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SMEAR TECHNIQUES FOR SURFACE MONITORING FOR RADIOACTIVE MATERIALS

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Introduction

While it has been recognized that the smear is probably the best device for detecting low level transferable radioactivity on surfaces, there are numerous variations which involve such considerations as the type of surface smeared, dry smear vs wet smear, total area smeared, solubility of the isotope or its adherence properties, and the efficiency of the counting equipment. A few field observations have been made of some of these variables. The effects of these variables on data obtained by smear sampling has been observed in a number of field tests reported below.

Dry Smears Versus Wet Smears

For this study, a solution of Cs^{137} was prepared and counted in a scintillation counter, making a determination in comparison to a standard. The activity was determined to be 13,800 d/m/ml. To preclude the probability of unknown contamination, new concrete was prepared in small pieces and was allowed to set for two months. One side of the concrete was smooth and the other side was porous.

New vinyl tile was secured and areas of 100 cm^2 were marked off on these and on the concrete and 2 ml of the Cs^{137} solution, or 27,600 d/m of activity, was pipetted onto each 100 cm^2 area.

After the solution dried, all smears were made in a uniform manner: wiping by five equal strokes in the horizontal and five similar strokes vertically across a single surface unit of 100 cm^2. The results are indicated in Table I.

In other activities the contaminated metal floor of the Charge Room in Bldg. 3026-D was smeared after it had been scrubbed to make the spread of contamination reasonably uniform. Wet and dry smears were made of adjacent 100 cm^2 areas, using 20 pairs of paper towel discs and 20 pairs of Whatman-50 paper for the test. While the contamination was not studied statistically, the wet smears consistently gave higher counts than the dry smears, with a rather narrow range of individual values for each technique. The average values are given in Table II to indicate the relative effectiveness of these techniques on a metal surface. Only the beta-gamma results are tabulated, but alpha findings were similar. The contamination resulted from decladding uranium fuel elements.

It may be noted from Table II that the wet towel disc and the wet Whatman smear values have a difference of only 3%. However, the dry Whatman smear values were only 60% of the dry paper towel values.

Variations of Total Area Smeared

In order to determine the effect of making a normal smear in an arc at arm's length vs an absolute smear of 100 cm^2, 14 pairs of smears were made on the stainless steel floor of the discharge room in Bldg. 3026-D. All smears were wet when the samples were taken and the net results indicated that the smears which were limited to 100 cm^2 averaged only 40% of the average values derived from those made in a normal arc.

Rough Paper Towel vs Whatman-50 Paper

In other observations, Whatman-50 paper and discs from paper towels were used to smear the concrete pad around the 3029 stack. Positive readings were noted twice as frequently on the paper towels, and these values were also about twice as great as the values recorded on the Whatman-50 paper.

Conclusions

1. Smears made of cesium oxalate contamination on unpainted and unsealed concrete were less than 1% of the available activity and dry smear values were only 20% of those obtained with wet smears. These values might be different for differing chemical or physical forms of contamination.
2. Smears of smooth vinyl surfaces picked up about 30% of the available radioactive material, indicating that the 10% value expressed in current procedures is adequately conservative for this type surface. Likewise, this type surface is prevalent within the Laboratory, especially in the 4500 area.
3. Over one hundred per cent more radioactive material may be smeared off a metal surface with a wet smear than can be removed with a dry smear. Also, dry Whatman-50 paper is only 60% as effective as dry, rough paper towels.
4. A smear made in an arm's arc upon a surface will collect about twice as much material as would be smeared off a surface of 100 cm^2.
5. On rough concrete, paper towels are about twice as effective as is Whatman-50 paper.

6. The smear only samples the total area that has been wiped. To establish the presence, or absence, of transferable contamination, the wiping of a larger area than 100 cm^2 can give useful information with considerably less labor than restricting the area per smear to 100 cm^2. The smear technique generally cannot be regarded as a quantitative monitoring of contamination, and thus the expression of results in terms of d/m/100 cm^2 is of principal interest only for intercomparison of areas or to establish that tools, equipment, and work surfaces are below the permissible tolerances.

Table I

Surface	Total Activity Applied/100 cm^2	Average Dry Smear	% of Total Activity	Average Wet Smear	% of Total Activity	Dry/Wet
Smooth Concrete	27,600 d/m	26 d/m	0.1	152 d/m	0.55	17%
Porous Concrete	27,600 d/m	38 d/m	0.14	160 d/m	0.58	24%
Vinyl Tile	27,600 d/m	7613 d/m	27.6	8968 d/m	31.4	90%

Table II

Surface	Paper Type	Average d/m Dry Smears	Average d/m Wet Smears	Dry Smears/ Wet Smears
Stainless Steel	Paper Towel	20,878	49,361	42%
Stainless Steel	Whatman-50	13,192	47,756	28%