

**Toolkit for establishing
laws to eliminate
lead paint**

2021 Update

Paint Basics

Module A-3

Outline

- What are Paints and Coating Materials?
- What is Lead, and Why is It Used in Paint and Coating Materials?
- Why is Lead Paint a Problem?
- Identifying Paints and Functions of Individual Paint Components
- Paints and Coatings That Can Contain Lead
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What Are Paints and Coating Materials?

- **Coating material** is a product, in liquid, paste or powder form, that, when applied to a substrate, forms a layer possessing protective, decorative and/or other specific properties
- **Paint** is pigmented coating material which, when applied to a substrate, forms an opaque, dried film having protective, decorative or specific technical properties
- ISO 4618:2014 defines additional terms used in the field of coating materials (paints, varnishes and raw materials for paints and varnishes).

What Is Lead, and Why Is It Used in Paint and Coating Materials?

- Lead is a naturally occurring, toxic element used in a range of primarily industrial applications.
 - Lead is used in all types of paints and coating materials, such as for decoration of interior and exterior surfaces in homes and public buildings, on roads and bridges, and also on toys, furniture and playground equipment.
 - Lead compounds are added to provide a range of properties in paint (e.g., color, drying ability, rust resistance)
 - Trace quantities of lead may sometimes be present in the fillers and other earth-based ingredients that are used in paint formulation.

Why Is Lead Paint a Problem?

- **Lead paint can leave a legacy of potential human exposure** for many years into the future – **children are particularly vulnerable**.
 - **Lead paint is a source of lead exposure** during its manufacture, application, aging (decay after application) and removal.
 - **For example, most of the public would be exposed to lead paint as it breaks down over time** fragmenting into flakes and dust that can contaminate the domestic environment (for more information, see Module B-1).
 - **Lead is persistent in the environment**, and when released can remain there indefinitely.

See the following modules for more details on the dangers of lead: A-1 The Need for Regulating Lead Paint; B-1 The Health Impacts of Lead Exposure; and B-2 The Environmental Impact of Lead

Identifying Paint

Paint is described and identified in many different ways.

- Sometimes identified by its **solvent base**: Water-based vs. Organic solvent-based paint
- Paints are also identified by their **function in a protection system** as primers, intermediate coats and topcoats (Sometimes identified by their appearance, e.g., Enamels - hard, glossy and opaque finish)
- Paint is sometimes identified by its **binder**, e.g., alkyd, epoxy, polyurethane
- Though paint is sometimes identified by its **intended use**, e.g., Decorative vs. Industrial paint, there are no internationally agreed definitions of these.

Functions of Individual Paint Components:

Pigments and Fillers

- Paint is typically a mixture of **resins, pigments, fillers, solvents**, and other additives.
- **Pigment** is typically a mixture of resins, pigments, fillers, solvents, and other additives.
 - Pigment is used for selective absorption, light scattering, optical effects, UV protection, and corrosion protection.
- **Filler (extender)** is substance in powder form, insoluble in the medium and used to modify or influence certain physical properties.
 - Fillers are used for ‘filling’, sandability, improvement of mechanical technological coating properties, and improvement of anticorrosion properties.

Pigments and **fillers** in paint must be dispersible, insoluble, lightfast and weather resistant, heat resistant and chemical resistant.

Functions of Individual Paint Components:

Resins, Solvents, Driers and Other Additives

- **Resins** function as a binder (non-volatile part of a medium) to hold the pigment particles together.
 - Their properties directly relate to paint performances like durability, scrub resistance, hardness, flexibility, weather and chemical resistance, gloss and gloss retention.
- **Solvent** - single liquid or blend of liquids, volatile under specified drying conditions and in which the binder is soluble
- **Thinner** - single liquid or blend of liquids, volatile under specified conditions of use, added to a coating material to reduce viscosity or influence other properties
- **Driers** (drying agents) - compounds, usually metal soaps, that are added to paints drying by oxidation (oil, alkyd, alkyd-epoxy) to accelerate this process.
- **A paint additive** - any substance, added in small quantities to a coating material, to improve or otherwise modify one or more properties.

Paints and Coatings that Can Contain Lead

- **Decorative Paints**

- Also called architectural paints or household paints
- Used on the exterior of buildings such as houses, schools, and commercial premises, and on interior surfaces such as walls, ceilings, floors, windows, and doors

- **Aerosol Spray Paints**

- Also called aerosol paints and applied via a pressurized can; mostly for use by consumers
- Used in almost all types of surfaces and painting applications, i.e., as a touch-up paint for automobiles, furniture, and household appliances; as a convenient stuff for sprucing up accessories and decors; and as a material for school projects, artworks, murals, graffiti, etc.

- **Anticorrosive Paints**

- Applied as the first layer (primer) for rust prevention
- Used on metal structures, i.e., furniture, playground equipment, gates, bridges, oil rigs etc.

Paints and Coatings that Can Contain Lead (Continued)

- **Glazes** – coatings used on pottery, e.g., food containers, cups, bowls, cooking pots.
 - **Industrial paints** are intended for use by industry, e.g., as coatings for automobiles, equipment, plastic components, etc.; also used by the manufacturing industry in the manufacture of toys, school supplies, children's articles, coating furniture, appliances, gadgets, and kitchenware
 - **Road marking paint** – used for traffic markings on roads
 - **Artist's paint** – specialized oil paints containing lead pigments, usually exempted from regulatory controls

Lead Compounds are Added to Provide a Range of Functions in Paint

- Lead compounds can be used in the manufacture of all kinds of paints to give properties and characteristics, e.g. colour, rapid drying, corrosion resistance.
- Examples of lead use in **pigments** include:
 - Lead chromate molybdate sulphate (Pigment Red 104), Lead chromate (Pigment Yellow 34) , Chrome green (mixture of lead chromate and iron blue (Pigment Green 15), Lead tetra oxide (Pigment Red 105)
- Examples of **driers**:
 - Lead naphthenate and lead octoate
- **Alkyd resins** could be source of lead in alkyd paints, because alkyd resins can be made using lead catalysts

Lead May Be Present in the Following Types of Paints and Their Components

Paint Type	Pigments	Fillers	Driers
Oil, alkyd-based primers, intermediate and topcoats*	X	X	X
Primers, other bases	X	X	
Intermediate coats, other bases		X	
Top-coats, other bases	X	X	

*Alkyd resins may be a source of lead because of lead catalyst used in their synthesis.

Safer Alternatives to Lead Compounds Used in Paint

- **Lead Pigments**
 - Yellow and red lead pigments may be successfully substituted with combination of organic and inorganic pigments
- **Lead Driers**
 - Strontium-based driers are some of the safer alternatives to lead
- **Lead-based Corrosion Resistance Coatings/Primers**
 - Iron oxide and zinc phosphate-based primers are some safer alternatives to lead

Further information is available in Module D-3 Alternatives to Lead in Paint.

Concentrations of Lead in Paint

- **Concentration** of lead in paint is expressed in terms of the proportion of lead to the weight of the total non-volatile part of the product, or of the weight of the dried paint film.
- A **range of units** may be used to express this concentration, e.g. parts per million (ppm), percent (%), micrograms/gram ($\mu\text{g/g}$), milligrams/kilogram (mg/kg)
 - For reference, $10 \text{ ppm} = 0.001\% = 10 \mu\text{g/g} = 10 \text{ mg/kg}$
 - Note: some measurement instruments use “mg/cm²” which is an area measurement and not comparable to ppm (for more information see Toolkit Module C-2 Analytical Methods for Measuring Lead in Paint)
- **Lead-based pigments may contribute around 1500 to >100,000 ppm**, depending on whether they are mixed with other pigments or used alone.
 - Red, orange and yellow paints may have particularly high lead content.

Concentrations of Lead in Paint (Continued)

- **Lead-based driers** may contribute around 1200 to 6000 ppm or more.
 - Due to **unintentional contamination** of ingredients with traces of lead, such as can be the case with marine anti-fouling coatings, paints with no added lead compounds may still contain an amount of residual lead exceeding 90 ppm
 - Though it is possible to reach very low levels of lead in paint (less than 90 ppm), it is **not possible to have paint with 0 ppm of lead** as raw materials, such as clays and fillers, can contain trace amounts of lead.
 - **Alkyd paint** can have levels over 90 ppm, caused by a high content of alkyd resin

For information on testing lead content via country-based studies of paint, see Toolkit Module C-3 Summary of Lead Paint Testing in Low and Middle Income Countries.

A 90 ppm Limit on Lead Content is Technically Feasible

- Alternative, non-lead compounds can perform as well as lead-based ones and the paint is of equivalent quality.
- Non-lead pigments and driers are available and are used by many manufacturers to produce high quality paints
- **Paint made with compounds that are not lead-based** will have a lead content <90 ppm
- **If care is taken to source uncontaminated raw material ingredients** the lead content can be much lower than 90 ppm

For more information, see also Toolkit Module A-1 The Need for Regulating Lead Paint

A 90 ppm Limit on Lead Content Promotes Trade

- **90 ppm is becoming an accepted international standard** around the world for lead levels in paints
- **As awareness about danger of lead paint grows** there will be an increasing demand for safer paint
- **Already used in a number of countries**, e.g. Canada, Cameroon, China, Ethiopia, Georgia, India, Kenya, Nepal, the Philippines, Ukraine, the United Republic of Tanzania, and the United States of America

For more information, see also the following Toolkit Modules: A-1 The Need for Regulating Lead Paint and E-2 The Model Law: Testing Requirements and Implications for Industry Compliance and Lab Capacity

Goals of Paint Formulation

- Paints are formulated to have various specific technical properties, such as:
 - Chemical or weather resistance,
 - Signal or camouflaging effect,
 - Decorative effects,
 - Insulation or conductive properties, and
 - Antibacterial properties
- Beyond these technical properties, paint is also formulated to:
 - Adapt to a variety of underlying surfaces, known as substrates
 - Fulfil the needs for various methods of application.

Reformulation of Paint

- According to the paint industry, reformulation of paints to replace lead compounds is technically feasible and cost impacts manageable – though implementation is sometimes a challenge.
- By producing or using paints without lead compounds, paint manufacturers and users (such as toy manufacturers) can ensure access to markets where lead content in paint has already been restricted.
- Because many lead-containing paint formulations exist to provide specific paint properties, each reformulation requires a specific approach.

Reformulation here refers to the change in components in formulation of a specific paint, in this case to substitute lead raw materials and/or modify the production process.

Reformulation Of Paint (Continued)

- Some small enterprises do not have all the necessary equipment to carry out testing and scale-up.
 - Supplier's technical support is important as well as communication with international resource person/experts.
 - **For additional information, see the [UNEP Technical Guidelines on Paint Reformulation \(PDF\)](#)**

Summary

- Paints and coating materials are formulated to have various specific technical properties, adapt to use on underlying surfaces, and meet the needs of different types of application.
 - Lead compounds are added to many kinds of paints and coating materials to achieve specific characteristics.
 - Lead paint can leave a legacy of potential human exposure for many years into the future – children are particularly vulnerable.
 - Non-lead ingredients, such as pigments and driers, are available and are used by many manufacturers to produce paints. Paint made with compounds that are not lead-based will in most cases have a lead content <90 ppm.
 - By producing or using paints without lead compounds, paint manufacturers and users (such as toy manufacturers) can ensure access to markets where lead content in paint has already been restricted.
 - Eliminating lead paint provides a net benefit to society and public health.

**Please contact the Chemicals and Health Branch
of the United Nations Environment Programme
should you have any questions.**

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