

Criteria for Evaluating Lead Hazard of Painted Surfaces

I. Dosage

Currently some city housing and health codes limit the lead content of surface coverings to 1 percent. Percent by weight, calculated as elemental lead, is a good criteria for content of paint per se. However, this is not a good criteria for evaluating the health hazard present in paint chips from surface coverings of walls, windows, doors, furniture, and other objects. This conclusion can be supported by the example presented in the following table:

Table 1. Amount of Lead in Single and Multiple Layers of Paint vs. Percent Lead Content of Paint			
Painted Surface Covering		Lead Content of Paint Chip	
No. Layers	Wgt. of Paint Chip* (Milligrams)	Percent by Weight	Amount (Milligrams)
1	10mg	1%	0.1mg
6	60mg	1%	0.6mg
10	100mg	1%	1.0mg
* Same area, e.g., 1 square centimeter of 1, 6, 10 layers of paint.			

The amount of lead increases as the number of layers and hence the weight of the chips are increased while the percent lead content remains at 1 percent of the weight of the chip regardless of the number of coats of 1 percent paint applied. The health hazard for a child

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ingesting a paint chip is related to the amount, specifically the weight, of the lead in the chips he ingests and absorbs.

In 1956, at a meeting of the Committee on Hazards to Children of the American Standards Association, the recommendation was made that paints may be considered safe for use on children's toys, furniture, and housing interiors if the lead content does not exceed 1 percent of the total solids. At that time Dr. Julian Chisolm stated that

"It is essential to recognize that this recommendation applies only to the two or three layers usually applied to a surface, not to multiple layers of paint as may be found in deteriorated housing."

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(Pediatrics, 18, No. 6, Dec. 1956.)

II. Measurement

The amount of lead contained in a given surface covering is determined by percent lead content of each layer or coat of paint and the number of coats that have been applied. A paint chip from the surface covering will have a certain volume--area x thickness.

It is time-consuming and frequently very difficult to determine the number of layers in a given area of paint or to measure the thickness of chips from hand painted surfaces. A given area, however, can be marked on a surface covering and a paint chip having the precise area can be removed including all layers of paint down to the wood or other substrate. The amount of lead available in the three dimensional paint chip is the factor determining the health hazard for children.

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The amount of lead in a single layer or multiple layers of a surface coating can be measured by wet chemical analysis or by x-ray fluorescence analyzers (X-R-F). Here the meaningful units of measurement would be the actual quantity of lead per unit volume.

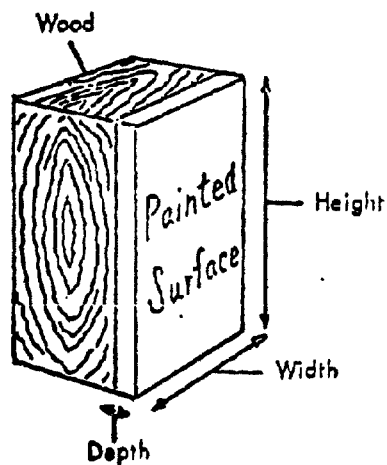
The X-R-F instruments with radioisotope sources of suitable energy can penetrate successive layers of paint and measure the amount of lead lying within the area "viewed" by the instrument. Here the meaningful units, accepted by convention, can be expressed as amount per unit area (milligrams per square centimeter). Implicit in such a statement is "area of a given surface covering of a given thickness."

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PAINT CHIP

MEASUREMENT OF Pb CONTENT



Chemical Analysis

mg/unit volume (mg/cm^3)
or
mg/unit weight of chip

X-R-F Analysis

(mg/cm^3)
or by convention
" (mg/cm^2) "

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III. Recommended Limit

It is recommended that the quantity of lead in surface coverings with single and multiple layers of paint, should not exceed 0.03 mg/cm². Where this limit is exceeded the surface covering should be removed, covered, or otherwise treated to ensure that the contained lead is no longer available to children.

IV. Rationale for Recommended Limit

Kehoe established that 0.6mg of lead per day was the maximum that could be ingested by an adult with no increase in blood lead level; at this level input exceeded output with a slight accumulation of body lead burden. A corresponding value for the child was estimated to be 0.3mg lead per day from all sources by an ad hoc committee of pediatricians and biological scientists qualified in the area of prevention of lead poisoning in children.* A range of values for estimated average intake of lead per day in the diet is 0.100mg to 0.140mg. Thus, the ingestion of more than 0.2 mgPb/day from supplementary sources, such as paint chips, would result in an intake in excess of the limiting value recommended for children.

The weight of one and multiple layers of dried interior house paint chips have been measured on prepared samples (Table 2.).

* In the manuscript of the report, the maximum daily limit for intake of lead from all sources is referred to as daily permissible intake (DPI).

Table 2. Paint Chips, $\pm$ 1% Lead Content--Weight Per Unit Area		
Interior House Paint	Range ng/cm ²	Average ng/cm ²
1 layer paint	5.2 - 8.0	6.5
2 layers	11.7 - 14.4	13.0
6 layers	37.0 - 40.6	38.8

The lead content for single and multiple layers of 1 percent lead by weight can be compared to the limiting value (0.2 ng/day) for ingestion of lead from non-diet (supplementary) sources (Table 3.).

Table 3. Area Equivalent of Limiting Value for Supplementary Pb Ingestion			
(Pb content per unit area per layer paint: 1% by wgt/per layer)			
No. of Layers	Chip Wgt ng/cm ²	Wgt Pb Content ng	No. of cm ² Containing Approx. 0.2 mgPb
1	6.5	0.065	3.1
2	13.0	0.130	1.5
6	38.8	0.388	0.5

From Table 3 it can be seen that the limiting value will be exceeded if a child ingests more than 1 cm² of a covering of 2 layers of 1 percent lead-based interior house paint.

The lead content of a surface covering of dried paint should not exceed 0.03 mg/cm². The area equivalent of the limiting value for one

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layer of 1 percent interior house paint is 3.1 cm². The 0.03 mg/cm², however, does not depend upon the number of layers of paint--e.g., many layers of lead free paint may comprise the greater portion of the thickness of the surface covering.

Some Estimates of the Quantity of Paint Chips Eaten by Children

a. X-ray simulating an abdominal plate classified clinically as Grade 3 contained 1 gram of dried paint chips (Dr. Sachs, Chicago); 7 out of 10 abdominal plates showing large amounts of ingested rubbish by children visiting the clinic had been classified as Grade 3. The average weight of 69 paint chips taken from deteriorated buildings in Philadelphia is 89.6 mg/cm² consisting of multiple coats some with high lead content. If the average value is assumed, the 1 gram of dried paint would represent the covering of approximately 11 cm².

b. A child, with a fecal lead of 180mg, hospitalized for encephalopathy, was living in a dwelling in which the painted surface was known to contain 9.5 percent lead by weight. Thus, the quantity of paint chips ingested was approximately 1,900mg. Again, using the paint chip weight of 90 mg/cm² observed in Philadelphia, this would represent approximately 20 cm² surface covering. If Philadelphia's observed maximum value for paint chips was 163 mg/cm², the area from which the chips were taken would have been about 11.5 cm².

Examples given in (a) and (b) show that children can ingest large quantities of paint chips in a relatively short period--one or two days.

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