Analytical Bio-Chemistry Laboratories, Inc.

February 16, 2011

Mr. Kevin Null
United States Regulatory Commission
Division of Nuclear Materials Safety
U.S. NRC Region III
2443 Warrenville Road, Suite 210
Lisle, Illinois 60532-4352

SUBJECT: Alternate disposal request per 10.CFR.20.2002

Dear Mr. Null:

I am writing to submit the attached request for alternate disposal for bulk mixed soils and research soils. The request for bulk mixed soils is needed for the decommissioning plan now being reviewed by the commission, and the need for an alternate method for research soils is needed for ongoing efforts to reduce and manage research wastes within the scope of license 24-13365-01.

I hope you will find the attached request to be complete and acceptable for your review, but please contact me if you have any questions or need additional information.

Best Regards,

Bradly D. Keck

Bradly D. Keck, PhD, CHP
Radiation Safety Officer
Analytical Bio-Chemistry Laboratories, Inc.

Cc: Katherine Streit, USNRC
Mike McCann, USNRC
Scott Ward, ABC

Attachments: 1. Request for Alternate Disposal of Bulk Mixed Soil and Research Soil Containing Carbon-14

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Request for Alternate Disposal of Bulk Mixed Soil and Research Soil Containing Carbon-14

Bradly D. Keck, PhD, CHP, RSO; Analytical Biochemistry Laboratories, Columbia, Missouri 65202.
Bradly D Keck

Introduction

Analytical Biochemistry Laboratories (ABC) operated a sanitary lagoon from 1986 until 2004, and this lagoon presently contains a sediment of a radiochemical concentration of 476 picocuries per gram (pCi/g)[1]. This will be removed by excavation which will include a 6 – 12 inch margin of clay that forms the lagoon and thus, as removed, will be of approximately 300 pCi/g when mixed (bulk mixed soil). Separately, studies of metabolism and environmental fate are routinely done and these produce soils that contain radiolabeled analytes at concentrations of a few hundred to a few thousand pCi/g. Currently, these are disposed as low level radioactive waste (LLRW) at a significant cost (typically $6 per pound) and requiring transport of several thousand miles. This request would facilitate good radiation protection and support research and development efforts.

The cost of disposal is prohibitive to good radiological remediation in the case of the bulk mixed soil, and detrimental to research costs in the case of research soils. Moreover, carbon-14 in soil at this concentration is effectively shielded by the soil matrix regarding external exposure and may be safely handled with regard to any ingestion and inhalation risk during removal, handling and transport. Municipal and commercial landfills that are constructed with liners to prevent soil migration, final covers to limit water penetration and engineering barriers to intrusion provide long term protection and result in maximum radiological doses of only 0.23 mrem per year. One such landfill is the Pike County Landfill in Baylis, IL.[2]

This request asks that bulk mixed soil and research soil containing carbon-14 at less than the exempt concentration of 8 nanocuries per gram (nCi/g)[3] be disposed in a suitable, unlicensed landfill, and not disposed as low level radioactive waste. Should such a mixture contain some quantity of hydrogen-3, we are asking that this be included, provided that the total activity does not exceed 8 nCi/g (conservative as tritium has a much higher DAC, ALI and exempt concentration[4]).

The shielding provided by the matrix is discussed below and each type of waste is described. The potential for inhalation exposure from soils is estimated for the excavation process and the estimate for human exposure while in the landfill is estimated.

Carbon-14 is a low energy beta emitter with a maximum energy of 156 keV[5] and is non-penetrating with regard to skin[6]. Consequently the matrix is self shielding with regard to the direct emanation of

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[1] Bradly D. Keck, "Site Characterization and Remediation Plan in Support of Decommissioning for Analytical Biochemistry Laboratories Sanitary Lagoon, Revision 2.0," 2011.
[2] Audit Package for Pike County Landfill, Pike County Landfill, Inc. PO Box 9071, Peoria, IL, 61612.
[3] 10.CFR.30,Part 70 Schedule A.
[4] *ibid*
[5] Lederer and Shirley (eds.), Table of Isotopes.

electrons, save for the superficial 3 millimeters of matrix; also carbon-14 is effectively shielded by the skin itself. For these reasons, external dose is not of relevance and is not further considered.

Possible inhalation of dust, however, is a potential dose route and is assessed for soil dusts. The probable value of dust density [7] is about 0.06 mg/m^3, but this estimation is done using a high value for dust density of 1.3 mg/m^3 in similar work. [8] To further ensure conservative estimation, the radiochemical concentration of the sediment is used whereas the bulk mixed soil will be lower. An air concentration is calculated as a percentage of the derived air concentration[9] (DAC). Based on those results, a potential maximal intake is then calculated by using the ventilation rate for modest exertion[10] of 35 liters per minute (L/min) and a conservative estimate of respirable fraction of 30%,[11] and an exposure time of 2,400 minutes at maximum concentration and a protection factor of 10.[12]

Description of proposed wastes

Bulk Mixed Soil This soil is a mixture of lagoon sediment from a lagoon which has not been active since 2004 and is not considered hazardous chemically or biologically, and clay which forms the walls and floor of the lagoon. This will be removed in a single excavation and mixed in roughly equal amounts. This is by far the greatest volume of this request – estimated at 800 to 1000 cubic yards or 940 to 1,170 tons (English units, and if dry). Tests have shown that the sediment and underlying clay are not hazardous.[13] This would result in a hauling need for about 100 truck loads to either the Pike County Landfill, or a similarly constructed Missouri landfill. This will be sent under landfill-specific requirements for moisture (paint filter test), pH and biological activity (if any), or any other required testing to conform to landfill requirements.

Research Soils This soil is a relatively small volume, compared to the bulk mixed soil. We currently have approximately 1,500 pounds, and we can expect to generate several hundred pounds per year as result of metabolism and environmental fate studies. These soils are varied and are comprised of silty loam, loam and sandy soils. A complication with this soil is that much of it is of foreign origin and is consequently USDA-regulated[14] in addition to being distinguishable by measurement of radioactivity (hence, LLRW). Currently there are no sites that can receive this dual-regulated waste. We are developing a mechanism to treat the soil pathogen hazard, and the availability of alternate disposal per this request would - in conjunction with the treatment of the pathogen – provide a mechanism to efficiently manage these research soils and avoid their accumulation. These soils typically have 500 – 5,000 pCi/g ^{14}C, but this depends on the specific study undertaken. While there are no tritium-containing soils at present, we are requesting that tritium laden soils be included so long as the total activity (^{14}C plus

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[6] Bernard Shleien (ed), Radiological Health Handbook, Revised Edition, 1992. p 184.
[7] Massachusetts Department of Environmental Protection, Characterization of Risks Due to Inhalation of Particulates by Construction Workers, Section 7.3, 2008.
[8] Marple, V.A. and Liu, Y.H., Aerosols in the Mining and Industrial Work Environments: Characterization, p. 444, 1983.
[9] 10.CFR.20 Appendix B.
[10] Bernard Shleien, *op.cit.*
[11] Sparks, D. L., Advances in Agronomy, Volume 80, Academic Press, 2003, p. 17.
[12] Bernard Shleien (ed), Radiological Health Handbook, Revised Edition, 1992, p. 418 .
[13] Analytical Biochemistry Laboratories, Internal technical report, 2010.
[14] United States Department of Agriculture permits S-76545, and S-74546.

^{3}H) does not exceed 8 nCi/g. These soils are contained in closed buckets, barrels or sacks for transport and disposal, so no opportunity exists for aerosolization, hence neither inhalation nor direct exposure.

Air concentration for excavation of bulk mixed soils

The maximum potential radionuclide air concentration may be calculated as:

[^{14}C]uCi/mL = {airborne particulate maximum)mg/m^3 x (radionuclide concentration)pCi/mg x (m^3/10^{6}mL)

Where: Airborne particulate = 1.3 mg/m^3

Radionuclide concentration = 0.476 pCi/mg

One m^3 = 10^6 mL

So, the maximum airborne concentration expected during excavation of bulk soil is 6.2 x 10^{-7} pCi/mL.

This is far below the DAC for ^{14}C of 1 pCi/mL (10^{-6} uCi/mL), and is 0.00006% of the DAC.

Likely maximum intake for the excavation process for bulk soil

Using the air concentration from above, and expecting a one week (40 hour) exposure during the excavation, this may be calculated as:

Intake$_{max}$ pCi = [Air concentration]pCi/mL x Respiratory fraction x [Respiration rate] mL/min x (exposure time)min / (protection factor)

Where: Air concentration = 6.2 x 10^{-7} pCi/mL

Respiratory fraction = 0.3

Respiration rate = 3,500 mL/min

Exposure time = 2,400 min

Protection factor = 10 (half face respirator)

So, the likely maximum intake for the excavation process is 0.16 pCi, well beneath the ALI of 2 mCi.

Doses for the landfill phase are calculated using the methodology of Kocher (NUREG CR-1413)[15] under three different scenarios: 1) Assuming that the entire landfill is filled with mixed bulk soil, 2) assuming that the landfill is filled to stated capacity (4.7E6 ton) with one thousand tons of bulk mixed soil; and 3) a dose conversion factor for soil (mrem m3 /y ton uCi) is calculated for considering the addition of research soil in more limited quantity –this could be calculated for any suitable landfill. All scenarios are based on the intruder scenario using the pathways per Kocher, and is more conservative than probable scenarios.

Scenario 1. Assuming that the entire landfill is mixed bulk soil at 360 uCi/m^3:

$H_{tede} = C\ U\ D$

Where: H_{tede} = total effective dose equivalent

C = concentration of ^{14}C in uCi/m^3 = 360

U= Useage factor (unity for intruder scenario) = 1

D = Dose conversion factor mrem/y per uCi/m^3 = 6.3 E-4.

So, for this scenario – assuming the entire landfill is bulk mixed soil, the dose rate is calculated to be 0.23 mrem/y.

Scenario 2. Assuming that the bulk mixed soil contributes equally to other contents of the landfill, intended to be at capacity at 4.7 E6 tons, and that we ship one thousand tons

$H_{tede} = C\ U\ D$

Where: H_{tede} = total effective dose equivalent

C = concentration of ^{14}C in uCi/m^3 = 0.076

U= Useage factor (unity for intruder scenario) = 1

D = Dose conversion factor mrem/y per uCi/m^3 = 6.3 E-4.

So, for this scenario – assuming the entire landfill is bulk mixed soil, the dose rate is calculated to be 4.8 E-5 mrem/y.

Scenario 3. Dose as a function of concentration and weight

Lastly, considering the disposal of research soil which would have a maximum concentration of 9,600 uCi/m^3 (at a density of 1.2 g/cm^3), and would have an initial volume of about one ton, and future annual volumes of about one half ton, a dose conversion factor is calculated with which a landfill dose may be

[15] Kocher, D.C., A Radionuclide Decay Data Base, NUREG/CR-1413, Oak Ridge National Laboratory, 1980.

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