COVIDIEN

Contact:
Karen Burke
Director, Environmental Remediation
Direct Dial: (314) 654-5838
Fax: (314) 654-6486
e-mail: karen.burke@covidien.com

August 19, 2008

Mr. John Buckley, Project Manager
Division of Waste Management and Environmental Protection
U.S. Nuclear Regulatory Commission
Mailstop TWFN 8F5
Washington, DC 20555-0001

Re: Maximum Radioactive Contamination on Items to be Released from Plant 5 Without Restriction (Docket No. 40-6563, License No. STB-401)

Dear Mr. Buckley:

In Mallinckrodt's C-T Phase II Decommissioning Plan, Chapter 10 §Radiation Survey, we propose to adopt NRC guidance, as specified in Mallinckrodt's Materials License, STB-401, to apply to maximum acceptable radioactive contamination on surfaces of items to be released without restriction from a radiologically restricted area of C-T decommissioning. Mr. Youngblood has asked what the corresponding measurable numerical limits would be. Attached is a tabulation of the numerical limits Mallinckrodt proposes to apply along with an explanation of the basis of derivation of the maximum acceptable average contamination limit.

We trust this will resolve this issue; although if any additional explanation might be helpful please contact me at (314) 654-6314.

Sincerely yours,

Karen M. Burke

Karen. M. Burke
Director Environmental Remediation

Cc: Document Control Room

NMSS01

SUNSI Review complete
per. PM John Buckley

MAXIMUM RADIOACTIVE CONTAMINATION ON ITEMS TO BE RELEASED FROM PLANT 5 WITHOUT RESTRICTION

Maximum acceptable radioactive contamination on items that may be released from a radiologically restricted area in Plant 5 during C-T Phase II decommissioning without restriction on use will be in accordance with NRC *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material*[1] as specified in Materials License STB-401, Condition 16.[2] A single value for implementation that would represent the mixture of uranium series and thorium series comprising the potential contaminant and that is stated in practically measurable units would be useful.

Phase 2 of C-T decommissioning involves cinder fill soil, sewerage, pavement, and building slabs. The most extensive characterization survey included measurement of key, long-lived radionuclides in cinder fill soil samples. Five hundred and thirty-five samples collected above the subsoil clay layer were analyzed to evaluate the characteristics of the uranium series and thorium series mixture and to interpret a representative uranium series-to-thorium series ratio. This representative U-to-Th ratio provides a basis for deriving a maximum acceptable areal contamination on items in numerical, measureable units.

Cinder soil and sewer sediment samples were analyzed for key, long-lived uranium series and thorium series radionuclide concentration. Representative uranium and thorium concentrations were derived from the analytical results in C-T Phase II Decommissioning Plan Tables 4-1, 4-7, 4-8, 4-9, 4-10, 4-11, 4-12, 4-13, 4-14, 4-15, and 4-16, excluding clay samples in subsoil beneath the cinder soil fill. Uranium-238, Th^{230}, and Ra^{226} concentrations in each sample were arithmetically averaged to represent uranium concentration in the sample and to relate to a category in NRC FC 83-23. Thorium-232, Ra^{228}, and Th^{228} were arithmetically averaged to represent uranium concentration in the sample. The uranium-to-thorium ratio representative of each sample was derived.

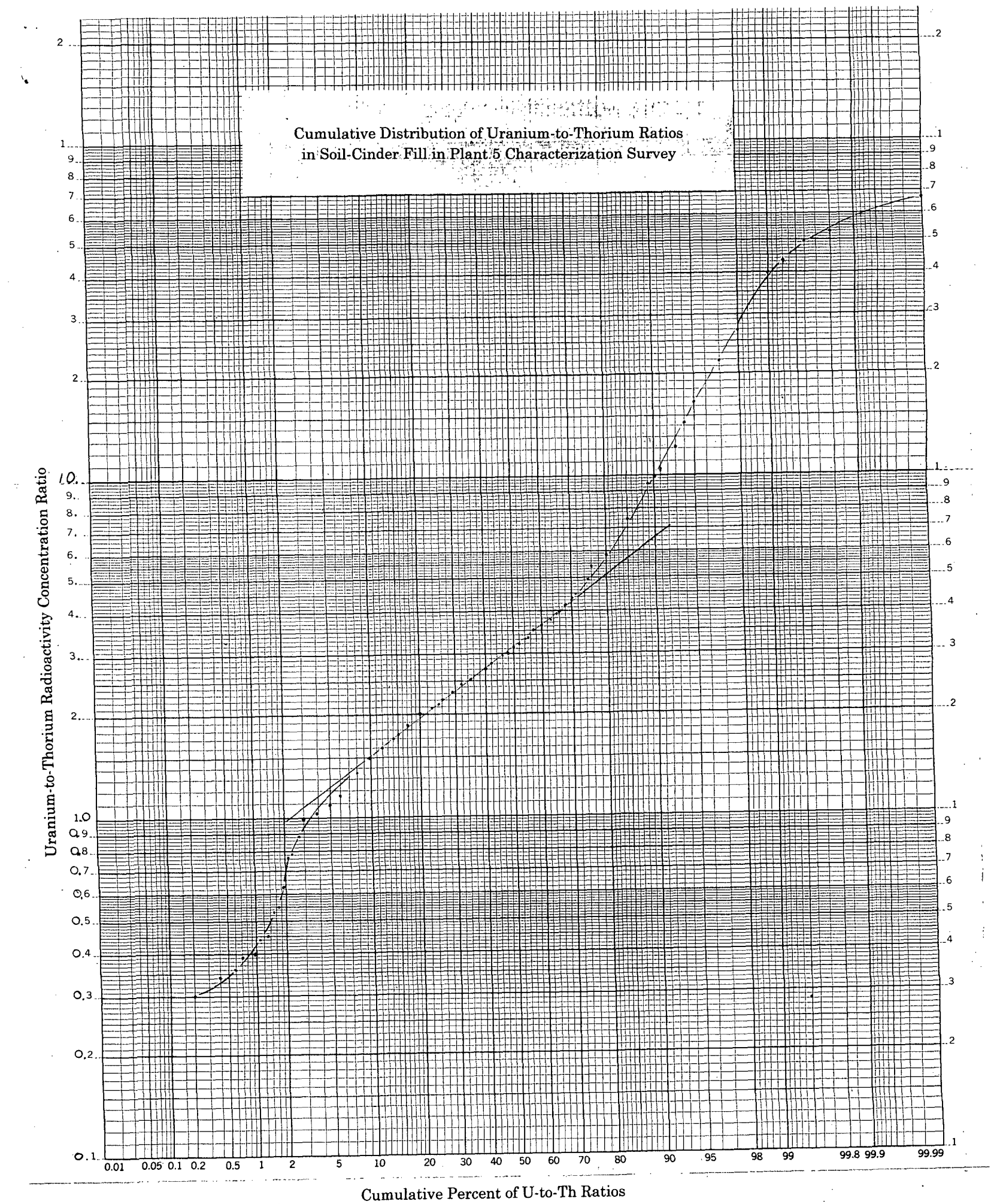
The cumulative distribution of the 535 uranium-to-thorium ratios was plotted graphically with cumulative probability on the abscissa and uranium-to-thorium ratio on a logarithmically scaled ordinate. Ideally, if data produce a straight line, the data are distributed lognormally. Most of the data in the accompanying graphical plot indicate the uranium-to-thorium ratio is lognormally distributed. At the 50^{th} cumulative percentile, the lognormal, or geometric mean uranium-to-thorium ratio is observed to be approximately 3.

Maximum acceptable contamination on an item considered for release without restriction on its use diminishes as the U-to-Th ratio diminishes. Thus, one should consider the likelihood of whether the U-to-Th ratio in contamination on an item might be

---

1 NRC. Policy and Guidance Directive FC 83-23. "Termination of Byproduct, Source, and Special Nuclear Material Licenses. Nov. 4, 1983.

2 Mallinckrodt. *C-T Phase II Decommissioning Plan.* §10.1.6.2 Radiation Surveys. April 14, 2003.


Cumulative Distribution of Uranium-to-Thorium Ratios
in Soil-Cinder Fill in Plant 5 Characterization Survey
Uranium-to-Thorium Radioactivity Concentration Ratio
2
1
9
8
7
6
5
4
3
2
10.
9.
8.
7.
6.
5.
4.
3.
2.
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99
Cumulative Percent of U-to-Th Ratios

substantially lower than 3. When the U-to-Th ratio ≤ 3, only 0.06 of samples contain > 10 pCi U+Th per gram soil, *i.e.*, are substantially above background. Consequently, the areal density of soil on an item considered for release is unlikely to produce more than maximum acceptable areal radioactivity when that limit is derived on the basis of U-to-Th ratio = 3. These observations suggest the geometric, or lognormal mean U-to-Th ratio = 3 is a representative ratio on which to derive the maximum acceptable contamination limit on surface of an item considered for release from a restricted area during C-T Phase II decommissioning. The likelihood of it being applied non-conservatively is low; that is, the probability that soil having U-to-Th ratio < 3 would also contain U series + Th series in concentration enough to cause the derived limit to be exceeded is low.

The maximum acceptable average surface contamination on an item to be released from premises for unrestricted use is specified in NRC guidance[3] as:

Table 1. Maximum Acceptable Surface Contamination Level

Nuclides	Average [B]
U_{nat}, U-235, U-238, and associated decay products	5000 dpm α/100 cm²
Th_{nat}, Th-232 [A]	1000 dpm/100 cm²

[A] Traditional practice assumes associated decay products

[B] Traditional practice interprets Th series units to be same as U series, in dpm α/100 cm²

The combined limit for a U-to-Th ratio = 3 is derived as:

$$Avg\ Limit = \frac{C_U \times \alpha_U + C_{Th} \times \alpha_{Th}}{\frac{C_U \times \alpha_U}{Lim_U} + \frac{C_{Th} \times \alpha_{Th}}{Lim_{Th}}}$$

Where:

Avg Limit = maximum acceptable average alpha emission by U + Th contamination on a surface of an item to be considered for release without restriction on use. (α/min 100 cm²)

C_U = relative concentration of natural uranium with associated decay products (pCi/g)

C_{Th} = relative concentration of natural thorium with associated decay products (pCi/g)

α_U = number of alpha rays emitted by U series per parent U^{238} disintegration = 8

α_{Th} = number of alpha rays emitted by Th series per parent U^{238} disintegration = 6

Lim_U = maximum acceptable average alpha emission by U series contamination on a surface of an item to be considered for release without restriction on use. = 5000 α/min 100 cm²

Lim_{Th} = maximum acceptable average alpha emission by Th series contamination on a surface of an item to be considered for release without restriction on use. = 1000 α/min 100 cm²

[3] NRC. Policy and Guidance Directive FC 83-23.

The derived maximum acceptable average contamination on the surface of an item is:

$$Avg\ Limit = \frac{3\times 8 + 1\times 6}{\frac{3\times 8}{5000} + \frac{1\times 6}{1000}} = 2800\ \frac{\alpha}{min\cdot 100\ cm^2}$$

The derived maximum acceptable contamination on the surface of an item to be released for removal from a radiologically restricted area in Plant 5 during C-T Phase II decommissioning without restriction on future use is specified in this Table 2.

Table 2. Maximum Acceptable Surface Radioactivity on Items to be Released for Removal from a Restricted Area Without Restriction on Use

Nuclides	Average (α/min·100 cm^2)	Maximum (α/min·100 cm^2)	Removable (α/min·100 cm^2)
U + Th mix in Plant 5	2800	8400	600

[A] As used in this table, dpm α means the rate of emission of alpha rays determined by correcting instrument counts per minute for background, efficiency, and geometric factors

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

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

[D] 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 is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.