February 26, 2007

MEMORANDUM TO: Brian E. Holian, Director
Division of Nuclear Materials Safety, Region I

FROM: Scott C. Flanders, Deputy Director **/RA/**
Environmental Protection and Performance
Assessment Directorate
Division of Waste Management
and Environmental Protection
Office of Federal and State Materials
and Environmental Management Programs

SUBJECT: RESPONSE TO TECHNICAL ASSISTANCE REQUEST DATED APRIL 24, 2006, FOR CURTIS BAY DEPOT SITE

By technical assistance request (TAR) dated April 24, 2006 [ML061150182 and package number ML060540148], the Division of Waste Management and Environmental Protection (DWMEP) was tasked by Region I to approve site-specific derived concentration guideline levels (DCGLs) for the Curtis Bay Depot site [ML060580566]. Based on a review of background documents provided in the TAR, DWMEP generated requests for additional information transmitted to Region 1 by letter dated May 18, 2006 [ML061380016], which were transmitted to the licensee, Defense Logistics Agency/Defense National Stockpile Center (DLA/DNSC), by letter dated June 19, 2006 [ML061730044]. DWMEP staff reviewed additional information provided by the licensee in a letter dated August 8, 2006 [ML062290404], including results of a characterization survey provided by letter dated September 19, 2006 [ML062650300]; and additional information provided following a November 22, 2006, teleconference between the U.S. Nuclear Regulatory Commission (NRC) and the licensee by letter dated January 12, 2007 [ML070160372], and finds the DCGLs calculated for the Curtis Bay Depot site to be acceptable.

It is important to note that the licensee has provided DCGLs for surficial soil contamination only and that it is not appropriate for DLA/DNSC to apply these DCGLs for known contaminated areas significantly thicker than 15 centimeter (cm). DLA/DNSC expects to completely remove all known subsurface soil contamination in the radioactive waste disposal pit and results of the final status survey should be consistent with the assumption that residual contamination above background is less than 15 cm thick or DCGLs should be calculated for contaminated areas significantly thicker than 15 cm. Additionally, DLA/DNSC did not provide calculations for elevated region DCGLs, thus if smaller areas of the site have average concentrations above DCGLs, DLA/DNSC must perform additional remediation or calculate elevated area DCGLs to demonstrate compliance with license termination rule criteria.

Enclosure: Basis for Approval

CONTACT: Cynthia S. Barr, FSME/DWMEP
(301) 415-4015

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**BASIS for DERIVED CONCENTRATION GUIDELINE LEVELS APPROVAL**

**In Response to Technical Assistance Request (Region I)**
**License No. STC-133, Docket No. 040-00341, Control No. 138458**
**Site-Specific Derived Concentration Guideline Levels Calculation Review**
**Defense Logistics Agency, Defense National Stockpile Center**
**Curtis Bay Depot**

**Cynthia Barr**
**January 29, 2007**

By technical assistance request (TAR) dated April 24, 2006, the Division of Waste Management and Environmental Protection (DWMEP) was tasked by Region I to approve site-specific derived concentration guideline levels (DCGLs) for the Curtis Bay Depot site. The licensee calculated soil DCGLs of 3.3 picocuries/gram (pCi/g) for natural thorium (Th) and 2.2 pCi/g for natural (U); and building DCGLs of 400 disintegrations per minute/100 square centimeters (dpm/100 $cm^2$) for natural thorium and 800 dpm/100 $cm^2$ for natural U[1]. Based on a review of the "Preliminary Site-Specific Derived Concentration Guideline Levels" report (Boerner et al, 2006), U.S. Nuclear Regulatory Commission (NRC) staff determined that additional information was needed to approve DCGLs for the site. Requests for additional information were generated to address important parameters (see Table 1 and 2 below) and exposure pathways identified during NRC staff's independent review. The primary pathways of exposure for natural Th and U contaminated soil are the external gamma and plant ingestion pathways. Additionally, U could also migrate to groundwater and pose a risk through the drinking water pathway. The primary pathway of exposure for a building occupancy scenario is the inhalation pathway for both natural Th and U; therefore, parameters related to dilution of air contamination (e.g., building size and air exchange rate), source available for inhalation (e.g., source area, removable fraction, air fraction), source release rate (e.g., release time), and exposure parameters (e.g., indoor time fraction, breathing rate) are most important to peak dose for a building occupancy scenario.

Requests for additional information addressed uncertainties in the hydrogeological conceptual model for the site, the depth of soil contamination for soil DCGLs; and behavioral parameters and the assumed exposure scenario for residual contamination on concrete slabs and other deconstructed building surfaces for building DCGLs. Additionally, several key parameters required further justification due to their significance to peak dose.

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[1]Although the licensee states that DCGLs apply to natural Th and natural U, the DCGL calculations are surrogate analyses where the limits actually apply to Th-232 and U-238 only. The natural Th DCGL is for Th-232 only, not for the sum of Th-232, Th-228 and Th-230 (but includes the contribution from Th-228 and other progeny assumed to be in secular equilibrium). The DCGL for natural U applies to U-238 only and not for the sum of U-238, U-234, and U-235 (but includes the contributions from U-234 and Th-230 assumed to be in secular equilibrium with U-238; and U-235 decay chain members expected to be naturally present at a ratio of 0.05 the U-238 values).

| TABLE 1 SENSITIVE RESRAD PARAMETERS | | | |
|---|---|---|---|
| **Radionuclide** | **Parameter** | **Radionuclide** | **Parameter** |
| Thorium | Distribution coefficients for Th and associated decay products | Uranium | Distribution coefficients for U and associated decay products |
| | External Gamma Shielding Factor | | External Gamma Shielding Factor |
| | Indoor Time Fraction | | Indoor Time Fraction |
| | Thickness of Contamination | | Thickness of Contamination |
| | Plant Transfer Factor for radium (Ra) | | Plant Transfer Factor for Ra and lead (Pb) |
| | Depth of Roots | | Depth of Roots |

| TABLE 2 SENSITIVE RESRAD BUILD PARAMETERS | | | |
|---|---|---|---|
| **Category** | **Parameter** | **Category** | **Parameter** |
| Uncertain Parameters Related to Room Size Assumption | Floor Area | Uncertain Behavioral and Other Physical Parameters (for a given room size) | Removable Fraction |
| | Room Height | | Area of Source |
| | Building Exchange Rate | | Air Fraction |
| | | | Release Time |
| | | | Breathing Rate |
| | | | Indoor Fraction |

The following specific issues were addressed by the licensee.

- The licensee did not perform a characterization survey prior to its submittal of a request for DCGL approval for surficial (15 cm) soil contamination. In the "Radiological Scoping Survey of the Curtis Bay Depot" report (Vitkus, 2006), it was acknowledged that a broad area of subsurface contamination exists at the former radiological waste disposal area. Therefore, NRC requested additional information (Ullrich, 2006) justifying the depth of contamination of 15 cm assumed in the licensee's DCGL approval request (Boerner, 2006). Following issuance of requests for additional information, the licensee submitted the results of its characterization survey (Pecullan, 2006) that showed significant subsurface contamination at the radiological waste disposal area between 0.5 and 2 meter (m) in depth and extending in some cases past 4 m in depth over an area of 440 $m^2$. Because the depth of contamination significantly impacts the DCGL calculations (as the thickness of contamination increases, the plant ingestion pathway becomes more important and the peak mean dose increases), the licensee was asked to further justify the appropriateness of surface DCGLs for the radiological waste disposal area and to address the sensitivity of the results to the uncertainty in parameters related to the plant ingestion pathway. In its January 2007 response (Pecullan, 2007), the licensee stated that it expects to remediate all areas of the site with known subsurface contamination. The licensee did not think consideration of uncertainty in parameters related to the plant ingestion pathway was warranted for surficial contamination (Reilly, 2006). Final survey results should confirm that contamination is not significantly thicker than 15 cm in the radiological waste disposal area post-remediation. It is not appropriate for the licensee to use the calculated surficial soil contamination DCGLs for areas of the site with contamination significantly thicker than 15 cm.

- Additional justification for the Decontamination and Decommissioning code (DandD) default external gamma shielding factor used in the RESRAD code was needed. The external pathway is the single-most important pathway for surficial U and Th soil contamination and the DandD default value is lower than the RESRAD default and not specific to a single radionuclide or decay chain. In the initial submittal, the licensee did not specifically address the appropriateness of the DandD default value of 0.55 used in the analysis. The licensee provided additional radionuclide-specific support for its selection of the external gamma shielding factor in its August 8, 2006, submittal (Reilly, 2006). NRC staff finds this justification adequate.

- The licensee did not use the indoor time fraction recommended in NUREG/CR-5512, Volume 3 for residual soil contamination. The indoor time fraction was changed to 0.66 and a revised DCGL calculation provided for total Th in the licensee's August 8, 2006, submittal of 2.9 pCi/g (Reilly, 2006).

- Additional justification for the distribution coefficients used in the RESRAD analysis was needed. Section 1.3, page 4 of the DCGL approval request (Boerner, 2006), discusses the presence of a subsurface clay layer which serves to mitigate the potential radiological impacts to groundwater. Credit was taken for the expected attenuation capacity of loam and clay subsurface materials during the selection of distribution coefficients for input in the RESRAD code used for soil DCGL calculations. It was not clear that the clay layer extended laterally across the entire site. Because the clay layer significantly retards contaminant migration to saturated groundwater, the presence of

this clay layer is important to the results of the DCGL calculation. In fact, in its August 8, 2006, submittal (response to comment 5 [Reilly, 2006]), the licensee clarified the conceptual model for the site and showed a cross-section that contained only sandy loam and no clay on the west end of the site. Additional sensitivity runs performed by the licensee also indicated that if the clay layer is absent and the vadose zone thickness is 20 ft (6 m) or less, that the DCGL would be significantly lower at a value of 1.1 pCi/g (Table 2, Reilly, 2006). In fact, the vadose zone thickness as reported in the licensee's most recent January 12, 2007, submittal (response to comment 4 [Pecullan, 2007]), shows a depth to groundwater of 19.2 feet (ft) (6 m) in the vicinity of the radiological waste disposal area and 26 ft (8 m) in the vicinity of the medical supplies burial area. The depth to groundwater provided by the licensee is from the top of well casing. Using well construction log information provided in a Parsons Engineering report (1999), the vadose zone thickness should be around 17 ft (5 m) near the radiological waste disposal area and 22 ft (7 m) in the vicinity of the medical supplies area. Using the actual vadose zone thickness measured at the radiological waste disposal area and the medical supplies area, the deterministic soil DCGL for natural U (U-238) for the west end of the site would be approximately 1.1 pCi/g using loam Kds and no clay layer. However, based on a review of additional information and its own independent probabilistic dose assessment, NRC staff concluded that assigning the licensee's proposed loam Kds to all hydrostratigraphic layers in the model is overly conservative. Despite the description of the subsurface geology provided by the licensee in its August 8, 2006 response (Reilly, 2006), well construction logs for groundwater wells CB-GW-03 and CB-GW-04 located near the medical supplies burial area and radiological waste disposal area, respectively, show the presence of a clay and silt layer at approximately 8 to 16 ft (2 m to 5 m) below ground surface in the CB-GW-03 borehole and some clay present in various intervals between 4 to 25 ft (1 m to 8 m) below ground surface in the CB-GW-04 borehole. While other areas of the site do not appear to have the same clay interval (e.g., CB-GW-02 near stockpile area two), the most contaminated areas of the site appear to have some clay intervals present in the subsurface which will provide significant attenuation to mitigate the potential impact to groundwater. Therefore, the U soil DCGL of 2.2 pCi/g calculated assuming the presence of a clay layer in the vadose zone is reasonable.

- NRC requested additional information regarding groundwater sampling performed for the site to support the licensee's statement that there was no existing groundwater contamination. Deep subsurface contamination in the radiological waste disposal area poses a threat for contaminant migration to groundwater. The licensee provided reports as an enclosure to its August 2006 submittal (Reilly, 2006) published by Parsons Engineering (1999 and 2000) which contained the results of a preliminary assessment and site investigation used to determine the potential for environmental impact and the pathways of migration of contamination into the environment. These reports indicated a potential for groundwater migration and potential impacts to nearby drinking water receptors. Positive detections of Th in a well located near the radioactive waste disposal pit (CB-GW-04) below drinking water standards were provided in this report (Parsons, 2000). During a November 22, 2006, teleconference between the NRC and the licensee, the NRC requested that the contractor for the licensee, Oak Ridge Institute for Science and Education (ORISE), perform additional groundwater sampling of the existing wells and provide the results to the NRC to support its statement that groundwater was not contaminated from licensed operations. The licensee also agreed to sample surface water in the vicinity of the radiological waste disposal area. The

licensee provided results from the groundwater sampling in its January 2007 submittal (comment 4, Pecullan, 2007). This sampling indicates no detectable levels of Th or U in groundwater near the radiological waste disposal and medical supplies burial areas of the site, nor in surface water at Back Creek on the western end of the site.

Additionally, the licensee clarified that the depth of the contamination in the radiological waste disposal area did not extend to saturated groundwater (boreholes were advanced in 0.5 m intervals until several intervals showed no visible sign of materials present in the pit). Remedial activities should result in the removal any potential deep source of contamination in the radiological waste disposal area that presents a threat to groundwater.

- NRC also questioned the greater than expected depth of contamination underneath one of the contaminated buildings (B-911) from contamination which migrated from the building into the underlying foundation and subsurface which indicates a higher mobility than would be expected for Th assuming a distribution coefficient of 3300 L/kg. The licensee attributed the high mobility of natural Th to the presence of a relatively thick sand layer placed as a foundation for the building that resulted in the settling of the floor slab and the creation of multiple cracks in the slab that allowed liquid spills to penetrate to a depth greater than would be expected into the subsurface (comment response 3, Pecullan, 2007). NRC staff finds this explanation reasonable.

- The licensee did not provide sufficient justification for use of the default inhalation rate for the RESRAD-BUILD DCGL calculations. The default inhalation value recommended in NUREG/CR-5512, Volume 3, is 33.6 cubic meters/day ($m^3$/day) while the default value of 18 $m^3$/day in RESRAD BUILD was used in the licensee's analysis. The licensee corrected the breathing rate and also noted in its August 2006 submittal (Reilly, 2006) that the default value for the indoor time fraction should have been more appropriately assigned a value of 0.27. The changes to these parameter values offset one another, and the licensee requested continued use of the building DCGLs it proposed in its original submittal.

  While there is significant uncertainty in the parameters and parameter distributions used to calculate building DCGLs, NRC staff's independent assessment shows the licensee's DCGLs are reasonable and that the licensee attempted to minimize the amount of dilution of air contamination by selecting room sizes that were significantly smaller than the total warehouse area and volume. It is important to note that the floor area is negatively correlated to dose, while competing with the source size which is positively correlated to dose (source size can increase with increasing floor area). A comparison of results for various floor areas and corresponding source areas was made. The higher the floor area, the lower the dose. These results suggest that the increased dilution inherent in a larger room size is of greater magnitude than the increased dose from a larger source area. Therefore, while some of the licensee's selection of parameter values may not be conservative, NRC staff finds that on balance the licensee's analysis is reasonable.

- The licensee did not differentiate between or discuss the potential exposure pathways for deconstructed building materials, e.g., concrete pads and debris piles, compared to residual contamination associated with buildings and/or soil contamination. In its August

2006 submittal (Reilly, 2006), the licensee explained that all deconstructed building surfaces would remain on site and that these materials were not expected to be contaminated and that characterization survey results did not indicate the materials had been contaminated from licensed operations. Therefore, the licensee argued that there was no need to develop additional site-specific DCGLs for these deconstructed building materials. The region should confirm that the deconstructed building materials were adequately surveyed and that survey results indicate no significant contamination from licensed activities.

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