Designation: E3190 – 19

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

This standard is issued under the fixed designation E3190; 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 "fixed-type" radiological or surrogate contamination on porous surfaces; these methods provide a surface contamination that is not easily removed by brushing or flushing with water.

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

1.3 This practice is intended to be practiced primarily on porous surfaces such as concrete, marble, granite, grout, brick, tile, asphalt, vinyl floor tile, latex painted gypsum wall board and polyurethane coated wood. Preparation of non-porous substrates is not addressed, although similar methodology may be used.

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

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

3. Terminology

3.1 *Definitions:*

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

3.1.2 *deminimus sample result, n*—a result below which no further effort of quantification is required, typically about 2 % of the original contamination value. For fixed contamination calculations, the 2 % of the original contamination value is adequate due to the difficulty in achieving such results and the essential nature of the precision of the method.

3.1.3 *fixed contamination, n*—contamination that is not removable by brushing or flushing it away with water at pressures below 0.689 MPa (100 psi).

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

3.1.5 *non-radiological surrogate, n*—a material used in place of a radioactive material to evaluate a proscribed method without necessitating the use of actual radioactive material. For use of surrogates, the user shall ensure adequate chemical, mechanical, etc. mimicry of the proposed radiological material the surrogate is replacing.

3.1.6 *personal protective equipment (PPE), n*—refers to the protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or contamination. The hazards addressed by protective equipment may include physical, electrical, heat, chemicals, and radiological hazards.

3.1.7 *radiological work permit (RWP), n*—a written work authorization prepared by the facility radiological control

[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.

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[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.

organization that describes the 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.

3.1.7.2 *Discussion*—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 ALARA (As Low As Reasonably Achievable) work activity planning.

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

3.1.9 *stippling, n*—a 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 solution of the contaminant is applied to a pre-cleaned test coupon and dried 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*: Spray coating the contaminant solution onto the desired surface.

4.2.2 *Method B*: Stippling the contaminant solution onto the desired surface.

4.3 The protocol for determining the decontamination factor/efficiency is provided when the coupons are utilized to test a decontamination method. The detection method (for example, gamma analysis or x-ray fluorescence) 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 fixed radiological or surrogate contaminant on the surface.

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

5.4 This method 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.

6. Reagents and Equipment

6.1 All solutions shall be prepared with high-resistivity water (ASTM Type I as outlined in D1193) and high purity standards.

6.2 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 to introduce multiple sources. When using Cs-137, a standard (stock solution) with a concentration of about 7.4E5 becquerels per millilitre (Bq/mL) (20 uCi/mL) will provide a good, long lasting standard. Lesser concentrations may be used. The recommended Cs-137 working solution will be about 1.48E4 Bq/mL (0.4 uCi/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 (0.004 uCi/mL) may be more suitable given it is an alpha emitter. These solutions are slightly acidic, unbuffered.

6.3 Non-radioactive contaminant solutions of cesium chloride and zirconium chloride have been used at a concentration of about 1 mg/mL.

6.4 A special "spray device" created using two syringes is shown in Fig. 1. This apparatus may be prepared well in advance. Exercise caution making this device as the needle on the delivery syringe is quite sharp (though not removed once in place) and shall be completely contained within the body of the spraying syringe (and held in place with tape).

7. Procedure for Contaminating Materials

7.1 Prepare coupons for contamination:

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

NOTE 1—If using a concrete coupon (Fig. 2), the top surface of concrete coupons is the only one used in these tests. The top surface has a "floated" texture and did not contact the plywood mold/form.

7.1.2 Label coupons with unique identifiers.

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

7.1.4 Prior to placing them in the hood where spraying operation (Method A, 4.2.1) will take place, place tape around the sides (to form a "chimney", see Fig. 3) to help prevent contamination from reaching the sides, if using radiological contamination.

7.2 *Prepare Working Solution:*

7.2.1 Perform dilution preparation necessary to achieve desired contamination level on coupon surface. The typical Cs-137 level used in the contamination of 225 cm^2 concrete coupons was 37 000 Bq (1 uCi) distributed over the surface. In