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IN REPLY REFER TO DNSC-ME

JAN 1 2 2007

U.S. Nuclear Regulatory Commission
Region 1, Nuclear Materials Safety Branch
Division of Nuclear Materials Safety
ATTN: Ms Betsy Ullrich
475 Allendale Road
King of Prussia, PA 19406-1415

Re: License STC-133

SUBJECT: Request for Additional Information Concerning Application for Amendment to License Control Nos. 138087 and 138458

Dear Ms. Ullrich:

In reply to the Nuclear Regulatory Commission's November 22, 2006 conference call and follow-on correspondence from Cynthia Barr (NRC/HQ) to Eric Abelquist of the Oak Ridge Institute for Science and Education (ORISE), received on November 22, the Defense National Stockpile Center of the Defense Logistics Agency (DNSC) is providing the attached responses and commitments associated with the requests for clarifying information. To assist the NRC, each of the Agency's requests provided in the November 22 email are repeated as originally provided to the DNSC along with the DNSC response. The NRC/HQ follow-up conference call on November 30 with Alex Boerner (ORISE) reiterated the need to justify the radium K_d in support of the proposed DCGL for U-238 at the Hammond Depot. The information necessary to address that justification is also included.

Sincerely,

Michael J. Pecullan
Radiation Safety Officer

Attachment

RESPONSE TO COMMENTS
NRC/DNSC/ORISE/ORNL NOVEMBER 22, 2006
RAI FOLLOW-UP CONFERENCE CALL REGARDING
SITE-SPECIFIC DERIVED CONCENTRATION GUIDELINE LEVELS
FOR THE CURTIS BAY AND HAMMOND DEPOTS

1. **Comment:** DCGLs for surficial soil contamination (15 cm or less) are acceptable provided DLA agrees to remediate areas of the site where significant subsurface contamination exists at both sites (e.g., radiological waste disposal site at Curtis Bay, and the AOC southwest of the burn cage/rubble pile at Hammond). Post-remediation, DLA should provide information that supports its assumption that contamination is generally no thicker than 15 cm in the remediated area.

   DNSC Response: The scope of work that has been prepared specifically requires that all surficial and subsurface contamination throughout both sites be remediated to levels below the proposed DCGLs. At Hammond, in most cases, this will result in removing all soil that overlies the monolithic slag layer and at Curtis Bay, excavating all surface and subsurface contamination, including the former radiological waste disposal area and beneath the floor of Building B-911. Both remedial action support and final status survey data will be collected that demonstrates this objective has been achieved for both sites.

2. **Comment:** DLA should provide additional justification for K_ds for Ra and Pb in the uranium decay chain for industrial slag present at the Hammond site, provide a revised DCGL estimate for U (if necessary), **or** show why uranium is not a significant contributor to dose (show that U is expected to contribute less than 10% of total dose or 2.5 mrem/yr of the allowable 25 mrem/yr peak dose to the average member of the critical group for unrestricted release of the site, based on Th and U characterization data prior to remediation).

   DNSC Response: Background—Between the original "Preliminary" DCGL reports and the follow-up comment response letters, detailed justifications were provided for the K_d values used for Th and U (ORISE 2005a and b, DLA 2006a and b). However, the K_d used for Pb-210 (decay product of the uranium series) was not specifically mentioned or justified. The value used in the modeling was not intuitively conservative, especially to a reader that compares this value to the lower RESRAD default K_d. The NRC also requested that further justification be provided for the assumption that the radium K_d value is conservative when applied to the slag layer.

   Response: It is important to recall the K_d justifications in the previous comment responses. The RESRAD default K_d values are considered placeholders, and are not intended to be used if there is site specific information available. This statement is made in the RESRAD help file, as well as in the following excerpt from the RESRAD application guide (Yu 1993).

> “The default distribution coefficients used in the RESRAD code are listed in Table 32.2. From Tables 32.1 and 32.2, it can be seen that K_d is quite variant; that is, it assumes different values under different circumstances. Because K_d is one of the important input parameters that has a strong influence on the calculated results in the RESRAD code, a site-specific value, if available, should always be used for risk assessment.”

Yu 1993 provides a comparison of K_d values for specific soil types based on a review of values published in other literature. The suggested K_d values are reported in tables of geometric means of the literature values. These geometric mean K_ds for each soil type could be considered the “suggested” K_d values for RESRAD runs.

Geometric means for lead:
Loam – 16,000 ml/g
Clay – 550 ml/g
Sand – 270 ml/g

An extensive literature review was conducted in lieu of performing K_d analysis to determine actual conditions. In addition to soil type impacting the lead K_d, pH and lead equilibrium concentrations also impact the K_d. Two primary literature sources fully support and demonstrate the conservatism of the lead K_d used in the DCGL development. Look-up tables provided by EPA list lead K_ds ranging from 190 ml/g (within a pH range of 4.0 to 6.3) to a maximum of 44,580 ml/g (within the pH range of 8.8 to 11.0) (EPA 1999). The alkaline soil/groundwater environmental conditions are well documented in the Hammond, Indiana area (USGS 1998). These alkaline conditions support the application of a lead K_d value well above the value selected. Furthermore, an extensive study has been documented regarding the characteristics of a variety of steel industry slag that included determination of K_d values for lead in blast furnace slag. The documented lead K_d arithmetic mean was 20,667 ml/g (Proctor 2000).

The lead K_d value used by DNSC for all soil layers, including slag, was 270 ml/g. It is the DNSC’s opinion that the selected K_d has been adequately justified and shown to be a conservative modeling parameter input.

Similarly available literature and site-specific conditions were evaluated to support the radium K_d value selected in lieu of the site-specific analysis. Yu provided the following radium K_d geometric mean values for consideration.

Geometric means for radium:
Loam – 36,000 ml/g
Clay – 9,100 ml/g
Sand – 500 ml/g

Further investigations of available literature, in general, supported these ranges. EPA provides tabulated radium K_d values compiled from multiple sources that range from 57 to 530,000 ml/g (EPA 2004). Because of this highly variable range, the EPA recommends that the geometric means not be used as the means do not represent any particular environmental system or geochemical conditions. Two of the primary variables that ultimately affect the actual observed radium K_d are pH and calcium content. The K_d for radium has been found to increase with increasing pH, but with the opposite effect for increasing calcium content due to absorption site competition. It is the DNSC's opinion that the complex geochemical conditions which exist at the Hammond Depot would be difficult to duplicate in a laboratory environment, and therefore we have elected to develop a U-238 DCGL using a very conservative radium K_d that ultimately equates to the geometric mean but has been validated based on available literature. It can realistically be expected that equilibrium conditions would exist between the effect caused by the alkaline pH environment and the high calcium content of the ubiquitous slag and that the actual K_d would lie between the EPA tabulated extremes.

However, it is essential to first evaluate the magnitude of the impact on the U-238 DCGL with further reduction in the radium K_d. RESRAD was therefore rerun, changing only the radium K_d input to the lowest published value of 57 ml/g. The resultant U-238 DCGL was reduced to 1.9 pCi/g, a 33% reduction from the original proposed DCGL of 2.5 pCi/g that was derived using a radium K_d value for all soil layers of 500 ml/g. When viewed together with the expectation that the actual K_d is most likely at least one order of magnitude higher than the lowest published value together with the relatively small comparable reduction in the DCGL, DNSC believes the radium K_d used of 500 ml/g to be appropriate and conservative for the soils and slag layer.

An additional factor to consider in the overall evaluation is the the analytical results from all ORISE outdoor samples presented in the characterization report that reflect that the thorium did not penetrate the slag nor was any uranium found that varied from the background concentrations.

The retardation of the contaminant migration created by slag versus the sand surrogate may be further demonstrated by comparing the ORISE characterization survey findings at both the Hammond and Curtis Bay Depots. At both depots, liquid spills occurred within the warehouses. Slag underlies the floor of Building 200E at the Hammond Depot. Sand followed by clay underlies the floor of Building B-911 at the Curtis Bay Depot. The characterization results for the sand/clay matrix beneath Building B-911 showed contamination migrated to depths of 0.5 meters or more. Alternatively, depth profile sampling of the slag beneath the floor of Building 200E showed that contamination had only penetrated a few centimeters. These facts back-up the use of a sand surrogate as being technically defensible in supporting the position that the presence of the slag adds conservatism to the DCGL determination. Figure 1 shows the slag *in situ*, which extends not only over the entire site but over 20 square miles of the Hammond locale.

Figure 1: Hammond Monolithic Slag Layer, Overlying Soil Removed, AOC Southwest of Burn Cage

In summary, the use of the geometric mean for the lead and radium K_ds for sand for all soil layers and the slag layer at Hammond is conservative.

Lastly, because the selected radium K_d is based on an assumed value—albeit conservative value—it is important that further bounding justification for the assigned K_d value be provided that evaluates the dose consequence between the proposed U-238 DCGL of 2.5 pCi/g and the 1.9 pCi/g RESRAD output when using the lowest K_d. It is DNSC's position that the dose contribution from U-238 (and the associated decay series) is insignificant relative to the primary contaminant, Th-232. Radiological characterization of each 'lot' of thorium nitrate stored at the Hammond Depot was completed by ORNL as part of an earlier work phase in order to gain approval to transfer the source material to the Nevada Test Site (NTS) for disposal. The process was rigorous and exhaustive in detail and results were documented in peer reviewed ORNL technical reports and reviewed/approved by NTS specialists associated with gaining an approved NTS source material transfer program. The results indicate that the Th-232 is considered the primary contaminant based on the ORNL thorium nitrate (ThN) characterization activities where the total thorium activity in the ThN was >100,000 pCi/g versus the total uranium activity of <5 pCi/g (ORNL 2003).

ORISE collected soils and slag samples during the characterization survey to comply with data quality objectives requirements. The ratio of Th-232:U-238 was determined using the analytical results from these characterization samples using only those sample results that clearly showed the presence of residual contamination from licensed activities—defined as containing greater than 5 pCi/g Th-232. The net concentrations of Th-232 and U-238 in all such samples were compared (excluding those ratio results that were negative). The average ratio was 14:1 for Curtis Bay Depot and 12:1 for Hammond Depot. The U-238 dose contribution limits for the two DCGL scenarios, relative to the total, for the Hammond Depot are as follows:

Scenario 1: Th-232 DCGL = 2.9 pCi/g = 25 mrem/y,
U-238 DCGL = 2.5 pCi/g = 25 mrem/y

Th-232:U-238 ratio = 12:1

Pre-remediation Th-232 Dose =
(12 × 2.5 pCi/g/2.9 pCi/g) × 25 mrem/y = 258 mrem/y
Pre-remediation U-238 Dose =
(2.5 pCi/g/2.5 pCi/g) × 25 mrem/y = 25 mrem/y

U-238 dose contribution to total = 25/(258 + 25) = 8.8 %

Scenario 2: Th-232 DCGL = 2.9 pCi/g = 25 mrem/y,
U-238 DCGL = 1.9 pCi/g = 25 mrem/y

Th-232:U-238 ratio = 12:1

Pre-remediation Th-232 Dose =
(12 × 1.9 pCi/g/2.9 pCi/g) × 25 mrem/y = 196 mrem/y
Pre-remediation U-238 Dose =
(1.9 pCi/g/1.9 pCi/g) × 25 mrem/y = 25 mrem/y

U-238 dose contribution to total = 25/(196 + 25) = 11.2 %

The DNSC believes this information adequately justifies the K_d values selected, that the proposed U-238 DCGLs of 2.5 pCi/g and 2.2 pCi/g are appropriate for the Hammond and Curtis Bay Depots, and that the U-238 dose contribution is insignificant (defined as less than 10 % of the total dose) relative to Th-232.

3. **Comment:** DLA should provide additional information regarding the 0.6 m depth of contamination under B-911 at Curtis Bay (explain why Th-232 was transported a greater distance than would be assumed with a K_d of 3,300 L/kg for Th). DLA should provide additional information about the nature and extent of contamination (basic description and geometry of contaminated materials) in the radioactive waste disposal area and point out any soil sample data collected in the radioactive waste disposal site that confirms natural materials underneath buried packaging material are not contaminated above the water table.

DNSC Response: The characterization investigations beneath the Building B-911 slab clearly showed that a relatively thick sand layer, as compared with the top soil for the remainder of the site, had been placed as the foundation for the building. The sand base is believed to be directly responsible for the settling of the slab that resulted in the multiple cracks present in the floor slab. The characterization sampling determined that the sand layer extended approximately 0.5 meter after which the expected clay layer was encountered that was seen throughout the site at approximately 0.15 to 0.30 meters in depth. The sand layer, coupled with the contaminating matrix—a large, liquid spill that is more mobile in this type of material—resulted in the contamination penetrating to a greater depth than what was determined in other areas of concern. The characterization sample results demonstrated a rapid reduction in the contamination concentration below the initial 0.30 meters, falling from 174 pCi/g to 7.82 pCi/g. The scope-of-work for the upcoming site remediation requires that all such contamination be removed to levels that are less than the proposed DCGLs, regardless of depth.

In the former radioactive waste disposal area, both scoping and characterization investigations determined that the material present with the associated elevated Th-232 concentrations is visible trash consisting of wooden lids and metal bands. Both boreholes and test pits showed the material was interspersed over the area with contamination typically encountered, when present in an area, at approximately one meter in depth. The boreholes were advanced until there was no visible sign of material for several 0.5 meter depth intervals, and the depth of contamination determined to extend to between 3 and 4 meters, which is above the known groundwater depth for that area of the site. The remediation scope-of-work for the site requires that the remedial action contractor excavate all areas of the former disposal pit, segregate clean from contaminated soil, and ensure all material is removed such that final soil concentrations are less than the proposed DCGLs.

4. **Comment:** DLA should indicate a reference for background levels of Th in groundwater to support the statement in Curtis Bay RAI response 4 that the Th detects in groundwater near the radioactive waste disposal site are indicative of background contamination (groundwater data for Th are provided on page 3-14 of Parsons, 1999).

DLA should sample the groundwater well near the radioactive waste disposal site for radioisotopes of Th and U (depth to water and pH would also be useful information). DLA should provide any details regarding the groundwater well location (orientation with respect to the radioactive waste disposal site, groundwater flow direction, and expected surface water discharge points) and well screen depth in relation to the average water table elevation. DLA also indicated that it might take a surface water sample. The location should be just downgradient from the expected discharge point to surface water (e.g., along a reach of Furnace Creek).

DNSC Response: ORISE collected water samples from three groundwater wells and one surface water location on December 11, 2006. These wells included the monitoring well located within the boundaries of the former radiological waste disposal area (sample ID W001), one of the three monitoring wells (MW-06) installed to the southwest of the disposal area in the medical supplies burial area (sample ID W003), and one of the background monitoring wells (BG-MW02) installed on the eastern edge of the site (sample ID W004). A surface water sample was also collected from the small creek that flows into Back Creek (sample ID W002). Figure 2 shows monitoring wells and creeks (Parsons 2006). The monitoring well within the radiological waste disposal area is shown in the 1999 Parsons report (Parsons 1999). Samples were collected in accordance with ORISE procedures. The depth to the water table was recorded for each well sampled. Each well was then purged an equivalent of three volumes prior to collecting the samples. The pH of each sample was determined in the ORISE laboratory prior to sample acidification and processing. Samples were analyzed by alpha spectroscopy for isotopic thorium and uranium. The results are provided in Table 1. All results were less than or equal to the minimum detectable concentration (MDC) of the procedure.

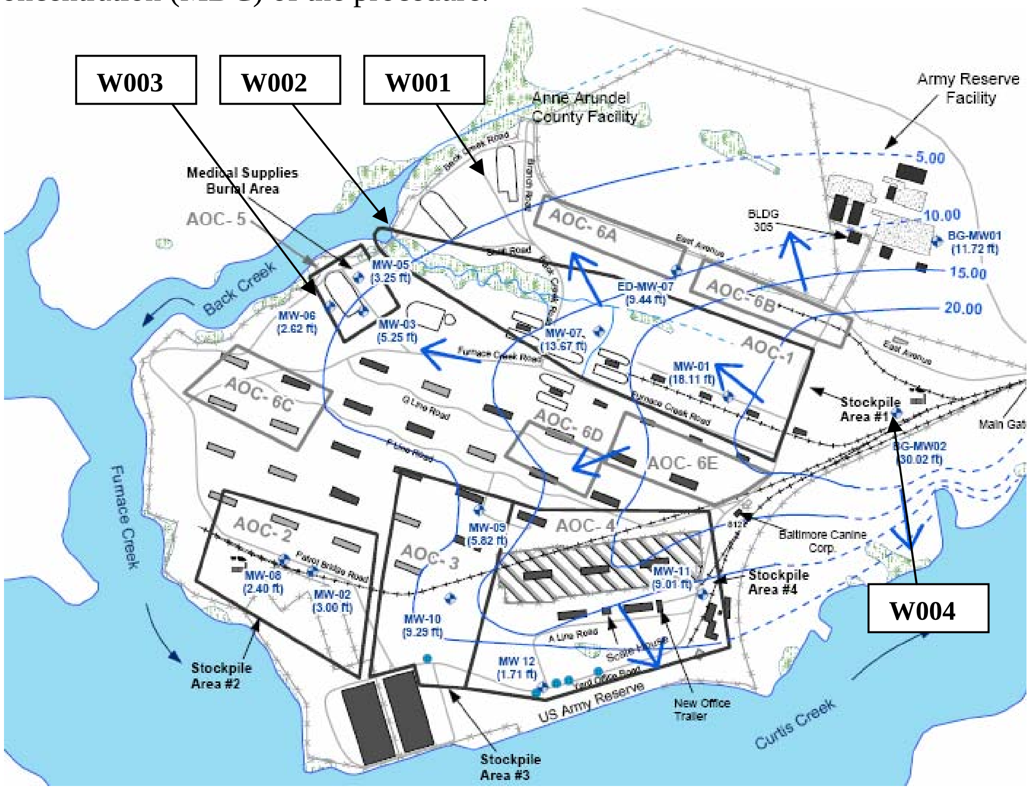

Figure 2: Monitoring Well and Surface Water Sampling Locations (Radioactive Waste Site Monitoring Well Location is Shown in the 1999 Parsons Report Previously Provided)

Furthermore, should groundwater percolate into the pit during remediation, samples will be collected at that time to verify that there has been no groundwater impact.

Table 1
Isotopic Thorium and Uranium Concentrations In Water Samples
Curtis Bay Depot,
Curtis Bay, Maryland

Sample ID[b]	Depth to Groundwater[c]	Radionuclide Concentration (pCi/L)[a]					
		Th-228	Th-230	Th-232	U-234	U-235	U-238
W001	19.2 feet	0.29 ± 0.24[d]	0.48 ± 0.20	-0.02 ± 0.06	-0.02 ± 0.11	0.02 ± 0.04	0.02 ± 0.04
W002	NA	0.29 ± 0.23	0.41 ± 0.20	0.02 ± 0.04	-0.02 ± 0.08	0.09 ± 0.09	0.00 ± 0.07
W003	26 feet	0.02 ± 0.18	0.40 ± 0.18	-0.02 ± 0.04	0.08 ± 0.09	0.00 ± 0.07	0.08 ± 0.08
W004	9.3 feet	0.02 ± 0.18	0.57 ± 0.22	-0.04 ± 0.06	-0.04 ± 0.09	0.04 ± 0.06	0.02 ± 0.06

[a]MDCs ranged from 0.06 to 0.36 pCi/L for thorium isotopes and 0.05 to 0.24 pCi/L for uranium isotopes.
[b]Sample pH ranged from 4.89 to 5.59 for groundwater samples and was 6.69 for the surface water sample.
[c]Depth to groundwater is from top of well casing.
[d]Uncertainties are total propagated uncertainties at the 95% confidence interval.

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