

# Analytical Methods for Measuring Lead in Paint

Modified from Module C.ii.

Lead Paint Alliance Toolkit for Establishing Laws to  
Control the Use of Lead in Paint

# Regulatory needs for measuring lead content of paint

- Regulations for lead in **new paint** often expressed as weight percentage of lead in the dry paint (% , ppm, mg/kg)
- Regulations for lead in **already painted surfaces** typically expressed as amount of lead per unit area (mg/cm<sup>2</sup>)

⇒ NOTE: There is no standard conversion factor between ppm and mg/cm<sup>2</sup>

# Methods and measurement units for test results

The choice of analytical method depends on purpose of study, e.g.

- Substrate: New or old paint; concentration by volume (ppm) or surface area (mg/cm<sup>2</sup>)
- Detection limits: What range of levels of lead are expected
- Budget available

## Two main options

- Laboratory analysis (various types)
- Portable analysis (X-ray fluorescence (XRF))
  - Portable XRF
  - High definition portable XRF (HDXRF)

# Detection limits

= the minimum level of lead you can measure with a high level of confidence

- Detection limits are decided by
  - The method: inherent properties of method
  - The amount of paint in sample
- Typically the lower the detection limit the higher the price

⇒NOTE: Lower detection limits does not imply lower reliability of test

⇒Key question: what limit of detection is sufficient?

# Laboratory analysis

Standard procedures include two steps

## 1. Sample preparation

1. (new) liquid paint – apply to a surface, then scrape off;
2. existing paint – scrape some off the surface.

## 2. Analysis

1.



Photo credit: EcoWaste Coalition/IPEN

2.



Photo from <https://www.epa.gov/sites/production/files/documents/paintchip.pdf>

# Methods laboratory analysis

Three commonly used methods are

1. Flame Atomic Absorption Spectrometry (FAAS)
2. Graphite Furnace Atomic Absorption Spectrometry (GFAAS)
3. Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)



Higher limit of detection



Higher price

# Laboratory analysis: Quality considerations

- Trained personnel and good quality assurance procedures are essential to ensure accuracy and reliability of results
- Laboratory should participate in a proficiency-testing scheme, e.g. the Environmental Lead Proficiency Analytical Testing (ELPAT) program (ref 2)
- International standards exist for sample preparation and analysis (see following slides)

# International standards

- Typically available through National Standard Agencies
- ISO paint standards:  
<https://www.iso.org/committee/47962.html>
- ASTM paint standards:  
<https://www.astm.org/Standards/paint-and-related-coating-standards.html>
- Specific standards for measuring lead in paint in upcoming slides and links at the end



# International standards for sample preparation

- **ISO 1513**, Paints and varnishes - Examination and preparation of test samples (ref 3)
- **ASTM E1645-01**, Practice for Preparation of Dried Paint Samples by Hotplate or Microwave Digestion for Subsequent Lead Analysis (ref 4)
- **ASTM E1979-12**, Practice for Ultrasonic Extraction of Paint, Dust, Soil, and Air Samples for Subsequent Determination of Lead (ref 5)

# International standards for test methods

- **ISO 6503**, Paints and varnishes - Determination of total lead - flame atomic absorption spectrometric method (for measurement of lead concentration of 0.01% to 2.0%) (ref 6)
- **ASTM D3335-85a(2014)**, Standard test method for low concentrations of lead, cadmium, and cobalt in paint by atomic absorption spectroscopy (for measurement of lead concentration of 0.01% to 5.0%) (ref 7)
- **ASTM E1613-12**, Standard Test Method for Determination of Lead by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), Flame Atomic Absorption Spectrometry (FAAS), or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) Techniques (measurement of lead concentration differs according to analytical technique) (ref 8)

# Considerations when choosing a laboratory

- Laboratory's experience in lead paint analysis
- Accreditation through a recognized proficiency testing scheme
- Analytical methods used (e.g. FAAS, GFAAS, ICP-AES)
- Limit of detection
- Costs per sample, including any shipping costs
- Specific sample requirements that the chosen laboratory may have
- Turn-around time

# Portable analysis: High-definition portable X-ray fluorescence analysis

- New technology that can measure very low concentrations of lead
- Lead concentration can be reported as ppm or mg/cm<sup>2</sup>
- Suitable for compliance testing of new paints
- If sampling new paint, samples should be prepared on a metal free homogeneous substrate, e.g. wood
- But: very few models available, expensive to buy

(For information on standard portable XRF see later slides)

# Existing painted surfaces: Options for measuring lead content

1. Laboratory analysis (off-site)
2. Portable X-ray fluorescence (XRF) analysis (on-site)

# Option 1: Laboratory analysis for existing painted surfaces

- Samples should be taken by trained personnel to ensure samples are adequate
- When taking a paint chip sample from a painted surface:
  - paint must be removed from the underlying material, i.e. it is necessary to damage the painted surface
  - it is important to remove a precisely-measured area of paint
- Paint sample must be prepared (e.g. by acid digestion) before analysis
- Laboratory analysis takes additional time compared to on-site analysis

# Option 2: Portable XRF

- Uses a radiation source or x-ray tube to detect and measure lead (radiation and x-ray safety precautions should be followed)
- Should be used by a trained operator to ensure reliable results
- Not all XRF devices are suitable for measuring lead in paint – check before using
- Equipment is relatively expensive but is more practicable for measuring a large number of surfaces than laboratory analysis



Photo credit: EcoWaste Coalition/IPEN

# Option 2: Portable XRF (continued)

- Tested surface does not need to be damaged
- Results are available immediately
- Good accuracy when used by a trained operator, though there is a larger margin of error than with laboratory methods
- Can only be used on smooth, flat surfaces
- Suitable for dry paint but not wet paint



# Summary

- Choice of analytical method to measure lead in paint depends on many factors, such as the reason for analysis, number of samples, cost limitations, need for precise measurement, etc
- For new paint, three good laboratory methods are available that vary in cost and level of detection
- For existing painted surfaces, measurement methods include off-site laboratory analyses plus two on-site tests that vary in cost and accuracy
- More detailed information at <https://www.unenvironment.org/toolkit-establishing-laws-eliminate-lead-paint>

# References

2. Environmental Lead Proficiency Analytical Testing (ELPAT) programme (<https://www.aihapat.org/Programs/ELPAT/Pages/default.aspx>, accessed 25 July 2017)
3. ASTM D3335-85a (2014), Standard Test Method for Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy, ASTM International, West Conshohocken, PA (<http://www.astm.org/Standards/D3335.htm>, accessed 25 July 2017)
4. ASTM E1613-12, Standard Test Method for Determination of Lead by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), Flame Atomic Absorption Spectrometry (FAAS), or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) Techniques, ASTM International, West Conshohocken, PA (<http://www.astm.org/Standards/E1613.htm>, accessed 25 July 2017)
5. ASTM E1645-01 (2007), Standard Practice for Preparation of Dried Paint Samples by Hotplate or Microwave Digestion for Subsequent Lead Analysis, ASTM International, West Conshohocken, PA (<http://www.astm.org/Standards/E1645.htm>, accessed 25 July 2017)

# References (continued)

6. ASTM E1979-12, Standard Practice for Ultrasonic Extraction of Paint, Dust, Soil, and Air Samples for Subsequent Determination of Lead, ASTM International, West Conshohocken, PA (<http://www.astm.org/Standards/E1979.htm>, accessed 25 July 2017)
7. ISO 1513:2010, Paints and varnishes - Examination and preparation of test samples (available in English, French and Russian).  
([http://www.iso.org/iso/iso\\_catalogue/catalogue\\_tc/catalogue\\_detail.htm?csnumber=50490](http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=50490), accessed 25 July 2017)
8. ISO 6503:1984, Paints and varnishes - Determination of Total Lead - Flame Atomic Absorption Spectrometric Method (available in English and French)  
([http://www.iso.org/iso/iso\\_catalogue/catalogue\\_tc/catalogue\\_detail.htm?csnumber=12880](http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=12880), accessed 25 July 2017)

# Additional information

Brief guide to analytical methods for measuring lead in paint (available in Chinese, English, French and Spanish). Geneva: World Health Organization; 2011 ([http://www.who.int/ipcs/assessment/public\\_health/lead/en](http://www.who.int/ipcs/assessment/public_health/lead/en), accessed 25 July 2017).