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UCAR Carbon Company, Inc

Technical Evaluation Report

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Introduction

UCAR Carbon Company, Inc. (UCAR) has requested approval for the disposal of solid low-level radiological waste at the Waste Control Specialists (WCS) facility in accordance with 10 CFR 20.2002. Under a permit issued by the state of Texas, WCS operates a hazardous waste landfill located west of the Texas-New Mexico border, near Andrews, TX. The WCS facility has a history of disposal of residual radioactive materials contaminated with source material, specifically ^{238}U and ^{232}Th, which has been exempted under 10 CFR 40.

UCAR has proposed to dispose of fifteen intermodal containers of soil, rubble, and debris, which are contaminated with residual enriched uranium contamination. The wastes are resultant from voluntary remedial activities which are being conducted at the UCAR site located in Lawrenceburg, TN.

Source Term

Using in-situ gamma spectrometry techniques, the intermodal containers were radiologically characterized. The resultant isotopic concentrations were averaged, resulting in 25 pCi/g of ^{235}U and 1,082 pCi/g of total uranium. The combined total average ^{234}U and ^{238}U concentrations were calculated by subtracting the ^{235}U concentration from the total uranium concentration, resulting in 1, 057 pCi/g for the average ^{234}U and ^{238}U concentrations. Additionally, samples of the waste were analyzed and results indicate a wide range of uranium enrichments throughout the waste. The isotopic concentrations of the waste are presented in Table 1.

Table 1. Isotopic Concentrations used in the UCAR assessment

Intermodal ID Number	^{235}U Concentration (pCi/g)	Total U Concentration (pCi/g)
MHFU 1748	19	845
MHFU 1864	16	715
MHFU 1579	24	1,045
MHFU 2219	38	1,668
MHFU 1581	23	1,012
MHFU 1367	26	1,146
MHFU 1415	21	926
MHFU 2222	16	724

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MHFU 1576	20	867
MHFU 1815	21	911
MHFU 2164	28	1,210
MHFU 2259	45	1,958
MHFU 1901	25	1,115
MHFU 1997	32	1,421
MHFU 2123	15	671
Average	**25**	**1,082**

Scenarios and Pathways

The licensee evaluated three exposure scenarios to determine if the potential dose to individuals would be below the NRC policy limit of "a few mrem" per year. The three scenarios included: (1) transportation worker/driver, (2) disposal facility worker, and (3) resident farmer scenario.

Direct exposure to external radiation is the primary pathway for both the transportation worker/driver scenario and the disposal facility worker scenario. With respect to internal dose in these two scenarios, the proposal states that there are no internal dose hazards associated with the transportation scenario and that the activities associated with the disposal facility worker scenario has resulted in no measurable internal dose exposures.

Three different geometries for the intermodal containers were modeled for the transportation worker/driver scenario to bound any variations of the actual intermodal containers that may be actually used for waste transportation. The geometries were the following:

- A worse case (on contact) scenario with a dose receptor (one inch) adjacent to the center of the side of the intermodal container with dimensions of 10 ft x 20 ft x 10 ft;
- A representative dose receptor one meter from the center of the side of the intermodal container with dimensions of 10 ft x 20 ft x 10 ft; and
- A theoretical driver dose receptor two meters from the center of the front of the intermodal container with dimensions 20 ft x 10 ft x 10 ft.

For the disposal facility worker scenario, the geometry assumes a dose receptor centered 18 inches above a representative slab of material (after placement) which bounds any scenario which may occur after placement. The modeled slab has dimensions of 20 ft x 400 ft x 400 ft.

The resident farmer scenario was utilized to evaluate exposures at the landfill, in which it maximizes the pathways contributing to the peak dose to the critical group. Calculating the dose to the critical group is intended to bound the individual dose to other possible exposure groups because the critical group is a relatively small group of individuals, due to their habits, actions, and characteristics, who could receive among the highest potential dose at some time in the future. By using the hypothetical critical group as the dose receptor, it is unlikely that any individual would actually receive doses in excess of that calculated for the average member of

the critical group. The licensee used the following exposure pathways in the UCAR dose assessment:

- Direct exposure to external radiation from the contaminated media;
- Inhalation of airborne radionuclides;
- Ingestion of plants grown in contaminated soil and irrigated with contaminated water;
- Ingestion of meat and milk from livestock fed with contaminated fodder and water;
- Ingestion of aquatic foods from contaminated water;
- Ingestion of contaminated soil;
- Exposure due to radon.

It should be noted that the licensee included the radon exposure pathway in the residential farmer scenario. This pathway is typically suppressed in dose assessments for compliance with NRC regulations because radon is not an NRC regulated activity. Including this pathway is likely to lead to an overestimation of the dose in this scenario.

The staff finds these scenarios to be adequate and reasonable for the assessments required for compliance with 10 CFR 20.2002.

Conceptual Models

The licensee used both Microshield version 5.01 and RESRAD version 6.22 to evaluate the aforementioned three exposure scenarios. The staff finds the use of these codes to be acceptable and reasonable for the conceptual models used in this proposal.

Parameter Selection

The licensee performed deterministic analyses to determine the potential dose to individuals for compliance with the NRC policy limits. For the Microshield calculations, the assumptions were deemed to be appropriate for the scenarios proposed. However, it should be noted that for the transportation worker/driver and disposal facility worker scenarios, the parameter values selected for the density of concrete, 1.0 g/cm^3 and 1.5 g/cm^3, respectively, are conservative and would likely overestimate the dose compared to a typical value of 2.35 g/cm^3 for concrete.

For the RESRAD dose estimate, the licensee used a combination of site-specific information and RESRAD default parameter values as input parameters. As noted in NUREG-1757, Volume 2, the use of RESRAD default parameters are inappropriate without adequate justification. However, based on the staff's independent assessment, no additional information or justification of parameter values is warranted.

In modeling the source term, since the ratio of ^{234}U and ^{238}U varied with enrichment, the licensee evaluated the RESRAD model with each of the two isotopes optimized to determine the more conservative isotope. The results indicated a higher dose estimate assuming a ^{234}U concentration of 1, 057 pCi/g and no ^{238}U. Therefore, the licensee conservatively estimated material isotopic concentrations as 25 pCi/g of ^{235}U and 1, 057 pCi/g of ^{234}U. Additionally, the licensee assumed no down-blending with the addition of non-radiological waste disposal in the landfill concurrent with disposal of the subject waste. The staff finds these assumptions to be reasonable and acceptable for model use.

Licensee Results

The resultant dose rates for each of the three receptor points for the transportation worker/driver scenario are approximately 6.7 μR/hr on contact, 4.5 μR/hr at one meter, and 1.5 μR/hr at two meters, respectively. The licensee performed a bounding scenario which demonstrates that a worker would need to spend in excess of 749 hours, 1,103 hours, and 3,259 hours, respectively, at these receptor points to exceed 5 mrem/yr.

For the disposal facility worker scenario, the licensee calculated the resultant dose rate to the receptor point as approximately 11.3 μR/hr. As a bounding scenario, the licensee states that a worker would need to spend in excess of 441 hours at the receptor point to exceed 5 mrem/yr.

For comparison, a more credible scenario assumes that a worker will spend 100 hours of exposure during transportation. With a dose rate of 4.5 μR/hr at one meter, the worker would receive a dose of 0.45 mrem. Therefore, the staff believes that it is unlikely that a worker would exceed occupancy times which would result in 5 mrem/yr for the transport and disposal of fifteen intermodal containers.

For the residential farmer scenario, the licensee calculated a dose estimate of approximately 0.64 mrem/yr in which most of the dose is attributed to the radon exposure pathway.

Independent Analyses

Using Microshield version 5.05 and RESRAD version 6.22, the staff performed analyses using the parameter values selected by the licensee to confirm the conclusions of the proposal. The staff was able to verify the licensee's dose rates and dose estimate results. Additionally, for the external dose rate calculations using Microshield, the staff performed analyses using a parameter value of 2.35 g/cm^3 for the density of concrete. The staff assessment shows that the dose rates would decrease by a factor of two using the larger parameter value for the density of concrete. Since the licensee's results are more conservative than the staff's results, the selected parameter values are acceptable.

For the residential farmer scenario, the staff performed an analysis using RESRAD to determine the dose estimate with the suppression of the radon pathway. The staff's independent assessment demonstrates that the dose estimate for the residential farmer scenario is extremely low, near zero. The staff believes that the dose estimate in this scenario would likely be near zero because of the 5.0 meter cover depth for the disposal cell at the WCS facility.

Conclusions

The staff finds the dose assessment of the licensee to be adequate and reasonable to demonstrate that the potential radiation doses to individuals would not exceed the NRC policy limit of "a few mrem" per year. Staff's independent dose assessment confirmed the conclusions reached in the UCAR proposal. Further, the staff believes that the appropriate scenarios and conceptual models were used in the assessment. While the licensee failed to suppress the radon exposure pathway as well as justify the RESRAD default parameters used in the model, the staff's independent analysis found that these differences would not significantly change the resultant dose estimate.