APPENDIX A

Determining Site Specific Guidelines

Appendix A
Determining Site-Specific Guidelines

When multiple radionuclides are present, the sum of ratios of the concentration of each radionuclide to its respective guideline must not exceed 1. That is:

(A-1)

$$\frac{C_1}{G_1} + \frac{C_2}{G_2} + \ldots \frac{C_n}{G_n} \leq 1$$

where

$C_{1,2...n}$ is the concentration of radionuclide 1,2,...n
$G_{1,2...n}$ is the guideline value for radionuclide 1,2,...n

The presence of multiple radionuclides may require the development of site-specific guidelines based on relative ratios of their contributions to the total activity level. These site specific guidelines would provide the basis for comparisons with field measurements and for acceptance testing of survey results. The Manual user should consider that different radionuclides or radionuclide combinations may exist on different portions of the site and more than one set of guidelines may therefore be required.

For sites with multiple radionuclides, only those radionuclides remaining at the time of license termination, which would contribute greater than 10% of the total radiation dose from all contaminants or which are present at concentrations which exceed 10% of their respective guideline values, need be considered as significant contaminants.

Surface Activity Guidelines

For simplicity in application, radionuclides with comparable guidelines may be grouped, so that one guideline can be used for more than one radionuclide. If all significant contaminants are from the same group, the guideline level for that group may be used. For situations where radionuclides from several different groups with different guideline levels are present, a site-specific guideline level can be developed. This approach enables field measurement of gross activity, rather than determination of individual radionuclide activity for comparison to a release guideline. The gross activity guideline for surfaces with radionuclides from different groupings is calculated as follows:

1. Determine the relative fraction (f) of the total activity, contributed by each radionuclide group.

2. Obtain the guideline level (G) for each of the radionuclide group present from the NRC guideline tables.

3. Substitute the values of f and G in the equation.

(A-2)

$$\textit{Gross Activity Guideline} = \frac{1}{\left(\frac{f_1}{G_1} + \frac{f_2}{G_2} + \ldots \frac{f_n}{G_n}\right)}$$

Sample calculation:

Assume that 40% of the total surface activity was contributed by a radionuclide with a guideline level of 5000 dpm/100 cm^2; 40% by a radionuclide with a guideline level of 1000 dpm/100 cm^2; and 20% by a radionuclide with a guideline level of 500 dpm/100 cm^2.

$$\textit{Gross Activity Guideline} = \frac{1}{\frac{0.40}{5000} + \frac{0.40}{1000} + \frac{0.20}{500}}$$

$$= \quad 2100^{*} \text{ dpm/100 cm}^2$$

* rounded to 2 significant figures

Soil Concentration Guidelines

Concentrations of specific radionuclides, rather than gross activity, are measured for soil. The combination of all significant radionuclides must satisfy equation A-1. For a mixture of radionuclides present in known, relative fractions of the total activity, the site-specific guidelines for each radionuclide are calculated by first determining the gross activity guideline using equation A-2 and then multiplying that gross guideline by the respective fractional contribution of each radionuclide. For example, if three radionuclides with guideline levels of 50 pCi/g, 25 pCi/g, and 10 pCi/g are present in activity ratios of 40%, 40%, and 20%, respectively, the gross activity guideline:

$$\textit{Gross Activity Guideline} = \frac{1}{\frac{0.40}{50} + \frac{0.40}{25} + \frac{0.20}{10}}$$

$$= \quad 22.7^{*} \text{ pCi/g}$$

* rounded to 3 significant figures

The site-specific guideline levels for each of the contributory radionuclides, when present in the given activity ratios, would then be 9.1 pCi/g (0.40 • 22.7), 9.1 pCi/g (0.40 • 22.7) and 4.5 pCi/g (0.20 • 22.7).

Determining such site-specific guidelines enables an evaluation of site conditions based on analysis for only one of the contributory contaminants, provided the relative ratios of the contaminants does not change.

Exposure Rate Guideline

The exposure rate guideline is independent of the radionuclide source. A site-specific guideline level does not, therefore, have to be developed to account for multiple radionuclides at the site.

APPENDIX B

Statistical Tables
for
Guideline Comparison
and
Sampling Frequency Estimation

TABLE B-1

Factors for Comparison of Survey Data with Guidelines and Determining Additional Data Needs

Degrees of Freedom[a]	$t_{95\%}$	$t_{97.5\%}$
1	6.314	12.706
2	2.920	4.303
3	2.353	3.182
4	2.132	2.776
5	2.015	2.571
6	1.943	2.447
7	1.895	2.365
8	1.860	2.306
9	1.833	2.262
10	1.812	2.228
11	1.796	2.201
12	1.782	2.179
13	1.771	2.160
14	1.761	2.145
15	1.753	2.131
16	1.746	2.120
17	1.740	2.110
18	1.734	2.101
19	1.729	2.093
20	1.725	2.086
21	1.721	2.080
22	1.717	2.074
23	1.714	2.069
24	1.711	2.064

TABLE B-1 (continued)

Factors for Comparison of Survey Data with Guidelines and Determining Additional Data Needs

Degrees of Freedom[a]	$t_{95\%}$	97.5%
25	1.708	2.060
26	1.706	2.056
27	1.703	2.052
28	1.701	2.048
29	1.699	2.045
30	1.697	2.042
40	1.684	2.021
60	1.671	2.000
120	1.658	1.980
400	1.649	1.966
infinite	1.645	1.960

[a]Degree of freedom is the number of items of data minus 1; for values of degrees of freedom not in table, interpolate between values listed.

Reference (Gilbert 1987)

TABLE B-2

Factors for Estimating the Number of Sampling Locations for Guideline Comparison

$\frac{C_G - \overline{X}}{s}$	n
0.05	3,422
0.10	856
0.15	380
0.20	214
0.25	137
0.30	95
0.35	70
0.40	53
0.45	42
0.50	34
0.55	28
0.60	24
0.65	20
0.70	17
0.75	15
0.80	13
0.85	12
0.90	11
0.95	9
1.00	9

C_g = Concentration or activity guideline authorized by NRC

$\overline{x}$ = Mean concentration or activity determined for the survey unit.

s = standard deviation of the concentration for the survey unit.

n = number of samples to demonstrate meeting the cleanup guideline, assuming a desired false positive rate of 5% and a false negative rate of 10%, i.e. [$Z_{.95}$ $Z_{.90}$].

Reference (EPA 1989)