Designation: E3283 – 21

Standard Practice for Preparation of Loose Radiological/Surrogate Contamination on Nonporous Test Coupon Surfaces for Evaluation of Decontamination Techniques[1]

This standard is issued under the fixed designation E3283; 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 is intended to provide a basis for simulating radioactive contamination consistent with processes used to evaluate decontamination. The methods described provide a "loose-type" radiological or surrogate contamination on nonporous surfaces; these methods provide a surface contamination that may be easily removed by brushing or flushing with water.

1.2 This practice is intended for nonporous surfaces such as stainless steel, aluminum, glass, laminates, and epoxy painted surfaces. Preparation of porous substrates is not addressed, although similar methodologies may be used. A different practice is employed using Practice E3190, to produce "fixed" contamination.

1.3 The chemical simulants shall not include nor generate toxic byproducts as defined by U.S. Occupational Safety and Health Administration (OSHA) during preparation, application, or removal under normal conditions. A Safety Data Sheet (SDS) shall be provided so that appropriate personal protective equipment (PPE) can be selected.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.5 *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.*

1.6 *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]

D1193 Specification for Reagent Water

E3190 Practice for Preparation of Fixed Radiological/Surrogate Contamination on Porous Test Coupon Surfaces for Evaluation of Decontamination Techniques

3. Terminology

3.1 *Definitions:*

3.1.1 *contamination, n*—radioactive material in an unwanted location.

3.1.2 *fixed contamination, n*—contamination that is not removable by brushing or flushing it away with water at pressures below 0.689 MPa.

3.1.3 *loose contamination, n*—contamination that is removable by brushing or flushing it away with water at pressures below 0.689 MPa (100 psi).

3.1.4 *deminimus sample result, n*—result below which no further effort of quantification is required, typically about 2 % of the original contamination value.

3.1.4.1 *Discussion*—For fixed contamination calculations, the 2 % of the original contamination value is adequate because of the difficulty in achieving such results and the essential nature of the precision of the method.

3.1.5 *non-radiological surrogate, n*—material used in place of a radioactive material to evaluate a proscribed method without necessitating the use of actual radioactive material.

3.1.5.1 *Discussion*—For use of surrogates, the user shall ensure adequate chemical, mechanical, and general mimicry of the proposed radiological material the surrogate is replacing.

3.1.6 *personal protective equipment, PPE, n*—refers to the protective clothing, head protection, eye protection, and or

[1] This practice is under the jurisdiction of ASTM Committee E10 on Nuclear Technology and Applications and is the direct responsibility of Subcommittee E10.03 on Radiological Protection for Decontamination and Decommissioning of Nuclear Facilities and Components.

Current edition approved June 15, 2021. Published August 2021. DOI: 10.1520/E3283-21.

[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.

other garments or equipment designed to protect the wearer's body from injury or contamination.

3.1.6.1 *Discussion*—The hazards addressed by PPE may include physical, electrical, heat, chemical, and radiological hazards.

3.1.7 *radiological work permit, RWP, n*—written work authorization prepared by the facility radiological control organization that describes the potential radiation dose, work conditions, and contamination control measures to be used when performing radiological work.

3.1.7.1 *Discussion*—The specific facilities in which this work will be performed will define whether an RWP or equivalent document will be required for performance. Given the concentrations of radionuclides used in this practice and the potential for whole-body and extremity radiation dose, the facility radiological control organization may require as low as reasonably achievable (ALARA) work activity planning.

3.1.8 *simulation, n*—consistent, reproducible means for preparing test coupons (even those with radioactive contamination).

3.1.9 *stippling, n*—method of placing drops of solution (which may be measured by an adjustable pipette) onto the surface of a coupon to provide a uniform distribution of contaminant on the surface.

4. Summary of Practice

4.1 For all methods described herein, a contaminant is applied to a pre-cleaned test coupon under ambient conditions. The amount of contaminant necessary to be applied to the test coupon shall be determined in advance of preparing coupons.

4.2 Two methods of applying contamination to the coupon are discussed:

4.2.1 *Method A*—Stippling the contaminant solution onto the desired surface, and

4.2.2 *Method B*—Distributing a powder via a "salt-shaker"-type container.

4.3 The protocol for determining the decontamination factor/efficiency is provided when the coupons are used to test a decontamination method. The detection method [for example, gamma analysis, visual, photographic or X-ray fluorescence (XRF)] provides data for this evaluation. The use of gamma-emitting radionuclides and a specific geometry high-purity germanium detector measurement process is recommended.

5. Significance and Use

5.1 This practice provides a protocol to compare different decontamination technologies with a standard contamination mechanism and analysis of subsequent decontamination factors/efficiencies.

5.2 The use of this practice provides for the preparation of test coupons with a known amount of loose radiological or surrogate contaminant on the surface.

5.3 A standard test coupon is described and a list of potential equipment, contaminants, and contaminating solutions is provided within the procedure.

5.4 This practice describes a contamination simulation process that meets the requirements of testing performed (previously) by the U.S. Department of Energy and U.S. Environmental Protection Agency for the removal of loose contamination.

6. Reagents

6.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[3] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

6.2 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water as defined by Type I of Specification D1193.

6.3 A concentrated radionuclide standard shall be procured for use if radiological tests are being performed (recommended use). It is intended that a single contaminant be applied to a coupon and not introduce multiple sources. When using Cs-137, a standard (stock solution) with a concentration of about 7.4E5 Bq/mL (2E-5 Ci/mL) will provide a good, long-lasting standard. Lesser concentrations can be used. The recommended Cs-137 working solution will be about 1.48E4 Bq/mL (4E-7 Ci/mL). This solution typically has a radiation reading of about 3 mSv/h (300 mrem/h) gamma on contact and 18 mSv/h (1800 mrem/h) beta/gamma on contact. The body field at 30 cm is typically below 0.5 mSv/h (50 mrem/h). Coupons prepared using these solutions exhibit a dose rate of about 0.2 mSv/h (20 mrem/h). When using Sr-85 and Co-60, similar activity concentrations may be suitable, but for Am-243, an activity concentration of 1.48E2 Bq/mL (4E-9 Ci/mL) is possible given it is an alpha emitter. These solutions are slightly acidic, unbuffered.

6.4 Nonradioactive contaminant solutions of cesium chloride and zirconium chloride have been used at a concentration of about 1 mg/mL.

7. Procedure

7.1 Prepare coupons for contamination.

7.1.1 Wash coupons with high-resistivity water (ASTM Type I as outlined in Specification D1193) or brush them lightly to remove dust. Some coupons may not require additional preparation beyond brushing and the application of a label.

7.1.2 Label coupons with unique identifiers.

7.1.3 Coat coupon sides with polyester resin to provide a surface that can be more easily decontaminated (if necessary).

7.2 *Prepare Working Solution:*

[3] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the United States *Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

7.2.1 Perform dilution preparation necessary to achieve desired contamination level on the coupon surface. The typical Cs-137 level used in the contamination of 225 cm^2 coupons is less than 37 000 Bq (1E-6 Ci) distributed over the surface. Nonradioactive specimens may have about 1 mg of contaminant applied. Other sizes of coupons with varying materials (such as stainless steel, aluminum, glass, etc.) can be used.

7.3 Prepare the area for innoculating coupons by placing blotter paper on surfaces and assembling racks for drying coupons. Place an additional pair of short hand gloves over inner glove PPE to prevent cross-contamination of coupons (for cross-contamination control only).

7.4 *Method A* (4.2.1)—Stipple the contaminant solution onto the desired surface.

7.4.1 Load the pipette with working solution at the desired concentration or activity. Set the pipette to deliver a small quantity of solution (about 10 µL) to stipple (place drops) onto the surface.

7.4.2 Stipple the measured volume of solution onto the coupon surface by placing drops of solution in a manner as to create a uniform distribution of contamination across the coupon surface. This can be done randomly or in a pattern to give a uniform distribution (a pattern is better but not necessary) (see Fig. 1).

7.4.3 Move the coupon onto a drying rack and place, or have a second person place, a new, prepared coupon into the hood.

7.5 *Method B* (4.2.2)—Distributing a powder via a "salt-shaker"-type container.

7.5.1 Place the desired amount of solid contaminant or surrogate into a "salt-shaker"-type device. This is a bottle with an array of holes in the top so a relatively uniform "dusting" of powder may be distributed onto the coupon.

7.5.2 Distribute the solid contaminant powder onto the surface of the coupon until the amount of material in the shaker has been completely dispersed. Make an even distribution, as uniform as possible, while retaining the contaminant on the surface of the coupon (see Fig. 2). This distribution is usually most successful with particles in the 10-200 µm range. If using a radiological material, powders and dust may be more closely monitored or restricted and thus can require additional radiological controls.

FIG. 1 Stippled Plate with "Drop Dots"

FIG. 2 Contaminant Distributed Uniformly on the Surface of a Coupon

7.5.3 A modification of this process can use a visible contaminant like a common ultraviolet (UV) active powder.

7.6 Repeat 7.4 or 7.5 until the required number of coupons have been contaminated. Allow coupons to dry for 12 h (if using a liquid contaminant).

7.7 Remove and package contaminated coupons in accordance with facility radiological control procedures. Each coupon is bagged individually. If coupons are prepared with nonradioactive simulant, this step can be omitted. Coupons prepared using powdered radiological material may require more coordination and additional controls, particularly if such coupons are being shipped to other laboratories for analysis or testing.

7.8 Determine the amount of contamination present on the coupon with proposed techniques in Section 8. This process is used before and after the decontamination test to determine the decontamination factor or contamination removal efficiency. Note that powdered surrogates can have a tendency to not remain fixed during transport and disturbance of the surface should be minimized.

7.9 If using an UV active powder, a UV light can be used to determine a before/after level of contamination. The use of photographic analysis may be used as in Fig. 3.

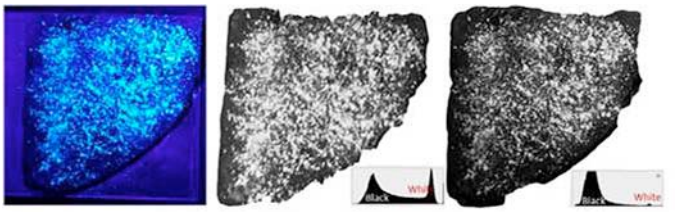

FIG. 3 Photographic Analysis of Before (Left and Center) and After (Right) after Processing in PhotoShop