



Designation: E2119 – 24

Standard Practice for Quality Systems for Conducting In Situ Measurements of Lead Content in Paint or Other Coatings Using Field- Portable X-Ray Fluorescence (XRF) Devices¹

This standard is issued under the fixed designation E2119; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the collection and documentation of quality control (QC) measurements for determining acceptable levels of instrumental performance when using field-portable energy-dispersive X-ray fluorescence spectrometry devices (XRFs) for the purposes of generating lead classification results from measurements on paint and other coating films within buildings and related structures.

1.1.1 This practice is not designed to determine the presence of a hazard as defined by authorities having jurisdiction in the United States or other jurisdictions. See Guide E2115 and the HUD Guidelines for more information.

1.2 QC procedures covered in this provisional practice include the performance of calibration checks, substrate bias checks, and specific instructions for documenting the collected data for later use in reporting the results.

1.3 No detailed operating instructions are provided because of differences among the various makes and models of suitable instruments. Instead, the analyst is to follow the instructions provided by the manufacturer of the particular XRF device or other relevant sources of information on XRF operation.

1.4 This practice contains notes which are explanatory and are not part of the mandatory requirements of this provisional practice.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

¹ This practice is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.12 on Sampling and Analysis of Lead for Exposure and Risk Assessment.

Current edition approved April 1, 2024. Published April 2024. Originally approved in 2000. Last previous edition approved in 2020 as E2119 – 20. DOI: 10.1520/E2119-24.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

E1605 Terminology Relating to Lead in Buildings

E1645 Practice for Preparation of Dried Paint Samples by Hotplate or Microwave Digestion for Subsequent Lead Analysis

E1729 Practice for Field Collection of Dried Paint Samples for Subsequent Lead Determination

E2115 Guide for Conducting Lead Hazard Assessments of Dwellings and of Other Child-Occupied Facilities

E2239 Practice for Record Keeping and Record Preservation for Lead Hazard Activities

E3193 Test Method for Measurement of Lead (Pb) by Flame Atomic Absorption Spectrophotometry (FAAS)

E3203 Test Method for Determination of Lead in Dried Paint, Soil, and Wipe Samples by Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES)

2.2 Other Documents:

40 CFR 745 Lead-Based Paint Poisoning Prevention in Certain Residential Structures³

HUD Guidelines Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, 2nd Edition, July 2012⁴

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, <http://www.epa.gov>.

⁴ Available from U.S. Department of Housing and Urban Development, 451 7th Street, SW, Washington, DC 20410, <http://www.hud.gov>.

3. Terminology

3.1 *Definitions*—For definition of terms not presented below, refer to Terminologies **D1356** and **E1605**.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *building component, n*—part or element of a building that is made of an industry product that is manufactured as an independent unit and is capable of being joined with other elements.

3.2.1.1 *Discussion*—Examples include doors, walls, baseboards, and exterior siding.

3.2.2 *calibration check, n*—a procedure that generates a QC measurement using a calibration test sample with one type of control block (usually wood).

3.2.3 *calibration mode, n*—a selected operating mode that permits adjustment of an instrument's calibration.

3.2.4 *calibration test sample, n*—a test film sample of a known lead level in mg/cm² which has a reported uncertainty of the lead level traceable to the National Institute of Standards and Technology (NIST) Standard Reference Materials (SRMs) or other national or international standard reference materials that have a known specified uncertainty for the known lead level.

3.2.4.1 *Discussion*—For example, use of SRM 2579a, Lead Paint Films for Building Surfaces (SRM 2570 through SRM 2575), is required in the United States when conducting lead-based paint inspections.

3.2.4.2 *Discussion*—Calibration test samples may be separate from a substrate or adhered to a substrate.

3.2.5 *continuing calibration check, n*—a calibration check performed during the testing day after the initial calibration check. A continuing calibration check also can serve as a final calibration check.

3.2.6 *control block, n*—a small block of material of an identifiable substrate type used to simulate a building material during QC measurements.

3.2.7 *display unit, n*—an electronic device that presents the results of an XRF measurement to the user. Other parameters such as total measurement time also may be presented.

3.2.8 *excitation source, n*—a part of an electronic device that emits X-rays or gamma rays, or both, that cause ionization of atoms in the sample, and subsequently a cascade of higher energy electrons into the vacated lower energy shells.

3.2.9 *final calibration check, n*—the last calibration check performed in a testing period.

3.2.10 *inconclusive lead classification result, n*—a lead classification result that reliably cannot be expressed, for example, reported, as either containing lead (positive) or not containing lead (negative) at or above an appropriate local, state, or federal action level for lead in coatings.

3.2.11 *initial calibration check, n*—the first calibration check of the testing period performed after the XRF instrument has been turned on and allowed to warm up.

3.2.12 *lead classification result, n*—an XRF measurement expressed, for example, as either positive-for-lead, or negative-

for-lead, at or above and appropriate local, state, or federal action level for lead in coatings.

3.2.12.1 *Discussion*—A negative-for-lead result does not mean there is no lead present.

3.2.12.2 *Discussion*—For some makes and models of XRF instruments, lead measurement values obtained near an appropriate local, state, or federal action level for lead in coatings may generate inconclusive lead classification results.

3.2.13 *nominal read time, n*—a read time that results when the radioactive source normally provided by the manufacturer for that XRF instrument is at its original source strength.

3.2.14 *operating mode, n*—one or more settings that define the operating parameters of an XRF instrument.

3.2.14.1 *Discussion*—Some XRF instruments have multiple settings for use under different testing situations, for example, substrates, time, or testing objectives.

3.2.15 *performance characteristic sheet (PCS), n*—defines acceptable operating specifications and procedures for a specific XRF lead-based paint analyzer as determined by HUD for use in housing in the United States.

3.2.15.1 *Discussion*—If an XRF analyzer does not have a PCS, or if it is not used, or if the data are not analyzed in accordance with its PCS, the actions and results may not be recognized for hazard determinations in housing in the United States.

3.2.16 *power-down, n*—an event where the power to the XRF instrument is turned off.

3.2.16.1 *Discussion*—The XRF instrument cannot collect and display any XRF measurements after a power-down.

3.2.17 *power-on, n*—an event where the power to the XRF instrument from the battery is turned on.

3.2.17.1 *Discussion*—The XRF instrument can collect and display XRF measurements after a power-on.

3.2.18 *probe, n*—a hand-held device containing an excitation source, X-ray detector and associated mechanical and electronic components that is placed against a test location or calibration test sample to obtain an XRF measurement.

3.2.19 *radioactive source, n*—a radioactive material (for example, ⁵⁷Co or ¹⁰⁹Cd) that emits X-rays or gamma rays, or both, that cause ionization of atoms in the sample, and subsequently a cascade of higher energy electrons into the vacated lower energy shells.

3.2.19.1 *Discussion*—As these electrons fall into the lower energy orbitals, X-rays characteristic of the atomic species, such as lead, are emitted from the test location.

3.2.20 *read time, n*—a period of X-ray data collection time controlled manually or automatically depending on the XRF instrument model.

3.2.20.1 *Discussion*—The read time begins with the opening of the XRF instrument shutter to expose the paint film surface to source gamma rays and X-rays, and ends when the source shutter is closed and the XRF reading is complete.

3.2.21 *sampling site, n*—a local geographical area that contains at least one unit being tested. A sampling site generally is limited to an area that is easily covered by walking.

3.2.22 *substrate, n*—the building material that lies under the coating.

3.2.23 *substrate bias check (SBC), n*—a procedure that generates a QC measurement using a calibration test sample and a control block to determine the effect of that substrate on the XRF measurement.

3.2.24 *substrate-corrected XRF measurements, n*—a procedure that corrects an XRF measurement for substrate effects (see the HUD Guidelines for more information on substrate corrections).

3.2.25 *substrate type, n*—the type of building material that lies under the coating.

3.2.25.1 *Discussion*—Examples include wood, plaster, gypsum wallboard, metal, brick, and concrete.

3.2.26 *testing period, n*—a block of time that defines the continuous power-on operation of an XRF instrument.

3.2.26.1 *Discussion*—Any power-down of an XRF instrument terminates the testing period.

3.2.27 *test location, n*—an area on a building component where a lead measurement value is obtained.

3.2.28 *unit, n*—all or a portion of a structure or facility that is the target of an investigation.

3.2.28.1 *Discussion*—Test locations are considered to be within a unit. An example of a unit is a single-family dwelling including a detached garage that is part of the property.

3.2.29 *X-ray detector, n*—a device that results in an electronic signal as a result of the interception of an X-ray.

3.2.29.1 *Discussion*—Examples include gas proportional counters, for example, Xe, solid scintillation counters, for example, CsI, and semiconductor devices of elemental composition, for example, Si or Ge, or compound composition, for example, HgI₂, CdTe, or CdZnTe.

3.2.30 *X-ray tube, n*—a device for generating X-rays that accelerates electrons to high energies to have them strike a metal target which emits the X-rays.

3.2.31 *XRF instrument, n*—a field-portable XRF device or analyzer with associated equipment designed and manufactured for use in measuring lead in paint or other coating films.

3.2.31.1 *Discussion*—XRF instruments, at minimum, include an excitation source, such as a radioactive source or X-ray tube, X-ray detector, probe, and a display unit.

3.2.32 *XRF measurement, n*—a procedure used to determine the lead content of a coating at a test location using an XRF instrument, or a lead result, expressed as mg of lead per cm² of surface, that is, mg/cm², obtained from a coating at a test location using an XRF instrument.

3.2.32.1 *Discussion*—An XRF measurement may be one reading or the average of two or more XRF readings.

3.2.33 *XRF reading, n*—a response, expressed as mg of lead/cm² of surface, that is, mg/cm², of an XRF instrument for one read time.

4. Summary of Practice

4.1 This practice covers the quality assurance (QA), QC, and recording procedures to follow when using field-portable

energy-dispersive X-ray fluorescence spectrometry devices (XRFs) to collect measurements of lead in paint or lead in other coating films for the purposes of generating lead classification results. This practice includes start-up procedures, beginning-of-day calibration check QC procedures, during-the-test-day QC check procedures, and end-of-day QC check procedures designed to complement standard operating procedures written by manufacturers for specific models of field-portable XRF instruments.

5. Significance and Use

5.1 This practice provides procedures to generate and document QC data for ensuring that an XRF is operating within acceptable tolerances throughout the testing period when being used to collect lead results during a lead-based paint (LBP) inspection for the purposes of generating lead classification results.

5.2 This practice is intended to supplement XRF instrument manufacturer protocols and PCSs⁴ through the use of QA and QC procedures to provide uniform lead testing practices among the wide variety of available field-portable XRF instruments.

NOTE 1—The United States requires that an XRF used to perform a lead-based paint inspection in housing is to be utilized according to the PCS for the particular instrument model in use.

5.3 While the QC results collected using this practice can provide assurances that an XRF instrument is operating within acceptable tolerances, this practice does not determine an actual level of confidence for a classification result obtained from an XRF measurement.

5.4 This practice does not address selection of test locations or representative sampling for leaded paint. Additional information on conducting measurements of lead in leaded paint or other coatings may be found in Guide E2115 and the HUD Guidelines, Chapter 7.

5.5 This practice involves the use of field-portable XRF instruments that may contain radioactive materials or X-ray tubes that emit X-rays or gamma rays, or both. These instruments are intended for use only by qualified, trained personnel.

5.6 The use of field-portable XRF instruments for measurement of lead may not accurately reveal low but still potentially hazardous levels of lead.

6. Materials and Equipment

6.1 (*Field-Portable*) *XRF Instrument*—One of a variety of the commercially available field-portable XRF instruments designed for use in measuring lead in paint and other coatings.

6.2 *Calibration Check Samples*—Calibration test samples that are used to verify XRF instrument calibration.

6.3 *Control Blocks*—A set of substrate materials for use in making QC measurements as defined in Table 1.

6.4 *Substrate Support*—A support material used to hold calibration check samples and control blocks away from any additional underlying material in a manner that will not interfere with the lead measurements on calibration check samples. The support material shall not itself have potentially