April 20, 1995

MEMORANDUM TO: See Attached List

FROM: Michael F. Weber, Chief [Original signed by]
Low-Level Waste and Decommissioning
Projects Branch
Division of Waste Management, NMSS

SUBJECT: FINAL DRAFT OF "SURFACE CONTAMINATION GUIDELINES FOR MATERIALS LICENSEES"

Enclosure 2 of Policy and Guidance Directive FC 83-23 contains the "Guidelines For Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, and Special Nuclear Material" (Guidelines). Table 1 of the Guidelines (Attachment 1) lists the surface contamination levels considered acceptable for the unrestricted release of facilities and equipment. Over the past several years, a number of technical issues have been raised regarding the application of the Table 1 surface contamination limits during decommissioning. Attachment 2 provides supplemental information to Table 1 which should resolve these technical issues and ensure that the limits are consistently applied.

Please review Attachment 2 and provide comments to David N. Fauver of my staff by electronic mail at "DNF" by May 12, 1995. After we receive and review the comments, a final version of the interpretation document will be issued. We will also work with the Office of Nuclear Regulatory Research to incorporate any new information in the regulatory guidance that will implement the new radiological criteria for decommissioning.

Attachments: As stated

cc: J. Glenn, RES

CONTACT: David N. Fauver, NMSS/DWM
415-6625.

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TABLE 1

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[b,c,f]	MAXIMUM[b,d,f]	REMOVABLE[b,e,f]
U-nat, U- 235, U-238, and associated decay products	5,000 dpm a/100 cm^2	15,000 dpm a/100 cm^2	1,000 dpm a/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1000 dpm/100 cm^2	3000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1000 dpm $\beta\gamma$/100 cm^2

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides should apply independently.

[b]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c]Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

[d]The maximum contamination level applies to an area of not more than 100 cm^2.

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface shou'.d be wiped.

[f]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

Attachment 1

DRAFT INTERPRETATIONS OF SURFACE CONTAMINATION GUIDELINES

Contact: David N. Fauver, NMSS/DWM

April 19, 1995

I. GENERAL

A. The guideline value represents the acceptable quantity of radioactive material remaining on the surface. Surface conditions, instrumentation parameters and capabilities, and survey techniques must be considered when converting portable instrument readings to contamination levels present.

B. The surface contamination levels represent the contamination within a surface area of 100 cm^2 or less. For example, if the limit is 5000 dpm/100 cm^2, and 5100 dpm/100 cm^2 is identified in a 10 cm^2 area, the limit is exceeded since greater than 5000 dpm/100 cm^2 is present in an area of 100 cm^2 or less, i.e., 10 cm^2. Averaging the 10 cm^2 spot over the surrounding 100 cm^2 is not allowed.

C. Selection of the appropriate radionuclide grouping(s) requires that an adequate characterization of the residual contamination be performed, to identify all significant radionuclides and to determine the equilibrium status of any parent/daughter combinations which are present.

D. For simplicity in application, radionuclides with comparable internal dose potentials have been grouped into several categories in Table 1. If all contaminants are from the same category, the guideline for that grouping is used. When radionuclides from different groupings are present either the most restrictive value may be used or a site-specific guideline may be developed, from the "unity" rule concept, based on the relative amounts of the various contaminants present. The guideline for surfaces with radionuclides from different groupings is calculated as follows:

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

- Obtain the guideline value (G) for each of the radionuclide groups present from the NRC guideline tables.

- Substitute the values for f and G in the equation.

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

Sample calculation:

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

$$\textit{Derived Gross Activity Guideline} = \frac{1}{\left(\frac{0.40}{5000} + \frac{0.40}{1000} + \frac{0.20}{100}\right)}$$

400 dpm/100 cm^2 (rounded to 2 significant figures)

When applying the "unity" rule for contaminants, other than those from the uranium and thorium series (see items II.A.-D. below), the alpha and beta contamination levels are compared separately with their appropriate guideline values from Table 1.

E. Alpha radiation may undergo significant and inconsistent attenuation/absorption when the contaminated surface is porous, rough, dirty, oily, damp, etc; measurement of alpha radiations may, therefore, not be a reliable indicator of the true activity present. Such surface conditions cause significantly less attenuation/absorption of beta particles than alpha particles. Therefore, for radionuclides or decay series, which emit both alpha and beta radiations, beta measurements may provide a more accurate determination of surface activity than can be achieved by alpha measurements. The relationship of beta to alpha emissions must be considered, when determining the surface activity for comparison with the guideline value.

F. Some radionuclides or combinations of radionuclides are not included in the Table of guideline values (Table 1). Examples include uranium ore (containing uranium isotopes in their natural abundances and all of the associated daughter products in secular equilibrium) and Po-210. The NRC will establish allowable surface contamination guidelines for such materials on a case-specific basis, as the need arises.

G. As discussed in I.B above, the surface contamination limits are expressed in terms of dpm/100 cm^2. The use of detectors with areas that exceed 100 cm^2 may cause the measurement to be biased low if the contamination is contained in an area that is smaller than the area of the detector. Therefore, detectors with areas greater than approximately 100 cm^2 should not be used for making total surface activity measurements unless the potential for underestimating the results is specifically addressed in the survey plan or procedures in a way that will ensure that the results are not biased low. Note that a number of commercially available detectors have an effective area of approximately 120 cm^2; these detectors are acceptable for making total surface activity measurements.

II. SPECIFIC

A. "U-nat" in the first radionuclide grouping, refers to processed uranium, i.e., uranium which has been separated from its longer half-life decay products by extraction of the uranium from the naturally-occurring ore state. U-nat is therefore composed of U-238, U-235, and U-234 at relative activity ratios of approximately 1.0/0.05/1.0; it also will contain the short half-life daughters of U-238, i.e. Th-234, Pa-234, and Pa-234 m, in secular equilibrium with the U-238.

B. Processed natural uranium emits alpha and beta radiations at a 1:1 ratio. Uranium depleted in U-235 (and U-234) content emits approximately 1 alpha particle for each 1.6 beta particle emissions (based on 0.2%, by weight, U-235). Uranium which is enriched in U-235 (and U-234) content, above the naturally occurring isotopic abundances, has a ratio of alpha-to-beta emissions exceeding 1. This ratio increases as the degree of enrichment increases. If, as described in I.F. above, beta radiations are measured as an indicator of the uranium activities

present, then appropriate factors must be used in relating the beta measurements to the alpha activities present. For example, if the ratio of beta to alpha emission were determined to be 1.6, the allowable residual activity, which would be equivalent to the guideline of 5000 alpha dpm/100 cm^2, would be 8,000 beta dpm/100 cm^2 (1.6 times 5000). Conversely, if the beta to alpha ratio 0.44 (ratio for 3% enriched uranium) the equivalent beta limit would be approximately 2200 dpm/100 cm^2.

Due to the common practice of mixing uranium of different enrichments to obtain the desired isotopic content, it is important to confirm the isotopic distribution by laboratory analyses, when establishing the guideline for a specific site or facility.

C. Guideline values for natural thorium and Th-232 are not specifically defined in Table 1 in terms of alpha or beta radiations. For the purpose of consistency between the uranium and thorium decay series, the guideline values for Th-232 and natural thorium will be implemented in terms of alpha dpm/100 cm^2. As described in I.E. above, the measurement most representative of the actual contamination level should be performed, and comparison with all guidelines should then be based on established ratios of the different radiations being emitted from the contaminant and its associated decay products. For the thorium series in secular equilibrium, the activity level providing 1000 alpha dpm/100 cm^2 would result in about 670 beta dpm/100 cm^2.

Natural thorium consists of Th-232, in secular equilibrium with a series of radioactive daughters; the entire series has a total emission rate of approximately 6 alpha particles and 4 beta particles for each decay of the Th-232 parent. Separation of thorium from ore results in a product initially containing only Th-232 and Th-228. Half lives of the various radionuclides in the thorium series are such that there is relatively rapid ingrowth of certain daughter products. To ensure that the thorium surface contamination limit (1000 dpm alpha/100 cm^2) is not exceeded at some time in the future due to the ingrowth of daughter products the equilibrium status should be evaluated. If the thorium was separated more than 20 years before the survey is to be performed no further evaluation is necessary and the 1,000 dpm/100 cm^2 limit applies. If the thorium was separated less than 20 years before the survey, the limit should be adjusted downward such

that 20 years after the survey the alpha contamination will not exceed 1000 dpm alpha/100 cm^2.

D. Groupings 2 and 3 include the following specific radionuclides from the naturally occurring uranium, thorium, and actinium decay series: Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, Ra-223, and Ra-224. The guidelines for these particular radionuclides are applicable only when the radionuclide has been separated from the materials which precede it in the decay series; radionuclides in this list may, however, have associated radioactive daughter products present in various states of equilibrium. The guideline values for these radionuclides include the total activity of the parent plus all subsequent decay products present.

E. The guideline values for total and removable surface activity of H-3 and Fe-55 are not specifically listed. The guideline values for total and removable H-3 and Fe-55 are:

Average Total Surface Activity	200,000 dpm/100 cm^2
Maximum Total Surface Activity	600,000 dpm/100 cm^2
Removable Surface Activity	1,000 dpm/100 cm^2

F. Footnote (f) to Table 1 establishes maximum direct radiation levels from beta contamination. At surface activity levels of 5000 dpm/100 cm^2 and 15000 dpm/100 cm^2, beta-gamma emitting contamination will have associated surface dose rates of less than 0.2 mrad/hr and 1.0 mrad/hr, respectively. The surface activity levels (in dpm/100 cm^2) are thus the more restrictive limit, and compliance with the dose rate levels in this footnote does not have to be demonstrated, if the surface activity guideline values are satisfied. Note that demonstrating compliance with the exposure rate guideline of 5 uR/hr, above background, at 1 meter from building and equipment surfaces is still required.