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DIVISION OF WASTE MANAGEMENT
AND RADIATION CONTROL

Douglas J. Hansen
Director

May 16, 2023

Vern C. Rogers, Director of Regulatory Affairs
Energy*Solutions*, LLC
299 South Main Street, Suite 1700
Salt Lake City, UT 84111

RE: Federal Cell Facility - Additional References to Appendix O Request for Information (RFI) Second Addendum

Dear Mr. Rogers:

The Division of Waste Management and Radiation Control (Division) provided an RFI to Energy*Solutions*, LLC on January 25, 2023, relating to Appendix O of the Federal Cell Facility License Application. The Division wishes to provide supplemental information for RFI **O-21**, **O-25**, and **O-29**.

If you have any questions, please call Otis Willoughby at 385-622-2213.

Sincerely,

Douglas J. Hansen, Director
Division of Waste Management and Radiation Control

DJH/LTK/wa

Enclosure: Federal Cell Application: Appendix O Supplemental Information

c: Jeff Coombs, EHS, Health Officer, Tooele County Health Department
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Federal Cell Application: Appendix O Second Addendum

O-21: Neptune is unclear of the basis for the reviewer's assertion that the data standard deviation is used for Tc-99 while the standard deviation of the mean is used for all other radionuclides.

Table 2 of NAC-0023, R5, *Radioactive Waste Inventory for the Clive DU PA* (August 2021), presents DUO3 concentrations and uncertainties for numerous radionuclides including uranium isotopes and Tc-99. The uncertainty is stated to be the standard deviation in the column heading. However, Table 5 presents these same values and states the uncertainty is the standard error (i.e., standard deviation of the mean) in the column heading. The text of the report also states that the uncertainty is the standard error (page 11, fourth paragraph).

The uranium isotope data of Tables 2 and 5 are taken from that presented in Tables 14 and 15 of the Appendix to NAC-0023, R5. While SC&A is not able to reproduce the summary values in these tables (and believes them to be in error), the uncertainty for the uranium concentrations presented in Tables 2 and 5 is confirmed to be commensurate with the standard error of the data set.

The Tc-99 data are presented in Tables 13, 14, 15 and 16. Insufficient information is provided in the text of the report (Section 3.3) to reproduce the analysis conducted by Energy*Solutions*/Neptune. However, an analysis of the data confirmed the uncertainty for Tc-99 concentrations presented in Tables 2 and 5 is commensurate with the standard deviation of the data set. Furthermore, the data displayed in Figure 4, while in error (5^{th} percentile is not displayed correctly), are consistent with the standard deviation of the data set.

References:

Neptune 2021, *Radioactive Waste Inventory for the Clive DU PA*, Clive DU PA Model 2.0, NAC-0023-R5, 2 August 2021.

O-25: In review of Hightower 2000; Neptune does not find the Am-241 to Tc-99 ratio referred to in the RFI.

The ratio between ^{99}Tc and ^{241}Am is derived from the Hightower data. The information provided below is from Hightower Table 2 and Section 3.4.1 and 3.4.2.

^{99}Tc (Dispersed within the DUF_6 Cylinders):

Table 2 from Hightower, et al (2000) provides bounding values for contaminants of concern within the cylinders. The units provided in Table 2 are listed in terms of "ppb_U" which is "Parts per Billion Total Uranium." To convert these units to a more customary and usable form, the following is needed to convert from "ppb_U" to "pCi/g", or "pico-curies per gram":

^{99}Tc is given as 15.9 ppb_U:

$$\frac{15.9\ g\ ^{99}Tc}{1E9\ g\ U_{tot}} \times \frac{0.017\ Ci\ ^{99}Tc}{g\ ^{99}Tc} \times \frac{10^{12} pCi\ ^{99}Tc}{1\ Ci\ ^{99}Tc} = 270.3 \frac{pCi\ ^{99}Tc}{gU_{tot}}$$

Where,

- 0.017 Ci/g of ^{99}Tc is its specific activity,
- 10^{12} pCi of ^{99}Tc converts to units of 1 Curie of ^{99}Tc
- Results are calculated in units of "pCi/g"

A similar calculation can be used to convert the units for Am-241 using 0.0013 g as the upper concentration bound (ppb_U) and 3.4 Ci/g as the specific activity.

^{99}Tc (Dispersed within the DUF_6 Cylinder Heels):

Similarly, an example is provided below using the bounding values from contaminants of concern within a 25kg cylinder heel to calculate radionuclide concentration. These data are derived from Table 3 of Hightower, et al (2000).

^{99}Tc (Dispersed within the DUF_6 Heels)

$$\frac{5{,}700{,}000\ g\ ^{99}Tc}{1E9\ g\ U_{tot}} \times \frac{24{,}900\ g\ U_{tot}}{} \times \frac{0.017\ Ci\ ^{99}Tc}{g\ ^{99}Tc} \times \frac{6.37\ g/cm^3 Heel}{25{,}000\ g\ Heel} \times \frac{100^3\ cm^3 Heel}{1\ m^3 Heel}$$
$$= \frac{614.8\ Ci\ ^{99}Tc}{m^3 Heel}$$

Where,

- Total radioactivity is the sum of all contributing radionuclides listed in Table 3:
  - 1,005,755,606 ppb_U
- 24,900 grams of total uranium is the mass of the uranium in a 25 kg heel,

$$25{,}000\ \ g\ Heel \times \frac{1{,}000{,}000{,}000\ g\ U_{tot}}{1{,}005{,}755{,}606\ ppb_U\ Heel} = 24{,}857\ g\ U_{tot}\ or \sim 24{,}900 g\ U_{tot}$$

- 0.017 Ci/g of ^{99}Tc is its specific activity,
- 6.37 g/cm^3 is the uranyl fluoride (UO_2F_2) heel density,
  - Pg 12 of Myers, W. L.
- 100^3 cm^3 converts 1 m^3 to cm^3

References:

Hightower, J.R., L.R. Dole, D.W. Lee, G.E. Michaels, M.I. Morris, D.G. O'Conner, S.J. Pawel, R.L. Schmoyer, L.D. Trowbridge, and V.S. White, 2000. Strategy for Characterizing Transuranics and Technetium Contamination in Depleted UF6 Cylinders, ORNL/TM-2000/242, UT-Battelle, Oak Ridge National Laboratory, Oak Ridge, TN, October 2000.

Myers, W. L. A Literature Review of the Chemical and Physical Properties of Uranyl Fluoride (UO_2F_2), LA-11896-MS, Los Alamos National Laboratory, from the National Technical Reports Library:

https://ntrl.ntis.gov/NTRL/dashboard/searchResults/titleDetail/DE90014409.xhtml

O-29: Neptune needs a completed list and copies of references cited by DWMRC/SCA in Table 1.

References for 10 CFR 20 and IAEA 2022 are already available.

Leggett, R. W., Meck, R. A., 2018. Action Levels for Airborne Uranium Levels in the Workplace: Chemical and Radiological Assessments, U. S. Environmental Protection Agency (EPA), under Interagency Agreement DOE No. 1824 S581-A1, under contract No. DE-AC05-00OR22725 with UT-Battelle; and the Centers for Disease Control and Prevention (CDC) Office of Noncommunicable Diseases, Injury and Environmental Health, National Center for Environmental Health, under Interagency Agreement DOE No. 2220-Z051-16.

Organisation for Economic Co-Operation and Development, Nuclear Energy Agency, 2001. Management of Depleted Uranium, A Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency.