NATIONAL BUREAU OF STANDARDS REPORT

10 958

FINAL REPORT, PHASE I
LEAD PAINT SURVEY SAMPLING PLAN
AND PRELIMINARY SCREENING

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT
4608400

NBS REPORT
10 958

FINAL REPORT, PHASE I
LEAD PAINT SURVEY SAMPLING PLAN
AND PRELIMINARY SCREENING

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Sponsored by

Department of Housing and Urban Development

U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

ABSTRACT

A preliminary survey of interior and exterior paints commercially available for residential use was carried out to develop information regarding the nationwide inventory of lead-based paints (containing 1% or more Pb in total paint solids). The paints, totaling 341, were also analyzed chemically for their content of mercury, arsenic, selenium, cadmium, barium and antimony. A sampling plan was developed for carrying out a statistically based nationwide survey.

Key Words: Chemical Analysis; Lead Paint; Sampling Plan; Survey

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1. Introductory Comments

The Lead Based Paint Poisoning Prevention Act, PL 91-695, defined lead based paint as that which contains more than 1% lead, by weight, in the total non-volatile solids content of a whole paint. In order to determine the extent of availability and therefore the use of lead based paint, the Department of Housing and Urban Development (HUD) requested the National Bureau of Standards (NBS) to develop a program plan for carrying out a nationwide study of the inventory of proprietary paints intended for residential use. The proposal submitted by NBS described a three phase program of preliminary work, actual implementation of a nationwide survey, and long term monitoring of proprietary materials.

This Final Report constitutes Task 1c as described below in the Statement of Work for Phase I which outlines the scope of work for NBS under the sponsorship of HUD. The results of Tasks 1a and 1b are included in this report.

Statement of Work for Phase I

Tasks

1. PHASE I

a. Sampling Plan - Approximately 1,200 to 1,500 paint manufacturers produce 8,000 to 10,000 labeled products. A sampling plan will be

devised in order to determine the number of paint samples that will be tested in Phase II of the program to establish a given level of statistical reliability. Factors such as the size of the manufacturer, paint composition, designed use, regional marketing, distribution to the consumer and paint color will be considered in order to maximize the efficiency of the survey.

b. Preliminary Screening - A pilot testing program will be used to develop, calibrate and validate the Sampling Plan. It will also serve to provide early indications of patterns of production, distribution and usage of paints containing toxic heavy metals. Approximately 400 paints will be purchased on a representative sampling basis, which includes all regions of the country, and tested. Procurement, coding and testing procedures and methods will be developed and evaluated. The tests will be for lead and all other metals covered by the ANSI Z66.1 Standard.

c. Phase I Report - A report submitted to HUD at the conclusion of Phase I will contain the results of Phase I including the results of the analyses of the 400 paint samples, a program plan for Phase II and an analysis of the number of samples that should be tested as a function of varying levels of statistical reliability and the funding required for Phase II as a function of its proposed magnitude and scope.

2. Sampling Plan

Machol Systems, Inc. was contracted to develop a statistical sampling plan in accordance with Task 1a above and as described in the following Statement of Work.

Machol Systems, Inc., 741 Sheridan Road, Evanston, Illinois will provide to the National Bureau of Standards, Lead Paint Poisoning Project, the following items:

1. a. A list of all "counties" or districts of populations of approximately 50,000 people in the United States, including Hawaii and Alaska but excluding Puerto Rico and Military Reservations together with a detailed description, pretested and costed, of how "counties" are to be selected from this list for carrying out a paint survey. Suitable discussion of problems and difficulties arising from the development of the selection of "counties" will be included.

   b. A description, pretested and costed, as to how the frame for each "county" is to be developed so that the number of stores chosen in each "county" may be drawn from it randomly. Suitable discussion will be included of how the particular number of stores, finally decided upon, was chosen.

   c. A description, extensively pretested, as to how the frame at each store is to be developed so that a number of paint cans may be drawn from it randomly. Data forms, instructional methods for buyers, reduction procedures, etc., will be developed. Suitable discussion will be included of how the particular number of samples finally decided upon was chosen.

2. 250 cans of paint purchased in order to pre-test store-to-store variation and to assist in establishing the optimum number of cans per store, the optimum number of stores per "county" and the optimum number of "counties" in the finally proposed sampling plan.

3. A table of data and a methodology which can be used to calculate the required number of "counties", stores and total number of paint cans to be included in the Phase II Paint Survey, as a function of varying degrees of statistical reliability. The table of data will be used in conjunction with the results of the analyses of the 250 cans of paint at some time after the completion of this contract.

4. A preliminary report to be delivered to NBS by March 15, 1972 describing the progress achieved in the development of Items 1 through 3.

5. *A final report to be delivered to NBS by April 15, 1972 containing Items 1 through 3 and including discussion of all of the decisions, rationales and processes leading up to the development of Items 1 through 3."*

Because of contracting difficulties, the delivery date of April 15, 1972, for the final report to NBS was changed to May 30, 1972 on which date the report was received. The conclusions reached by the contractor (Machol Systems) can be summarized as follows:

a. The amount of leaded paint used in the United States for nonindustrial purposes is related closely to the amount sold annually through retail outlets. This amount sold can be determined from accessible turnover rates if the proportion of lead paint in the U.S. inventory is known. The estimated size of the U.S. paint inventory is about 600,000,000 cans of at least one half pint volume.

b. The percentage of paint cans containing lead paint in the inventory can be estimated with a "high degree of assurance" to within ±2 percentage points by sampling 10,800 cans of paint in 216 stores distributed throughout the country, at a cost of between $360,000 and $500,000. With a sampling of half as many cans, stores and dollars (i.e., 5400 cans, 108 stores, $250,000) this estimate can be made with a "reasonable" assurance of 2 percentage point accuracy.

The cost of sampling depends on travel and subsistence costs, salaries and the costs of purchase, shipping and testing the paints.

Both of the sampling plans mentioned in paragraph "b" yield the stated accuracy "at the 95% confidence level." The statistical characteristics of the sampling plans pertaining to the question of the percentage of paint cans containing lead paint in the can inventory were determined by mathematical analysis and verified by a series of computer simulations. Sampling plans for the estimation of the U.S. percent of lead paint by volume (i.e., number of gallons) rather than the number of cans, and "sub population" ratios such as lead percentages in exterior paint and lead percentages in a single brand or color were also investigated, and some recommendations have been advanced.

In setting up a sampling, or survey, the country is divided into approximately 4000 areas each having a population of about 50,000. These areas are called Primary Sampling Units (PSU). Three numbers are then specified: the number of PSU's to be sampled, the number of stores or paint retailers in each of the selected PSU's to be sampled, and the number of cans of paint in each store to be sampled. Thus the total number of cans in a survey is the product of the three numbers described above.

The random selection of (1) the specified number of PSU's, (2) the stores in each PSU and (3) the cans of paint from each store constitute what statisticians refer to as a "three stage sampling plan".

3. Preliminary Screening

3.1. Validity of Survey

As previously discussed, with the sponsor, this preliminary screening could not be a valid statistical nationwide sampling of commercial paints. The sample population was purposely biased toward the likelihood of obtaining paints containing lead. To achieve that end, dark tints of yellow, orange and green were obtained in the expectation that lead pigments would be used for coloring those paints.

The intention of this preliminary screening was to provide the background information and experience in the development and implementation of a statistical national paint survey in a subsequent phase of the program.

The purchasing plan used for obtaining the commercial paint samples was developed by the staff of the Lead Paint Poisoning Project. It was based on the best judgment and the limited data available at the time and reflected a need for a rapid response to the sponsor's immediate requirements.

3.2. Procurement of Commercial Paints

The first 100 paint samples were purchased, for the survey, in the Washington, D.C. Metropolitan Area by NBS Lead Paint Poisoning Project Staff. The intention of this activity was to guarantee the availability of a wide selection of paints for early testing and reporting.

In accordance with prior agreement, the ten regional offices of the Bureau of Community Environmental Management (BCEM) of the Department of Health, Education and Welfare (HEW) were instructed and funded to purchase any 400 out of 800 specifically described and listed commercial paints. Of that amount, only approximately 240 paints were purchased and transmitted to NBS for testing.

3.3. Analytical Chemistry Procedures

Two techniques were used for the analyses of lead and other heavy metals in commercial paints. Approximately 50% of the total number of samples were tested by Atomic Absorption, a technique that has been used routinely for paint analysis for many years.

The remainder of the samples were analyzed by a non-destructive X-ray fluorescence technique. The heavy metal content of whole liquid paints was determined on the basis of total paint solids by means of appropriate calibrations. Due to interference factors, it was not possible to analyze

the other heavy metals in the presence of high concentrations of lead. For that reason, the number of results for the analyses of lead is greater than the number of results for the analyses of the other heavy metals.

Because of cost and time considerations, approximately half of the total number of paints tested were not analyzed for soluble barium. However, they were analyzed for total barium and reported as having either more or less than 0.5%, by weight, of the total paint solids.

3.4. Information Coding Systems

3.4.1. Identification Code

Each sample of paint purchased was given a 9 digit identification code number based on the information described in Table 3.4.1.

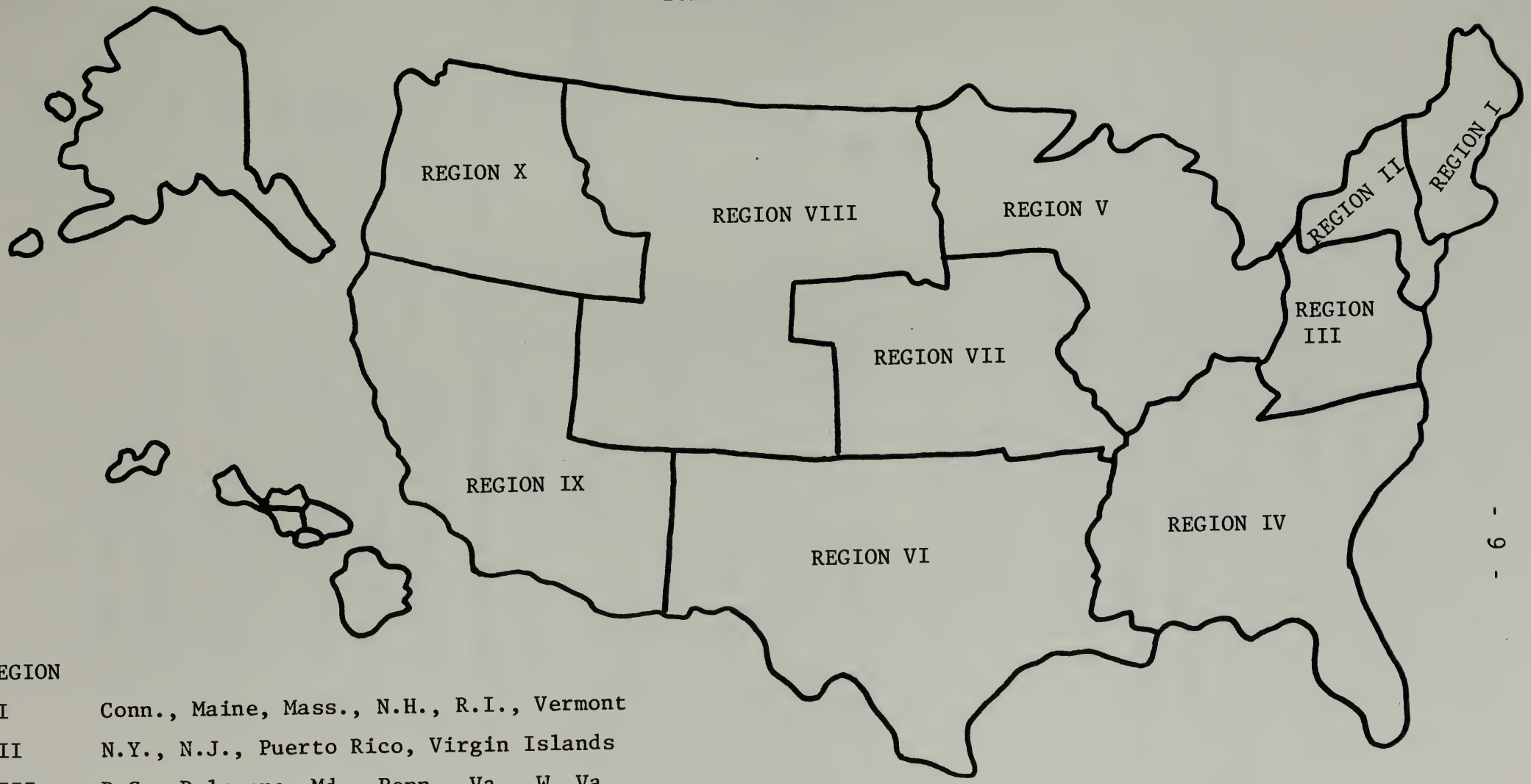
Table 3.4.1.
Identification Code Number

Digit	Information
1-3	Sequential order of purchase and coding
4-5	BCEM Regional Area of purchasing
6-7	Type of paint purchased
8-9	Color of paint purchased

The BCEM Regional Areas, types of paints and colors of paints included in the survey are described in Figure 3.4.1.1. and Table 3.4.1.3. respectively.

Figure 3.4.1.1.
Map of United States

BCEM REGIONAL AREAS



REGION	
I	Conn., Maine, Mass., N.H., R.I., Vermont
II	N.Y., N.J., Puerto Rico, Virgin Islands
III	D.C., Delaware, Md., Penn., Va., W. Va.
IV	Ala., Fla., Ga., Ky., Miss., S.C., N.C., Tenn.
V	Ill., Ind., Mich., Minn., Ohio, Wisconsin
VI	Ark., La., N. Mex., Okla., Texas
VII	Iowa, Kansas, Missouri, Nebraska
VIII	Colo., Mont., N.D., S.D., Utah, Wyoming
IX	Am. Samoa, Ariz., Calif., Hawaii, Guam, Nev., Trust Ter. of Pacific I., Wake I.
X	Alaska, Idaho, Oregon, Washington

Table 3.4.1.2.

Types of Paints

Code Number	Type	Abbreviations
1	Interior latex	IL
2	Exterior latex	EL
3	Interior alkyd	IA
4	Exterior alkyd	EA
5	Exterior oil	EO
6	Spray	SP
7	Varnish	VR

Table 3.4.1.3.

Colors of Paints

Code Number	Color	Abbreviations
1	White-tinting base	W-TB
2	White-factory mixed	W-FM
3	Green-custom mixed	G-CM
4	Yellow-custom mixed	Y-CM
5	Orange-custom mixed	O-CM
6	Green-factory mixed	G-FM
7	Yellow-factory mixed	Y-FM
8	Orange-factory mixed	O-FM
9	Clear-unpigmented	CLR

3.4.2. Paint Analysis Code

In order to simplify the process of data reduction and evaluation the Paint Analysis Code described in Table 3.4.2. was devised. The concentration ranges described below were chosen for convenience in tabulating data.

Table 3.4.2.

Paint Analysis Code

Code Number	Percent Heavy Metals in Paint Solids						
	Lead	Mercury	Barium	Antimony	Arsenic	Selenium	Cadmium
1	<0.1	<----------	----------	less than 0.01	----------	----------	---------->
2	0.1-1.0	<----------	----------	0.01 to 0.1	----------	----------	---------->
3	>1.0	<----------	----------	greater than 0.1	----------	----------	---------->

3.5. Summary of Paint Sample Characteristics

The following, Table 3.5. summarizes some major characteristics of the 341 paints purchased for the preliminary survey.

Table 3.5.

Paint Sample Characteristics

Region of Purchase	Number of Samples
1	3
2	34
3	134
4	23
5	25
6	30
7	29
8	8
9	39
10	15
Unknown	1

Type of Paint	Number of Samples
1-IL	140
2-EL	47
3-IA	47
4-EA	43
5-EO	37
6-SP	9
7-VR	18

Size of Manufacturer	Number of Samples
1-small	58
2-intermediate	137
3-large	146

Color of Paint	Number of Samples
1-W-TB	35
2-W-FM	76
3-G-CM	34
4-Y-CM	46
5-O-CM	34
6-G-FM	43
7-Y-FM	34
8-O-FM	21
9-CLR	18

3.6. Results of Chemical Analysis of Paints

3.6.1. Analyses of Standard Samples

Standard paint samples were prepared with known amounts of lead and the other heavy metals. These standards were packaged, coded and transferred to the two testing laboratories interspersed randomly with the proprietary paints. The laboratories were unable to identify the standards as such, and were thereby monitored for their accuracy and reliability.

3.6.1.1. Analyses for Lead

Table 3.6.1.1. summarizes the data obtained for the analysis of lead in the standard paint samples by means of atomic absorption spectroscopy and laboratory X-ray fluorescence.

3.6.1.2. Analyses for Other Heavy Metals

Table 3.6.1.2. similarly summarizes the data obtained from the analyses of the standard paint samples for other heavy metals by means of atomic absorption spectroscopy and laboratory X-ray fluorescence.

Table 3.6.1.1.

Analysis of Lead in Standard Samples

X-Ray Fluorescence Percent Lead in Solids			Atomic Absorption Percent Lead in Solids		
Added	Found	Difference	Added	Found	Difference
1.0	0.8	-0.2	1.0	0.8	-0.2
1.0	0.8	-0.2	1.0	0.9	-0.1
1.1	1.1	0	1.0	0.9	-0.1
1.1	1.0	-0.1	1.0	1.0	0
1.1	0.9	-0.2	1.0	1.0	0
1.0	0.7	-0.3	1.0	1.1	+0.1
1.0	0.9	-0.1	1.0	1.0	0
1.0	1.2	+0.2	1.0	0.9	-0.1
1.0	1.1	+0.1	1.0	1.1	+0.1
2.1	1.8	-0.3	0.5	0.6	+0.1
0.8	0.8	0	1.7	2.0	+0.3
1.2	1.2	0	4.9	4.8	-0.1
	Avg.	0.15	1.3	1.3	0
				Avg.	0.1

Table 3.6.1.2.a

Analysis of Heavy Metals in Standard Samples by X-Ray Fluorescence

Mercury			Barium			Antimony			Arsenic			Selenium			Cadmium		
Added	Found	Diff.	Added	Found	Diff.	Added	Found	Diff.	Added	Found	Diff.	Added	Found	Diff.	Added	Found	Diff.
.05	.05	0	.03	<0.5		.03	.06	.03	.06	.10	.04	.03	.03	0	.10	.09	.01
.14	.14	0	.03	<0.5		.03	.07	.04	1.1	.02	1.1	.03	.03	0	.10	.09	.01
0	.01	.01	.06	<0.5		0	<0.01	-	.01	.01	0	0	<0.01	-	0	<0.01	-
.06	.11	.05	.06	<0.5		.06	.09	.03	.03	.03	0	.06	.10	.04	.19	>0.2	?
.06	.11	.05	.01	<0.5		.01	.01	0	.01	.01	0	.003	<0.01	-	.01	<0.01	-
.03	.03	0	.03	<0.5		.03	.03	0	.06	.02	.04	.01	.01	0	.03	.02	.01
.03	.03	0	1.1	1.5	.4	0	0.01	.01	0.4	>0.1	-	.06	.10	.04	0	<0.01	-
.38	.38	0	.06	<0.5		.06	.09	.03	.03	<0.01	.02	0	<0.01	-	0	<0.01	-

Table 3.6.1.2.b

Analysis of Heavy Metals in Standard Samples by Atomic Absorption

Mercury			Barium			Antimony			Arsenic			Selenium			Cadmium		
Added	Found	Diff.	Added	Found	Diff.	Added	Found	Diff.	Added	Found	Diff.	Added	Found	Diff.	Added	Found	Diff.
.06	.13	.07	.06	<0.2		.06	.05	.01	.06	.03	.03	.06	.03	.03	.19	.002	.19
.01	.02	.01	.01	<0.2		.01	.01	0	.01	.003	.007	.01	.003	.007	.03	.03	0
.02	.01	.01	.01	<0.2		.01	.01	0	.01	.01	0	.01	.003	.02	.03	.03	0
.06	.14	.08	.06	<0.2		.06	.04	.02	.06	.03	.03	.06	.03	.03	.19	.18	.01
.03	.04	.01	.03	<0.2		.03	.04	.01	.03	.03	0	.03	.01	.02	.10	.09	.01
.06	.13	.07	.06	<0.2		.06	.05	.01	.06	.03	.03	.06	.03	.03	.19	.19	0
.03	.04	.01	.03	<0.2		.03	.03	0	.03	.01	.02	.03	.01	.02	.10	.09	.01
.01	.04	.03	.01	<0.2		.01	.01	0	.01	<0.0005	.01	.01	.004	.006	.03	.003	.03
.06	.06	0	.06	<0.2		.06	.06	0	.06	.03	.03	.06	.03	.03	.19	.19	0
.18	.18	0				0	.007	.007	.12	.09	.03	.03	0	.03	.05	.05	0
0.4	0.5	0.1				0	0	0	.46	.34	.12	0	0	0	0	.009	.01
0	0	0				0	.003	.007	0	0	0	0	0	0	0	0	0
0	0	0				0	.014	.014	0	0	0	0	0	0	0	0	0

3.6.2. Analyses of Cross Check Samples

In addition to monitoring the testing laboratories by means of the analyses of standard samples, each laboratory was also sent samples of some of the proprietary paints already tested by the other laboratory.

Table 3.6.2. summarizes the data for the analyses of commercial paints used for cross-checking purposes for the determination of lead.

3.6.3. Results of Analyses for Lead

Table 3.6.3.

Overall Distribution of Lead Contents

Lead Analysis Code	Subtotal	Percent of Total (341)
1. (<0.1%)	195	57
2. (0.1-1.0%)	62	18
3. (>1.0%)	84	25
Total	341	100

Table 3.6.2.

Analysis of Lead in Cross-Check Commercial Paints

Paints Containing 1% Lead or Less		Paints Containing >1% Lead	
Atomic Absorption	X-Ray Fluorescence	Atomic Absorption	X-Ray Fluorescence
0.15	0.1	13.2	5-15
0	<0.1	6.7	3-10
0.24	0.5	7.1	3-10
0.01	<0.1	6.2	5-15
0.01	<0.1	2.6	2-4
0.91	1.0	64	10-30
0.01	<0.1	6.3	3-10
0.19	0.3	14.2	10-30
0.01	<0.1	11.7	15-25
0.65	1.1	2.0	1.2
0.02	<0.1	3.1	2-4
0.5	0.5	3.0	2.5±0.5
0.02	<0.1	2.2	1.5-2.5
0.01	<0.1	9.2	5-15
0.02	<0.1	6.2	3-9
0.3	0.1	2.5	1.0
0.3	0.3	1.4	5-10
0.2	0.1		

3.6.3.1. Region of Purchase

Table 3.6.3.1.

Distribution of Lead Contents by Region of Purchase

Region	Regional Total	Lead Content Distribution			Percent of Regional Total >1.0% Pb
		<0.1%	0.1-1.0%	>1.0%	
1	3	1	0	2	66*
2	34	19	1	14	41
3	134	87	20	27	20
4	23	14	5	4	17
5	25	13	6	6	24
6	30	14	4	12	40
7	29	16	6	7	24
8	8	5	2	1	13*
9	39	20	13	6	15
10	15	6	4	5	33*
Totals	340	195	61	84	

*Questionable validity because of small number of samples purchased and tested.

3.6.3.2. Type of Paint

Table 3.6.3.2.

Distribution of Lead Contents by Type of Paint

Type	Total by Type	Lead Content Distribution			Percent of Type Total >1.0% Pb
		<0.1%	0.1-1.0%	>1.0%	
1-IL	140	117	8	15	11
2-EL	47	36	4	7	15
3-IA	47	17	15	15	32
4-EA	43	3	16	24	56
5-EO	37	11	8	18	49
6-SP	9	5	4	0	0*
7-VR	18	6	7	5	28*
Totals	341	195	62	84	

*Questionable validity because of small number of samples purchased and tested.

3.6.3.3. Color of Paint

Table 3.6.3.3.

Distribution of Lead Content by Color of Paint

Color	Total by Color	Lead Content Distribution			Percent of Color Total >1.0% Pb
		<0.1%	0.1-1.0%	>1.0%	
1-W-TB	35	29	4	2	6
2-W-FM	76	56	15	5	7
3-G-CM	34	17	12	5	15
4-Y-CM	46	20	6	20	43
5-O-CM	34	13	4	17	50
6-G-FM	43	24	6	13	30
7-Y-FM	34	21	5	8	24
8-O-FM	21	9	3	9	43*
9-CLR	18	6	7	5	28*
Totals	341	195	62	84	

*Questionable validity because of small number of samples purchased and tested.

3.6.3.4. Size of Manufacturer

The size of manufacturer is defined as follows in terms of the number of employees and is based on Census data.

a. small manufacturers: 39 employees or less

b. intermediate manufacturers: 40-350 employees

c. large manufacturers: more than 350 employees

Table 3.6.3.4.

Distribution of Lead Content by Size of Manufacturer

Size	Total by Size of Manufacturer	Lead Content Distribution			Percent of Size Total >1.0% Pb
		<0.1%	0.1-1.0%	>1.0%	
1-Small	58	31	7	20	34
2-Intermediate	137	78	25	34	25
3-Large	146	86	30	30	21
Totals	341	195	62	84	

3.6.3.5. Price of Paint

Table 3.6.3.5.

Distribution of Lead Content by Price of Paint

Price Per Gallon to Nearest Dollar	Total by Price	Lead Content Distribution			Percent of Price Total >1.0% Pb
		<0.1%	0.1-1.0%	>1.0%	
3	2	1	1	0	0
4	22	18	1	3	14
5	29	23	1	5	17
6	40	28	4	8	20
7	48	27	6	15	31
8	43	22	8	13	30
9	31	19	7	5	16
10	39	20	5	9	23
11	19	4	5	10	52
12	9	6	2	1	11
13	11	5	2	4	36
14	3	2	0	1	33
15	0	0	0	0	0
16	3	2	0	1	33
Total	294	177	42	75	

3.6.3.6. Correlation of Type and Color

Table 3.6.3.6.a.

Distribution of Paint Samples by Type and Color

Type	Color								
	1	2	3	4	5	6	7	8	9
	W-TB	W-FM	G-CM	Y-CM	O-CM	G-FM	Y-FM	O-FM	CLR
1-IL	19	26	17	23	18	15	15	7	0
2-EL	8	15	4	6	4	8	2	0	0
3-IA	4	11	6	8	6	3	4	5	0
4-EA	3	8	4	8	5	9	3	3	0
5-EO	1	16	3	1	1	5	7	3	0
6-SP	0	0	0	0	0	3	3	3	0
7-VR	0	0	0	0	0	0	0	0	18
Totals	35	76	34	46	34	43	34	21	18

Table 3.6.3.6.b.

Percentage of High Lead Paints (>1.0% Pb)
by Type and Color

(Percent of Total of Each Type-Color Classification)

Type	Color								
	1	2	3	4	5	6	7	8	9
	W-TB	W-FM	G-CM	Y-CM	O-CM	G-FM	Y-FM	O-FM	CLR
1-IL	5	0	0	25	44	0	0	0	
2-EL	0	0	0	50	50	13	50		
3-IA	0	0	17	63	50	66	25	60	
4-EA	33	13	25	63	80	78	66	100	
5-EO	0	25	100	100	0	60	57	100	
6-SP						0	0	0	
7-VR									28

3.6.4. Results of Analyses for Other Heavy Metals

Table 3.6.4.

Distribution of Contents of Six Heavy Metals

Heavy Metal	Total Number Analyzed and Reported	<0.01%		0.01-0.1%		>0.1%	
		Number	Percent of Total	Number	Percent of Total	Number	Percent of Total
Mercury	316	101	32	153	48	62	20
Barium	157*	63	40	80†	51	14	9
Antimony	314	224	71	77	25	13	4
Arsenic	316	263	83	53	17	0	0
Selenium	316	274	87	42	13	0	0
Cadmium	298	274	92	24	8	0	0

*Balance of samples reported as <0.5% total barium.

†Some data reported as <0.02% may in fact be <0.01%.

3.6.4.1. Region of Purchase for Paints Containing Mercury

Table 3.6.4.1.

Distribution of Mercury Content by Region of Purchase

Region	Regional Total	Mercury Content Distribution			Percent of Regional Total >0.1%
		<0.01%	0.01-0.1%	>0.1%	
1	3	2	1	0	0
2	31	15	14	2	6
3	121	27	62	32	26
4	23	7	11	5	22
5	20	4	11	5	25
6	29	12	12	5	17
7	27	9	11	7	26
8	8	5	2	1	13
9	39	17	20	2	5
10	12	2	7	3	25
Totals	313*	100	151	62	20

*3 samples - unknown region.

3.6.4.2. Correlation of Type and Color for Paints Containing Mercury

Table 3.6.4.2.

Distribution of High Mercury Paints (>0.1% Hg)
as a Function of Type and Color

Type	Total by Type	Color									Total by Type >0.1% Hg	Percent of Total by Type
		1	2	3	4	5	6	7	8	9		
		W-TB	W-FM	G-CM	Y-CM	O-CM	G-FM	Y-FM	O-FM	CLR		
1-IL	140	1	4	0	5	2	5	2	5	0	24	17
2-EL	47	2	8	2	3	1	4	1	0	0	21	45
3-IA	47	0	1	0	0	1	0	0	0	0	2	4
4-EA	43	0	1	0	0	1	0	0	0	0	2	5
5-EO	37	0	3	1	0	1	1	0	0	0	6	16
6-SP	9	0	0	0	0	0	1	0	1	0	2	22
7-VR	18	0	0	0	0	0	0	0	0	5	5	28
Total	341	3	17	3	8	5	11	2	6	5	60	

3.6.5. ASA Standard Z66.1

American Standard Specifications to

Minimize Hazards to Children from Residual Surface Coating Materials

1. Scope and Purpose

This standard specifies the requirements for coatings such as paints, enamels, lacquers, etc, applied in liquid form, that are deemed suitable from a health standpoint to be used to paint children's toys or furniture or interior surfaces so that the danger of poisoning will be minimized if, by chance, some of the dry coating should be ingested by a child.

2. Specifications

A liquid coating material to be deemed suitable, from a health standpoint, for use on articles such as furniture, toys, etc, or for interior use in dwelling units where the dry film might be ingested by children:

(1) Shall not contain lead compounds of which the lead content (calculated as Pb) is in excess of one percent of the total weight of the contained solids (including pigments, film solids, and driers);

(2) Shall not contain compounds of antimony, arsenic, cadmium, mercury, or selenium of which the metal content individually or in total (calculated as Sb, As, Cd, Hg, Se, respectively) is in excess of 0.06 percent by weight of the contained solids (including pigments, film solids, and driers);

(3) Shall not contain barium compounds of which the water soluble barium (calculated as Ba) is in excess of one percent of the total barium in such coatings.

3. Marking

Coatings complying with this standard may be marked: "Conforms to American Standard Z66.1-1964 for use on surfaces which might be chewed by children."

3.6.5.1. Paint Samples Failing ASA Standard Z66.1

Table 3.6.5.1.

Distribution of Paint Samples in Terms of Compliance with ASA Standard Z66.1

	Paints Failed	Paints Passed	Borderline >0.05 to ≤0.07
Number	181	128	32
Percent of Total Tested	53	38	9

3.7. Conclusions and Observations

3.7.1. Accuracy of Analytical Methods

3.7.1.1. Lead Determinations - Ref: Tables 3.6.1.1; 3.6.2.

The average differences between the percent lead added and the percent lead found in the standard paint samples are indicative of the reliability to be expected of laboratory X-Ray fluorescence and atomic absorption for the analysis of liquid paints. The accuracy of ±0.1% at the 1% level, that

was required of the two participating laboratories, was essentially satisfied.

The differences in percent lead detected by X-ray fluorescence indicated that the errors are primarily negative, that is, there is a tendency to obtain low results. The distribution of positive and negative errors with atomic absorption was normal, that is, an equal number of high and low determinations.

A comparison of the data for the analyses of the cross-check commercial paint samples shows that with two minor exceptions, in 70 analyses the techniques showed excellent correlation relative to the detection of lead in excess of 1%. There were only two sets of possible false positives or negative out of the 35 paints tested.

3.7.1.2. Determinations of Other Heavy Metals - Ref. Tables 3.6.1.2a and b.

The analyses of the standard samples for their contents of mercury, barium, antimony, arsenic, selenium and cadmium by laboratory X-ray fluorescence gave variable and unpredictable results. Absolute differences between percents added and found ranged from 0 to 0.05% for up to 0.15% of heavy metal. The relative amounts detected however, ranged higher than 100% in some cases.

Similar comments can be made for the analyses of the heavy metals in the standard paints by means of atomic absorption.

3.7.2. Distribution of Lead Content - Ref. Table 3.6.3.

As previously stated in 3.1., the sample population was purposely biased to find paints that would be likely to contain lead. Twenty five percent of the total number of paints purchased, on that basis, and tested were found to have greater than 1% lead by weight in the total paint solids. Fifty seven percent of the paints had less than 0.1% lead by weight in the total paint solids. A content of lead that is less than 0.1% indicates on the basis of common formulation practice that no lead was added to the paint in the form of driers, coloring agents or opacifying pigments.

3.7.2.1. Region of Purchase - Ref. Table 3.6.3.1.

High percentages of the paints purchased in Regions 2 and 6 (41% and 40% respectively) had more than 1% lead. The lead percentages for Regions 1, 8 and 10 are questionable because of the small number of samples purchased in those areas. This analysis of lead content distribution as a function of region of purchase may be invalid due to strong biases of the purchasing agents in particular regions.

3.7.2.2. Type of Paint - Ref. Table 3.6.3.2.

Paint types 3, 4 and 5, interior alkyds, exterior alkyds and exterior oils had the greatest number of samples with more than 1% lead, (32%, 56%, and 49% respectively, of the totals purchased as compared with 11% and 15% for the latex types). The data confirms what had been expected; that is, that lead would most likely be found in solvent type paints rather than in the latex types.

3.7.2.3. Color of Paint - Ref. Table 3.6.3.3.

Color types 4, 5, 6 and 7 (retailer mixed dark yellows and oranges and factory mixed dark greens and yellows) had the greatest number of samples with more than 1% lead (43%, 50%, 30%, 24%). Color types 1 and 2, tinting bases and factory mixed white paints had the fewest numbers with high lead (6%, 7%).

3.7.2.4. Size of Manufacturer - Ref. Table 3.6.3.4.

Although the percentage differences are not dramatic, it appears that small manufacturers are more likely to produce paint with more than 1% lead (34% of total) than are large manufacturers (21% of total).

3.7.2.5. Price of Paint - Ref. Table 3.6.3.5.

There are no trends indicating that either high or low priced paints are likely to contain lead. The average cost of the paints purchased was approximately $7.50 per gallon.

3.7.2.6. Correlation of Type and Color - Ref. Tables 3.6.3.6a; 3.6.3.6b

The data in Table 2.1.6.2. confirms that latex paints that are tinting bases or factory mixed whites are unlikely to have more than 1% lead. Oil and alkyd paints appear to be more likely to have more than 1% lead. They are often made with lead driers and coloring agents which may contain inorganic lead compounds.

3.7.3. Distribution of Other Heavy Metals - Ref. Table 3.6.4.

Although there was no intentional bias to obtain paints containing toxic heavy metals other than lead, the sample population is not representative of all paints and data pertaining to other heavy metals should be recognized as having been derived from a biased sample. Other than lead, the only heavy metal found frequently in the paints that were tested was mercury. Forty-eight percent of the total tested to date had between 0.01 and 0.1 percent and 20% had more than 0.1% by weight in the total paint solids.

3.7.3.1. Region of Purchase - Ref. Table 3.6.4.1.

No particular relationship between region of purchase (climate) and the incidence of mercury in paint could be discerned.

3.7.3.2. Correlation of Type and Color - Ref. Table 3.6.4.2.

No relationship between color and the incidence of mercury in paint can be observed but it appears that, as expected, exterior latex paints (Type 2) are very likely (45%) to have mercury added. Of 15 factory mixed white exterior latexes, 8 (53%) had more than 0.1% mercury.

3.7.3.3. Failure to Meet Z66.1 - Ref. Table 3.6.5.1.

With few exceptions, lead and mercury contents were responsible for the failure of 53% of the paints tested to meet the requirements of Z66.1.

4. Proposal for Phase II of Paint Survey

4.1. Statement of Work for Proposed Phase II

PHASE II

The objectives, scope and magnitude of Phase II of the Paint Screening Program will be established at the conclusion of Phase I.

a. *Paint Procurement - Regional Offices of Government Agencies will procure paints locally on the basis of the Sampling Plan previously devised. The paints will be transmitted directly to NBS.*

b. *Sample Coding* - *Test specimens will be taken from each paint sample for coding by NBS. The coded specimens will be transmitted to the testing laboratories for chemical analysis of toxic heavy metals. The identification of the paint samples will not be available to the testing laboratories.*

c. *Chemical Analysis* - *The methods of analysis and the cooperating laboratories will be established in Phase I of the Program. Regional, Federal and State laboratories and private testing laboratories as well as NBS will be considered potential cooperators.*

d. *Phase II Report* - *The final report will indicate the code numbers of those paint products found to contain heavy metals in excess of recommended non-toxic levels. Recommendations will be made for a continuing Program in Phase III.*

4.2. Recommendations for Implementation of Phase II

The difficulties we have encountered in the analyses of very low concentrations of heavy metals in paints warrants the immediate expenditure of research time and effort to develop specific analytic techniques of greater accuracy and reliability to do the work of Phase II.

Particular consideration should be given to increasing capabilities for the analysis of mercury in light of the large number of paints containing that heavy metal and the increasing concern of health officials with its toxicity.


DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS