), and chrome yellow (lead chromate $PbCrO_4$). By the early to mid 20th Century, alternative white pigments, such as titanium dioxide (TiO_2), zinc oxide (ZnO), and calcium oxide (CaO) were introduced commercially. Nonetheless, lead based paint was preferred due to its superior covering properties, ease of application, and preservative qualities (Toch, 1925).

Thus, the use of lead based paint in housing predominated until the mid 1950's when the severity of lead paint poisoning, particularly in children, became recognized. Since then, the health effects have been well documented (Boeckx 1986, Greeley 1991, Barnes 1990, Jelinek 1982). Some of the effects include kidney, liver, nerve, reproductive, immune, cardiovascular, and gastrointestinal damage. In children, there is ample evidence that lead has an adverse effect on intellectual development. Extremely high levels of lead causes degenerative brain disease, which, if untreated, can cause death.

To address these health concerns, Congress, in 1971, passed the Lead-Based Paint Poisoning Prevention Act, mandating that paint destined for household use after 1977 contain no more than 600 ppm (0.06%) lead by dry weight (Code of Federal Regulations, 1987). Despite this, the U.S. Department of Housing and Urban Development (HUD) estimated that 75% of all private housing built before 1980 has some lead paint, and 20 million of these have excess lead dust or chipped lead paint. Some form of lead abatement is required by state regulations when defective surfaces are found to contain more than 0.5% lead by weight. In general, an intact surface does not have to be abated, but regulations require a lead management plan be written which describes the intact surfaces.

To assess the degree of lead contamination, we analyzed 292 paint chip samples collected by the Quinnipiac Valley (QVHD) and New Haven (NHHD) Health Departments, between January 1988 and August 1991, from 47 older (pre 1950) dwellings. Since these samples were not collected randomly, the results are only indicative of the extent of lead based paint in homes in the New Haven area.

ANALYTICAL METHODS

Representative portions of the paint chips submitted for analysis were weighed, ashed at 550C for 1 hour, and digested in 50% nitric acid. After digestion, the samples were transferred to a 100 ml volumetric flask, brought to volume with deionized water, and the inert residues were allowed to settle overnight. Finally, the lead content was determined by inductively coupled plasma atomic emission spectroscopy (ICP-AES)(Paudyn and Smith, 1990). Background correction techniques were employed to subtract spectral interferences.

To validate this method, two quality control issues were addressed during this study: the first was spike recovery measurements and the second was sample homogeneity. For the recovery determinations, paint containing no lead was spiked (with a standard Pb solution) to a final solution concentration of 2 mg/l Pb, and processed with 15 sample batches. Recovery of Pb from the spiked solutions varied between 90%-110%, at the 95% confidence limit. This established that no analyte was lost by volatilization, and that any matrix effects between sample and standards were minimal. Sample homogeneity was determined by testing duplicate samples. In addition, 20 samples of a ground (<0.5mm) paint sample containing about 5% Pb were tested over a 1 year period. The results established that sample inhomogeneity (about 20% variation) was greater than the variance associated with the spike recovery (10%). Consequently, the values given below are considered accurate to within ±20% of the stated value. Imprecision arising from sample inhomogeneity has also been reported by Corl (1991).

RESULTS

The lead content in paint samples from different locations in the towns of Hamden, North Haven, and New Haven is given in Table 1. Several points concerning the data in Table 1 should be noted: 1) over half of the samples (154) contained more than 0.5% Pb; 2) almost 20% (52) of the samples contained more than 10% lead; 3) almost all of the dwellings (96%) had at least one sample greater than 0.5% Pb; and 4) about half (53%) of the dwellings had at least one sample containing more than 10% lead. These findings confirm that lead paint is prevalent in older houses in the Hamden-New Haven area.

Various reports prepared for HUD which have been summarized in the public press (e.g. Newsweek 7/15/91, New York Times 4/7/91) have indicated that certain surfaces, such as window trims and exteriors, are more likely to have leaded paint. To determine if this is valid for the towns studied, the frequency of occurrence was tabulated as a function of lead content and surface location (Table 2). Table 2 shows that it is much less likely to find a high lead content in paint on ceilings, walls, interior doors, and to a lesser extent, on door trims and baseboards than window trims and exterior surfaces. This is illustrated by the examples given in Figures 1-3. In Figures 1 and 3, the frequency distributions clearly depict the vastly lower probability of finding a high lead content in interior ceilings and walls compared to exterior surfaces. In Figure 2, the more problematic case of window surfaces is illustrated. Note that it is almost as likely to encounter a sample between any of the ranges shown, with the exception of >20% Pb.

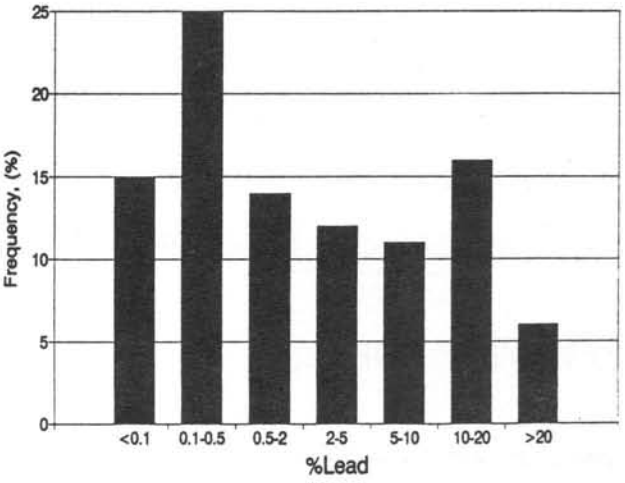

Figure 2. Frequency distribution of lead content in interior windows (Samples = 110)

Our data on the lead content in paint by sample location is summarized in Table 3. Exterior surfaces contained the highest lead contents. Taken together, 88% of all exterior surfaces sampled exceeded 0.5% lead, 43% of the samples contained more than 20% lead (Table 2), and some even exceeded 40% lead. Damaged exterior surfaces pose a health risk because the peeling paint can contaminate soil. Interior window trims also pose a risk, since about 60% of the window trim samples tested contained more than 0.5% lead, and 22% contained more than 10% lead (Table 2). The abrasion of surfaces by opening or closing a window can generate lead dust.

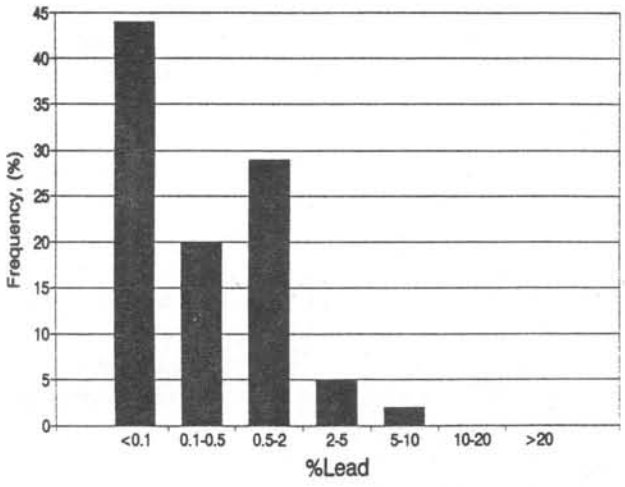

Figure 1. Frequency distribution of lead content in ceilings and walls (Samples = 41)

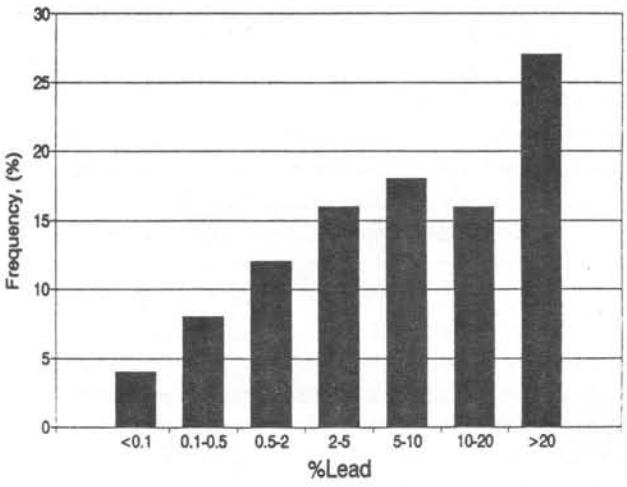

Figure 3. Frequency distribution of lead content in all exterior samples (Samples = 51).

Table 1. Lead content in paint samples from Hamden, New Haven, and North Haven.

Dwelling Number	Street* Location	No. Samples	Range % Pb	No. < 0.5% Pb	No. >0.5 % <10% Pb	No. > 10 % Pb
1	Arch St.(H)	3	0.003-5.5	2	1	0
2	Beacon St.(H)	4	0.04-24.6	1	0	3
3	Circular Ave.(H)	11	0.09-32.5	5	5	1
4	Dix St. (H)	16	0.01-12.5	10	4	2
5	Dixwell Ave. (H)	7	0.15-44	3	2	2
6	Dixwell Ave. (H)	4	0.06-19.5	1	0	3
7	Dixwell Ave. (H) 1st Floor	3	0.13-4.07	1	2	0
8	Dixwell Ave. (H) 2nd Floor	18	0.003-33.8	8	5	5
9	Goodrich St. (H) 1st Floor	3	0.07-0.73	1	2	0
10	Goodrich St. (H) 3rd Floor	4	0.01-0.68	2	2	0
11	Mather St. (H)	4	0.31-22.6	1	0	3
12	Morse St. (H)	6	0.05-3.0	5	1	0
13	Morse St. (H)	3	6.1-29.2	0	2	1
14	Paramount Ave. (H)	12	0.05-20.0	2	5	5
15	Whitney Ave. (H)	7	0.02-1.4	3	4	0
16	Winchester Ave. (H) 2nd Floor	4	0.19-1.3	3	1	0
17	Winchester Ave. (H) 3rd Floor	3	0.1-0.3	3	0	0
18	Beacon St. (H)	4	0.04-24.6	1	0	3
19	Gorham Ave. (H)	5	0.03-12.2	4	0	1
20	Whiting St. (H)	1	19.8	0	0	1
21	Maple Ave. (NOH)	1	8.9	0	0	1
22	Yale Legal Serv. (NH)	4	0.09-1.6	3	1	0
23	Dudley St. (H) 1st Floor	6	0.09-4.0	3	3	0
24	Dudley St. (H) 2nd Floor	4	0.81-5.4	0	4	0
25	Hillside Ave. (NH)	3	0.39-0.57	1	2	0
26	Dixwell Ave. (H)	4	0.2-21	2	1	1
27	Geenwich Ave. (NH)	14	0.05-8.0	5	9	0
28	Maplewood Terrace (H)	3	0.01-5.5	2	1	0
29	Beer St. (NH)	8	0.005-22.0	3	4	1
30	Harmon St. (H)	3	0.06-12	1	0	2
31	State St. (NOH)	5	0.01-4.3	1	4	0
32	Benham St. (H)	8	0.01-13	4	3	1
33	Dixwell Ave. (H)	3	0.2-0.8	2	1	0
34	Hamton Rd. (H)	2	2.3-9.0	0	2	0
35	Dixwell Ave. (H)	4	0.15-6.8	1	3	0
36	Helen St. (H)	10	0.05-25.3	7	1	2
37	Winchester Ave. (NH)	3	0.12-28.2	2	0	1
38	Elliot St. (NH)	6	0.02-5.91	4	2	0
39	YWCA (Residences) (NH)	18	0.02-6.5	11	7	0
40	Lamberton St. (NH)	5	0.0-0.26	5	0	0
41	Howard Ave. (NH)	7	0.11-13	5	1	1
42	First Ave. (NH)	6	0.55-46	0	1	5
43	#8950 (NH)	8	0.05-1.0	4	4	0
44	Howard Ave. (NH)	13	0.02-21	7	4	2
45	Pendleton St.(NH)	4	0.16-43	2	1	1
46	Quinipiac Ave.	15	0.01-14	7	5	3
47	Edgehill Rd.	3	0.51-30	0	2	1
TOTALS		292		138	102	52

* (H) = Hamden, (NH) = New Haven, (NOH) = North Haven (Street Address Omitted)

Moreover, window sills are more prone to environmental stress causing the paint to peel and crack.

Analysis of the lead content in painted interior window trim is further complicated by the variability found between different window trim within a particular dwelling. In eleven dwellings, three or more interior windows were sampled. In eight of these dwellings, we found a range of more than 5% total lead content between windows sampled in different rooms. For example, the range in lead content among windows for dwelling #4 (Dix St.-7 windows), dwelling #8 (Dixwell Ave.-11 windows), and dwelling #14 (Paramount Ave.-9 windows), was 0.01-12.5, 0.01-27, and 1-20% Pb, respectively. Moreover, significant variations were detected within a single window trim. For eight windows in five dwellings, multiple samples were taken from different parts of the same windows. In six instances the total lead content varied by more than 5%. For example, in one case (dwelling #8) the window sash contained 0.1% Pb, while the window sill-well contained 12% Pb. In other cases, the

Table 2. Frequency of % Pb by sample location (N= number of samples).

INTERIOR			EXTERIOR		
% Pb	No.	Freq.(%)	%Pb	No.	Freq. (%)
WINDOW SILLS/JAMBS/SASH (N=110)			EXT TRIM/JAMB-DOOR-WINDOWS (N=27)		
<0.1	17	15	<0.1	1	4
0.1-0.5	28	25	0.1-0.5	2	7
0.5-2	15	14	0.5-2	2	7
2-5	13	12	2-5	1	4
5-10	12	11	5-10	5	18
10-20	18	16	10-20	5	18
>20	7	6	>20	11	41
DOOR TRIM/BASEBOARDS (N=56)			EXT-WALLS AND DOOR SURFACE (N=11)		
<0.1	11	20	<0.1	0	0
0.1-0.5	28	50	0.1-0.5	0	0
0.5-2	9	16	0.5-2	3	27
2-5	6	11	2-5	3	27
5-10	1	2	5-10	3	27
10-20	1	2	10-20	1	9
>20	0	0	>20	1	9
CEILINGS/WALLS (N=41)			EXT-STAIR-WAY/WELL-ENTRY/PORCH (N=13)		
<0.1	18	44	<0.1	1	8
0.1-0.5	8	20	0.1-0.5	2	15
0.5-2	12	29	0.5-2	1	8
2-5	2	5	2-5	4	31
5-10	1	2	5-10	1	8
10-20	0	0	10-20	2	15
>20	0	0	>20	2	15
INTERIOR DOOR SURFACE (N=15)			ALL EXTERIOR SAMPLES (N=51)		
<0.1	9	60	<0.1	2	4
0.1-0.5	4	27	0.1-0.5	4	8
0.5-2	1	7	0.5-2	6	12
2-5	1	7	2-5	8	16
5-10	0	0	5-10	9	18
10-20	0	0	10-20	8	16
>20	0	0	>20	14	27

window jamb contained 34% Pb, while the window sill contained 0.2% Pb (dwelling #8), or the window inner sill contained 2.3% Pb, while the sill-well contained 20% Pb (dwelling #14). These variations suggest that many of these older structures have undergone some reconstruction which partially removed the leaded paint. These results imply that an accurate assessment of the total lead burden within a structure can only be accomplished by sampling every surface, which is an economic impracticality, for laboratory analysis. In addition, measurement of the lead content in a particular window trim is best accomplished by sampling the various trim surfaces. These samples could be blended to obtain an average value. Alternatively, field methods, such as X-ray fluorescence or chemical spot tests can be employed for the initial screening. Laboratory methods are more accurate, and should be used in those instances where the results from field methods are inconclusive.

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Table 3. Summary of lead in paint by sample location.

	No. Samples	%Pb Range	%Pb Avg	%Pb Median	% of Samples >0.5% Pb
INTERIOR					
Window Sills/Jambs/Sash	110	<.01-44	5.9	1.2	59
Door Trim/Baseboards	56	<0.01-14	1.0	0.26	30
Wall/Ceiling	41	<.01-5.5	0.6	0.14	37
Door	15	<0.01-3.5	0.4	0.06	13
EXTERIOR					
All Trim	27	0.03-43	15	12	89
Wall/Door	11	1.1-29	7.2	4	100
Stairwell/Entry/Porch	13	0.09-46	9.5	3	77
All Exterior	51	0.03-46	12	9	88
MISC. INT./EXT	19	0.01-6.5	1.5	0.5	50

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