STANDARD SPECIFICATION
DECONTAMINATION FACTORS AND TEST PROCEDURES

1.0 DESCRIPTION

1.1 This section provides guidance to decontamination factors and to methods and procedures for the quantitative evaluation of coating system decontamination.

1.2 The procedure includes:

1.2.1 Preparation of Test Specimens

1.2.2 Contaminant Composition and Contamination Procedures

1.2.3 Radiation Detection Equipment

1.2.4 Decontamination Counting, Reagents, and Procedures

1.2.5 Guidance to Decontamination Factors

1.2.6 Documentation

2.0 PREPARATION OF TEST SPECIMENS

2.1 Preparation of Steel Specimens:

2.1.1 Panels: The minimum size for carbon steel panels shall be 2 by 4 inches by 1/8 inch thick with rounded edges and corners. Larger sizes may be used where feasible. The steel for each specimen shall meet the requirements of ASTM A36, "Standard Specifications for Structural Steel."

2.1.2 Surface Preparation: Surface preparation shall be according to SSPC SP10 with a profile between 1S70 and 2S70 (approximately 1.0 to 2.0 mils) as read on a Keane-Tator Profile Comparator Disc.

3.0 APPLICATION AND CURE OF COATINGS

3.1 All specimens shall be coated completely with the entire coating system.

3.2 All applications shall be in accordance with the coating manufacturer's latest published instructions for the system. Care shall be taken to apply the materials so that the characteristics of the system are similar to the coatings applied on a full scale structure.

3.3 All specimens shall be marked for identification.

3.4 All coatings or coating systems shall be cured at ambient temperature. No elevated temperature curing is allowed.

4.0 CONTAMINANT COMPOSITION AND CONTAMINATION PROCEDURES

4.1 The radioactive contaminant to be used in these tests shall be a solution of mixed fission products of Ce-144, Ru-106, Cs-137, Zr-95 cooled at least

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90 days and no more than 3 years. The solution of mixed fission products shall have a minimum beta-gamma activity of 5 x 10(6) dpm, or disintegrations per minute of 0.1 ml. The stock solution of this material (prepared in 8M HNO(3) shall be stored in a polyethylene bottle or other approved container that will not absorb radioactive nuclides. Glassware is not acceptable.

4.2 Before contamination, all specimens shall be thoroughly degreased, then placed on a level surface inside a laboratory hood and allowed to dry. A minimum air velocity of 150 ft./min. shall be maintained at the face of the hood.

4.3 A portion of the stock contaminant solution (in 8M HNO(3)) shall be transferred to a clean polyethylene (or other approved) container and immediately adjusted to a pH of 4 with 8M NH(4)OH (ammonium hydroxide). This is the adjusted contaminant test solution.

4.4 Then 0.2 ml. of the adjusted contaminant test solution shall be quickly pipetted onto the center of the bottom 2 inch post section of each specimen. The contaminant solution shall be placed for maximum submergence during contamination. The contaminant shall cover an area about 1 cm. in diameter.

4.5 The specimens shall be air dried. After being dried, each specimen shall be placed in a separate plastic bag (1.5 mils thick) prepatory to being scanned (counted) with a gamma spectrometer.

5.0 RADIATION DETECTION EQUIPMENT

5.1 The detector shall be a gamma-sensitive device such as a sodium iodide crystal with photomultiplier and amplifier coupled to a pulse-height analyzer. The test specimen shall be properly mounted to give an optimum scanning geometry of the surface of the specimen. The detector shall be shielded to eliminate excessive background counts. Disintegration rates of each of the mixed fission products are calculated from the recordings posted by the instrument.

6.0 DECONTAMINATION COUNTING, REAGENTS, AND PROCEDURES

6.1 All specimens shall be scanned by use of the same geometry, with both the original count and the count following each decontamination step being recorded for each of the fission products. Specimens shall be decontaminated by placing each one in a stirred solution of the decontamination reagent. Each specimen shall be removed from its plastic bag and subjected, in succession, to the following three decontamination steps:

6.1.1 Decontamination with Water: Place a 600-ml. polyethylene beaker containing 400 ml. of tap water and a plastic-covered stirring bar on a magnetic stirrer. Rigidly suspend each specimen in the water to a depth of 2 inches with the contaminated side of the specimen facing the center of the beaker. Adjust the speed of the stirrer until the water vortex touches the stirring bar. Stir for 10 minutes, remove the specimen, rinse the back (uncontaminated side) with water, and air dry with the contaminated face up.

6.1.1.1 After each specimen has been dried, transfer it to a plastic bag and again scan as before. The ratio of the original radioactivity (counts per minute) to the radioactivity (counts per minute) detected after the water wash is recorded as the Water DF for each of the fission products.

6.1.2 Decontamination with Acid at Room Temperature (25 C): Using the same specimens as for Section 6.1, perform a second decontamination as described in Section 6.1.1, except use 400 ml. of an aqueous mixture of 0.4M oxalic acid, 0.05M sodium fluoride, and 0.3M hydrogen peroxide at 25C.± 2 C.

6.1.2.1 Scan after drying to determine the DF's, which are defined as the ratio of the radioactivity (counts per minute) after the room temperature acid wash to the counts per minute after the heated acid wash.

6.1.3 Decontamination with Heated (80 C) Acid: Continuing to use the same specimens as Section 6.1 perform a third decontamination as described in 6.1.2 except heat the mixture to 80 C. ± 2 deg. C. Scan after drying to determine the DF's, which are defined as the ratio of the radioactivity (counts per minuite) after the room temperature acid wash to the counts per minute after the heated acid wash.

6.2 The overall decontamination factor for the three decontaminations is the ratio of the radioactivity (counts per minute) before the tap-water wash to the radio-activity (counts per minute) after the heated acid wash.

6.3 Control Specimen: A contaminated untreated control specimen shall also be scanned at the time the original and final counts are made on the test specimens, and any decrease in radioactivity resulting from decay shall be recorded. The final radioactivity detected on the test specimen shall be corrected for nuclide decay before the decontamination factor, or percentage of contamination removed, is calculated.

6.4 Calculate the DR's for each decontamination step for each nuclide, as well as overall DF.

7.0 GUIDANCE TO DECONTAMINATION FACTORS

7.1 The effectiveness of radionuclide removal is defined by the decontamination factor (DF) as follows:

$$DF = \frac{\text{Original activity}}{\text{Activity after treatment}} \quad \text{(in consistent units)}$$

7.1.1 The fraction of radioactive nuclides removed and the decontamination factor may be related as follows:

$$\text{Fraction removed} = 1 - \frac{1}{DF}$$

For 99 percent removal, DF = 1 x 10 (2)

8.0 CRITERIA FOR ACCEPTANCE

8.1 In general, with the gentle treatments used in this standard test, high decontamination factors are not normally obtained for coatings. Certain generic types of coatings may contaminate more readily than others, and the responses to decontamination treatments also vary generically. In some cases the desired lev l of decontamination may be achieved only by removal of a thin film of coating surface leaving the coating thinned but serviceable. In other cases decontamination may be achieved only by complete removal of the coating. The decontamination test described in Section 6.0 and 6.3 gives a method of ranking the relative ease of decontamination of a coating system. The higher the overall DF, the easier the coating decontaminates.

8.2 Coating systems tested under the test methods given in this section for nuclear facilities shall have a minimum DF of 20 with a 95 percent Removal of Contaminants.

8.3 The loss of film thickness of the coating system or coating caused by the contamination/decontamination procedure shall be reported.

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9.0 DOCUMENTATION OF TEST RESULTS

9.1 The manufacturer shall submit the following documents for approval:

9.1.1 Sample Preparation Documentation:

Substrate: Steel, Concrete, or Other
Surface Preparation: (Describe)
Coating System: (Describe each coat specifically, film thickness, Batch No., etc.).
Curing Conditions: Time, Temp.

9.1.2 All test reports on tests performed by independent lab.

9.1.3 A color photograph in which the test specimen appears in at least the same size as the actual test specimen.

10.0 RETENTION OF RECORDS AND SPECIMENS

10.1 The test specimen shall be retained and be made available for observation until an approval by Bechtel is granted.