Request for Additional Information
Safety Evaluation
Rare Element Resources, INC.

RAI-1

Provide the following information related to compliance with public dose limits.

1. Provide justification for selected location for measurements to determine compliance with public dose limits.

Discussion

The regulations addressing dose limits for individual members of the public in 10 CFR 20, Subpart D, apply to an actual person (or group of people) receiving a radiation dose from a licensed operation. The public dose limit does not apply to hypothetical exposure scenarios.

The basis for the applicant's operational public dose compliance program is unclear. The applicant refers to "hypothetically maximally exposed member of the public", "nearest resident", "nearest actual receptor", "members of the public in the nearest neighborhood", and "critical group". The term "critical group" is confusing as it is used in 10 CFR Part 20, Subpart E, Radiological Criteria for License Termination. The history of the term "critical group" is explained in the final rule for license termination, 62 FR 39057, when it was first introduced into 10 CFR Part 20. The NRC staff has determined that the term "critical group" is not relevant to the evaluation for compliance with public dose limits during operations at the RER facility.

The applicant indicated that it would take measurements to demonstrate compliance with the public dose limits at one location at the restricted area fence. This monitoring location is shown in Figure RAI-1-1 below.

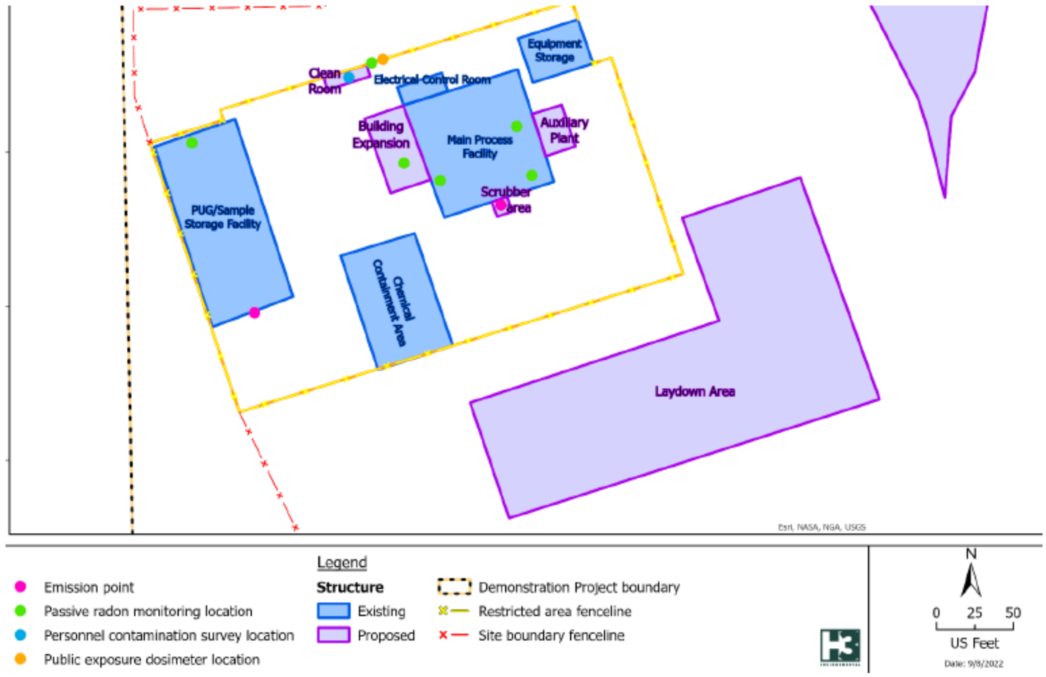

Figure RAI-1-1. Public exposure monitoring location (orange dot) at Demonstration Project [adapted from Figure 5 in RER Technical Report (RER, 2022a)].

The applicant indicated the nearest residents were located as shown in Figure RAI-1-2 below (label "A"). The nearest resident (label "A") is approximately 1.2 kilometers (km) (0.75 miles (mi)) from the proposed public exposure monitoring location (label "B").

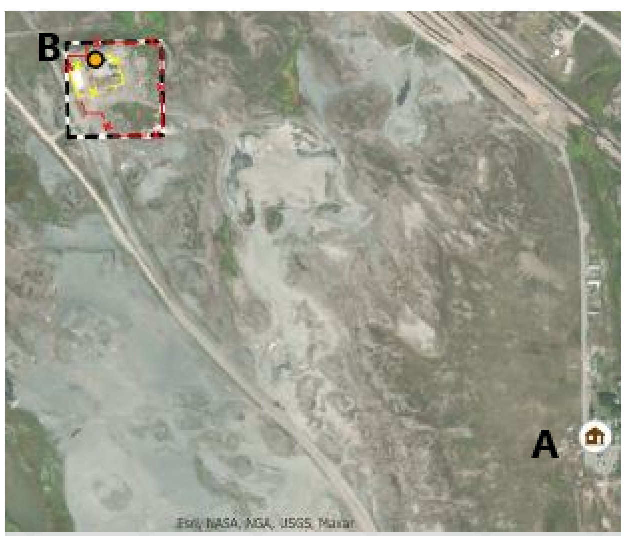

Figure RAI-1-2. Nearest residents (label A) and proposed public exposure monitoring location (label B) at Demonstration Project [adapted from Figure 6 in RER Technical Report (RER, 2022a)].

The NRC staff used Google Earth Pro to visualize downwind sectors based on a wind rose provided by the applicant (Figure 10 in the ER (RER, 2022a)). The wind rose and downwind sectors are shown in Figure RAI-1-3 below.

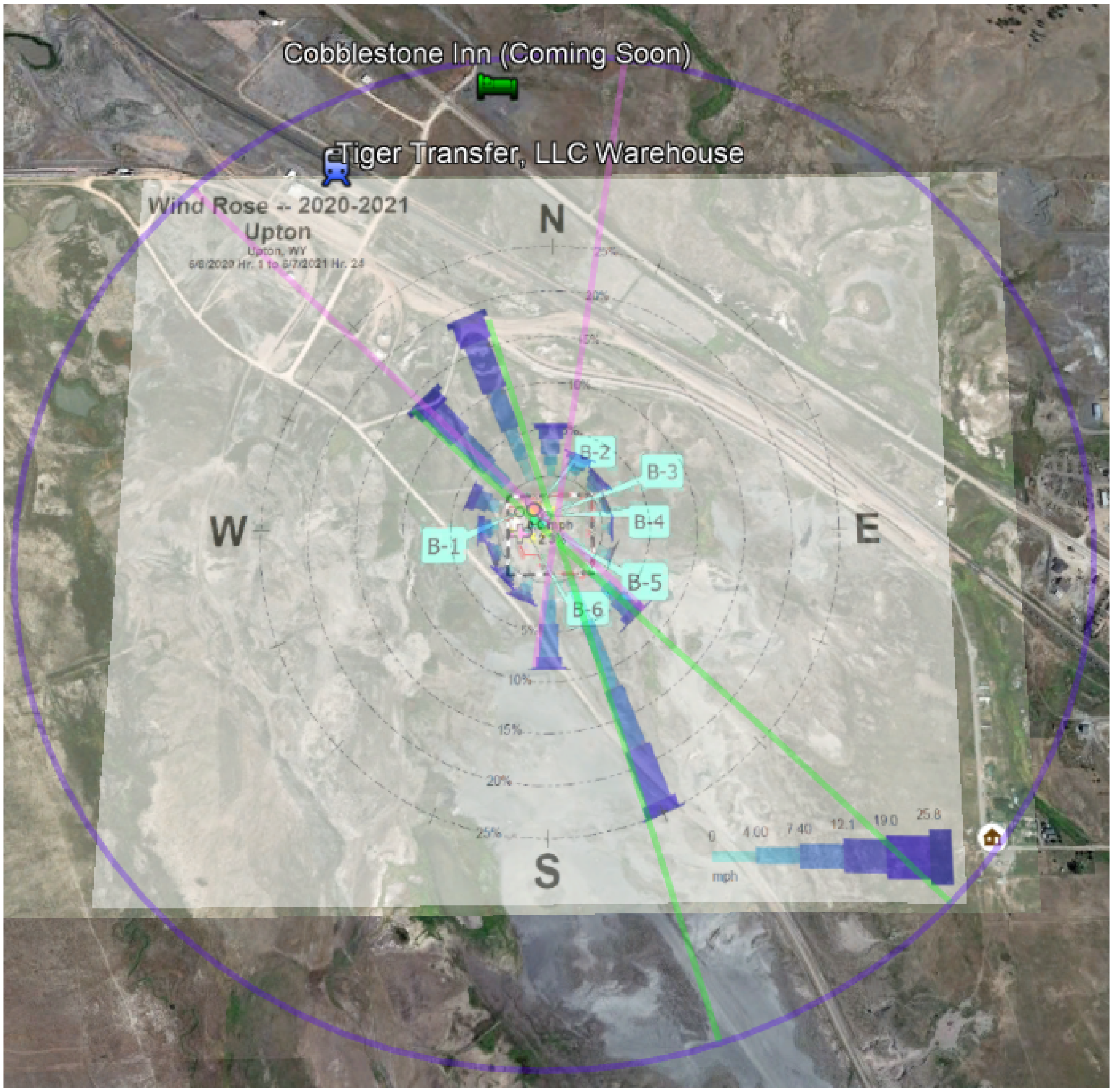

Figure RAI-1-3. Google Earth Pro representation of Upton wind rose and Demonstration Project [adapted from Map 4 in RER Environmental Report (RER, 2022a)].

The NRC staff also evaluated other potential receptors in the area near the Demonstration Project that could be located downwind from the facility. The NRC staff identified two additional potential receptors. Tiger Transfer, LLC appears to be an operating business and the Cobblestone Inn appears to be a business in the construction phase. Both of these locations appear closer in distance to the Demonstration Project than the nearest residents identified by the applicant.

The NRC staff also notes that using a single measurement location close to a source, such as the restricted area fence (see Figure RAI-1-1) at the RER facility, may not yield useful data for making compliance determinations. The NRC staff previously evaluated one such challenge during a previous licensing review (NRC, 2014).

The applicant should provide a clear description and rationale of the location for determining compliance with the radiation dose limits for individual members of the public and a monitoring location that supports that determination. For example, it is not sufficient to demonstrate that a dose to a hypothetical receptor from operations is below regulatory requirements.

2. Provide justification for not measuring airborne particulates for demonstrating compliance with public dose limits.

Discussion

In addition to Figures RAI-1-1 and RAI-1-2 above, the applicant described its monitoring program for public dose compliance in Table RAI-1-1 of the TR (RER, 2022a). The relevant aspect of this monitoring program is shown in Table 1 below.

Building	PUG/Sample Storage Facility	Main Process Facility	Other Facilities
Airborne Effluent Release Monitoring	• Mobile, continuous area air sampling outside of south side of building during PUG processing for emissions/public dose assessment • Real-time, continuous radon [d] monitoring at open end of facility during PUG processing	• Weekly, isokinetic stack monitoring for radon [d] from each scrubber stack for emissions/public dose assessment • Semi-annual particulate emission evaluation for stack by a third party for emissions/public dose assessment	• Passive radon [d] track etch and OSL dosimeter monitoring at restricted area fence over project duration for public dose assessment (Figure 6)

[a] Personnel onsite for less than 5 days are unlikely to receive an external dose exceeding 10 mrem based on the estimated external dose rate for a worker standing 1 meter away from a "wall" of stored exploration sample in super sacks, which is the most limiting external dose scenario for the Demonstration Project. The conservatively estimated external dose rate to this individual is 0.58 mrem hr^{-1}. 100% occupancy for 5 working days (40 hours) could result in an external dose of 23 mrem, however no more than 25% occupancy is considered realistic for the PUG/Sample Storage facility, which is open to the elements, does not have any office space, and will not have a routine use other than sample storage. Note: Any activity when the potential for exposure to radioactive material exists and for which no SOP already exists will be covered by a radiation work permit with appropriate dose monitoring.
[b] Radioactivity levels on surfaces for unrestricted release will meet the levels listed in Table M-2 of Appendix M to NUREG–1556, Volume 12, which are consistent with the "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material" (NRC 1987a).
[c] Occupational air monitoring in the Main Process Facility will be used to establish exposure potential. After exposure potential is established, frequency of sample collection may be reduced to monthly.
[d] Radon monitoring will have the ability to discriminate between radon-220 and radon-222. NRC's recommended equilibrium fractions of 0.5 for indoor exposures and 0.7 for outdoor exposures will be used (NRC 2019). A radon track etch and OSL dosimeter will be installed at the Met station indicated in Figure 6. Results from this location will be subtracted as a background value for public dose assessment.
[e] Frequency of contamination surveys is consistent with NUREG 1156, Volume 12, Appendix M, Table M-1 (NRC, 2000). However, expected contamination levels are low since processing occurs in a closed system with ventilation controls.
[f] An SOP, training, and signage within the restricted area will be used to direct all personnel to perform a contamination survey before exiting the restricted area.
DOT – US Department of Transportation
PUG – physical upgrade
SOP – standard operating procedure

Table RAI-1-1. Proposed routine radiological surveys and monitoring (excerpted from TR Table 18 (RER, 2022a))

The NRC staff notes that there is no proposed monitoring for airborne particulates at any location for public dose compliance purposes (including the background location, see footnote d to Table RAI-1-1) nor is there a proposed justification for not doing so.

Demonstration Project Area	Activities	External (mrem)	Inhalation (mrem)	Ingestion (mrem)	Total (mrem)
PUG/Sample Storage Facility	Airborne emissions from the PUG/Sample Storage Facility (particulates)	0.178	0.624	0.062	0.865
PUG/Sample Storage Facility	Airborne emissions from the PUG/Sample Storage Facility (radon)[a]	0	0.002	0	0.002
Main Process Facility	Airborne emissions from the Main Process Facility	Not estimated	Not estimated	Not estimated	Not estimated

Table RAI-1-2. Radiation dose estimates for hypothetical maximally exposed member of the public (from Table 12 in Appendix F of the Environmental Report (RER, 2022a))

The results of the applicant's dose assessment for a hypothetical maximally exposed member of the public are shown in Table RAI-1-2. As the applicant's assessment indicates, the projected dose from airborne particulates, while small, represents over 70 percent of the total calculated dose.

<u>Basis</u>

This information is needed to determine compliance with the following requirements:

- 10 CFR 20.1101(d) requires:

  To implement the ALARA requirements of § 20.1101 (b), and notwithstanding the requirements in § 20.1301 of this part, a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters, shall be established by licensees other than those subject to § 50.34a, such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 10 mrem (0.1 mSv) per year from these emissions. If a licensee subject to this requirement exceeds this dose constraint, the licensee shall report the exceedance as provided in § 20.2203 and promptly take appropriate corrective action to ensure against recurrence.

- 10 CFR 20.1301 requires:

  (a) Each licensee shall conduct operations so that—

  (1) The total effective dose equivalent to individual members of the public from the licensed operation does not exceed 0.1 rem (1 mSv) in a year, exclusive of the dose contributions from background radiation, from any administration the individual has received, from exposure to individuals administered radioactive material and released under § 35.75, from voluntary participation in medical research programs, and from the licensee's disposal of radioactive material into sanitary sewerage in accordance with § 20.2003, and

  (2) The dose in any unrestricted area from external sources, exclusive of the dose contributions from patients administered radioactive material and released in accordance with § 35.75, does not exceed 0.002 rem (0.02 millisievert) in any one hour.

  (b) If the licensee permits members of the public to have access to controlled areas, the limits for members of the public continue to apply to those individuals.

- 10 CFR 20.1302 requires:

  (a) The licensee shall make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public in § 20.1301.

  (b) A licensee shall show compliance with the annual dose limit in § 20.1301 by—

(1) Demonstrating by measurement or calculation that the total effective dose equivalent to the individual likely to receive the highest dose from the licensed operation does not exceed the annual dose limit; or

(2) Demonstrating that—

(i) The annual average concentrations of radioactive material released in gaseous and liquid effluents at the boundary of the unrestricted area do not exceed the values specified in table 2 of appendix B to part 20; and

(ii) If an individual were continuously present in an unrestricted area, the dose from external sources would not exceed 0.002 rem (0.02 mSv) in an hour and 0.05 rem (0.5 mSv) in a year.

RAI-2

Provide the following information on the contamination control program:

1. Provide additional justification for the proposed calculational approach to demonstrate compliance with radiation levels associated with average and maximum surface contamination levels of beta-gamma emitters.

Discussion

Note 6 to Table M-2 in NUREG-1556, Vol. 12, specifies that: "The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 millirad per hour (mrad/h) at 1 centimeter (cm) and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber."

The applicant provided a calculation (Equation 1) to demonstrate that the dose rate limits specified in Table M-2 would not be exceeded at the contamination levels associated with the limits specified in Table M-2. This calculational approach is based on a previous NRC staff finding for a uranium in situ recovery (ISR) facility (NRC, 2015).

$$\dot{D}_{\beta} = 3.6 \times 10^{-2} \times C_a \times \bar{E} \times \mu_{\beta,t} \times e^{(-\mu_{\beta,a} \times d)} \times e^{(-\mu_{\beta,t} \times 0.007)}$$

Equation 1. Dose rate to the basal cells of the skin (from Section 10.2.3.3 in RER, 2022a)

The NRC staff notes that the mixture of radionuclides expected in a uranium ISR facility will be different than what is expected at the applicant's facility. These differences are due to the different starting materials used in the respective industrial processes (i.e., pregnant uranium lixiviant versus ore containing uranium, thorium, and associated radioactive decay products.)

While the end result of the NRC staff's previous assessment (NRC, 2015) is correct, the explanation is not accurate. Specifically, assessing the dose rate from the most energetic beta-emitting radionuclide is not necessarily conservative. The NRC staff plotted Equation 1 for various maximum beta energies. Average energies were approximated by dividing the maximum energy by three (Shleien, et al, 1998). The NRC staff reasoned that this approximation was sufficient for trending purposes. The resulting dose rates are shown in Figure RAI-2-1.

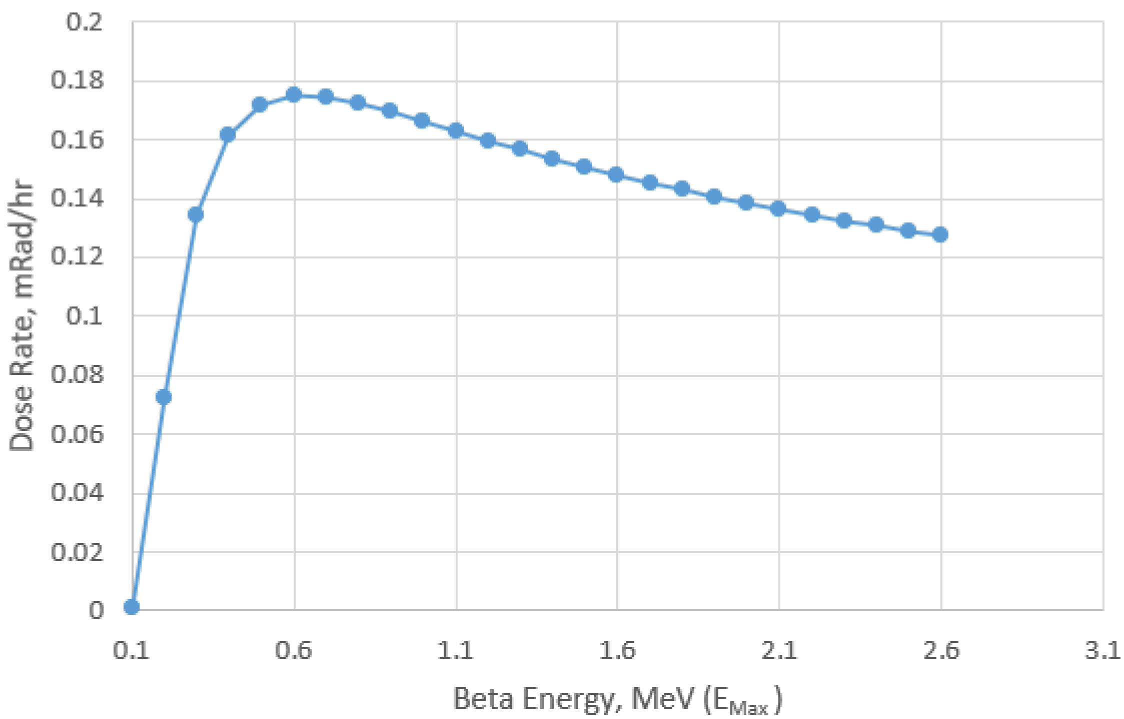

Figure RAI-2-1. Beta dose rate versus beta energy (5000 dpm/100 cm^2 surface contamination)

As Figure RAI-2-1 demonstrates, the dose rate is a maximum at around a maximum beta energy of 0.6 million electron volts (MeV) for the indicated contamination level and decreases with higher energies. This same trend is demonstrated in the applicant's calculations, shown in Table RAI-2-1.

Nuclide	C_a	E_{max}	$\bar{E}$	$\mu_{\beta,t}$	$\mu_{\beta,a}$	$e^{(-\mu_{\beta,t}\times 0.007)}$	$e^{(-\mu_{\beta,a}\times d)}$	$\dot{D}_\beta$
Pa-234m	0.83	2.28	0.82	6.146	5.160	0.958	0.994	0.14
Bi-214	0.83	3.27	1.27	3.725	3.094	0.974	0.996	0.14
Bi-212	0.83	2.25	0.83	6.276	5.272	0.957	0.994	0.15
Ac-228	0.83	2.08	0.75	6.985	5.881	0.952	0.993	0.15
Pa-234m	2.50	2.28	0.82	6.146	5.160	0.958	0.994	0.43
Bi-214	2.50	3.27	1.27	3.725	3.094	0.974	0.996	0.21
Bi-212	2.50	2.25	0.83	6.276	5.272	0.957	0.994	0.45
Ac-228	2.50	2.08	0.75	6.985	5.881	0.952	0.993	0.44

Ac-228 – actinium-228
Bi-212/214 – bismuth-212/bismuth-214
Pa-234m – protactinium-234 metastable

Table RAI-2-1. The applicant's estimated beta skin dose rate for most energetic emissions (excerpted from Table 16 of RER, 2022a)

According to the applicant, the calculations recorded in Table RAI-2-1 provide "…the results of conservative, empirical dose rate estimate for the two most energetic beta emitters in the thorium-232 and uranium-238 series for the Demonstration Project." However, using the applicant's results, the highest energy beta particle (Bismuth-214 (Bi-214), E_{Max}= 3.27 MeV) results in a lower dose in both surface contamination scenarios (i.e., C_a= 0.83 and C_a= 2.5).

This trend is particularly noticeable for the case of higher surface contamination (C_a= 2.5, the gray shaded area in Table RAI-2-1). In the case of higher surface contamination, the highest energy beta particle (Bi-214, E_{Max}= 3.27 MeV) results in a dose rate calculated by the applicant that is less than half of the dose rate from the lowest energy beta particle in Table RAI-2-1 (Actinium-228, E_{Max}= 2.08 MeV). Therefore, the applicant's approach does not appear to be conservative.

A reasonable calculational approach should consider all of the energy beta particles for the expected mixture of radionuclides at the facility and evaluated accordingly. In addition, Note 6 to Table M-2 in NUREG-1556, Vol. 12, includes gamma emitters. The applicant did not evaluate gamma emitters in addition to its dose rate estimate for beta emitters.

2. Provide additional discussion on the selection of the constant 2.71 vs. 3 for the static MDC equation.

Discussion

The applicant discussed its methodology for calculating static and scan MDC in Section 10.2.3 of the TR (RER, 2022a). The applicant proposed the following equation for calculating the static MDC:

$$MDC = \frac{2.71 + 3.29 \times \sqrt{R_b \times T_g \times \left(1 + \frac{T_g}{T_b}\right)}}{T_g \times \varepsilon_{total} \times \frac{probe\ area\ \mathrm{cm}^2}{100\ \mathrm{cm}^2}}$$

Equation 1. Static MDC (RER, 2022a)

According to the applicant (RER, 2022a), Equation 1 is derived from Equation 3.11 provided in NRC guidance document NUREG-1507, Revision 1 (NRC, 2020). Equation 3.11 in NUREG-1507 is provided as Equation 2 below:

$$MDC = \frac{3 + 3.29\sqrt{\mathrm{R}_B\,\mathrm{T}_{S+B}\left(1+\frac{T_{S+B}}{T_B}\right)}}{\mathrm{KT}_{S+B}}$$

Equation 2. Static MDC from Equation 3.11 in NUREG-1507 (NRC, 2020)

Equation 1 and Equation 2 are similar, except for the initial constants 2.71 (Equation 1) and 3 (Equation 2) in the top portion of the equations. The NRC staff recognizes that there are various formulas for determining MDC and that they yield similar results. However, each MDC formula has its own set of assumptions. The assumptions for Equation 3.11 in NUREG-1507, including the constant value of 3, can be found in the literature by various authors recommending that equation (Strom and Stansbury, 1992; NRC, 1986). The applicant did not discuss why the constant was revised from 3 to 2.71. Therefore, the NRC staff cannot determine that the applicant's proposed Equation 1 is correct.

In addition, the example MDC calculations in the applicant's Table 8 (RER, 2022a) should be updated as appropriate using the correct static MDC equation.

3. Provide additional discussion on the selection of an alpha-only scan MDC equation.

Discussion

The applicant proposed the following equation for calculating the scan MDC (variables defined in Table 7 of RER, 2022a):

$$MDC_{scan} = \frac{d' \times \sqrt{C_b} \times \frac{60}{i}}{\varepsilon_{sureyor} \times \varepsilon_{instrument} \times \varepsilon_{surface} \times \frac{probe\ area\ \text{cm}^2}{100\ \text{cm}^2}}$$

Equation 3. Scan MDC (RER, 2022a)

According to the applicant (RER, 2022a), Equation 3 is derived from Equation 6.4 provided in NUREG-1507.

The NRC staff finds that the applicant's proposed scan MDC formula is consistent with the guidance in NUREG-1507 for beta or alpha plus beta scans. However, as described in Section 6.2.4.2 of NUREG-1507, and previous NRC staff evaluation (NRC, 2015), Equation 3 is not the correct formula for alpha-only scans. The recommended formula for alpha-only scan MDC is:

$$\frac{\left[-\ln\left(1 - P(n \geq 1)\right)\right] \times (60/i)}{\varepsilon_i \times \varepsilon_s \times \frac{probe\ area}{100}}$$

Equation 4. Alpha-only scan MDC (NRC, 2020)

In addition, the example MDC calculations in the applicant's Table 8 (RER, 2022a) should be updated as appropriate using the correct alpha-only scan MDC equation.

4. Provide justification and additional discussion regarding the use of polonium-210 as the only calibration source for determining instrument efficiency for alpha particles.

Discussion

For the calibration of surface contamination measurement instruments, Appendix H to NUREG-1556 provides the following guidance:

> The efficiency of radiation survey meters must be determined by using radiation sources with similar energies and types of radiation that users of the radiation survey instrument intend to measure.

NUREG-1507 provides the following guidance on calibration sources:

> Depending on whether a single source or multisource calibration will be performed, different approaches are presented in national and international guidance with respect to calibrations and the determination of instrument efficiencies. For example, ANSI N323AB-2013 (American National Standard for Radiation Protection Instrumentation Test and Calibration, Portable Survey Instruments) indicates that "calibration should include adjustment and/or determination of readings of at least three points selected over the energy range appropriate to the needs of the user application," and that "single point calibrations are only valid for application to field measurement energies that are greater than the calibration energy."

The guidance in NUREG-1507 cited above, and similar guidance, was used in a previous NRC staff evaluation of counting efficiency (NRC, 2015).

Consistent with the guidance cited above and previous NRC staff findings (NRC, 2015), the NRC staff requested (NRC, 2022) information on how the applicant would determine instrument efficiency for each radionuclide. The applicant incorporated its response to the NRC staff's request in its TR (RER, 2022a).

The applicant discussed instrument efficiency in Section 10.2.3.2 of the TR (RER, 2022a). According to the applicant, it will determine instrument efficiency using the radioactive sources described in Table RAI-2-2. The applicant described the emission energies of the calibration sources (see Energy Notes in Table RAI-2-2) as "similar to those of the radionuclides of interest".

Source Type	Radionuclide	Energy Notes
Alpha	Polonium-210	5.3 MeV α
Beta	Technitium-99	0.11 MeV mean β^-

Table. RAI-2-2 Calibration sources [excerpted from Table 9 of the TR (RER, 2022a)]

The applicant provided an analysis of the alpha and beta particle emission energies of the thorium-232 (Th-232) and uranium-238 (U-238) radioactive decay series in Tables 10 – 13 in the TR (RER, 2022a). As part of the emission energy analysis, the applicant calculated a weighted average energy for each of the decay series. In other words, the applicant treated each series as a mixture and calculated a weighted average energy for the mixture. The applicant's analysis is demonstrated in Table RAI-2-3.

Isotope	Alpha energy (MeV)	Emission fraction	Weighted emission energy (MeV)
Uranium-238	4.15	21%	0.87
	4.20	79%	3.32
	Subtotal	100%	4.19
Uranium-234	4.77	71%	3.41
	4.72	28%	1.34
	Subtotal	100%	4.75
Thorium-230	4.69	76%	3.58
	4.62	23%	1.08
	Subtotal	100%	4.66
Radium-226	4.78	94%	4.49
	4.60	6%	0.28
	Subtotal	100%	4.77
Radon-222	5.49	100%	5.48
Polonium-218	6.00	100%	6.00
Polonium-214	7.69	100%	7.69
Polonium-210	5.30	100%	5.30
Uranium series		**8 alphas per decay**	**5.36 average energy**

Table RAI-2-3. The applicant's emission weighted alpha decay energies for the U-238 series [from Table 11 in the TR (RER, 2022a)]

The guidance in NUREG-1507 allows for weighted energy averaging on a radionuclide basis. The details are discussed in Appendix A to NUREG-1507 and demonstrated in Tables A-5 and A-6 of that appendix. The NRC staff did not find any guidance, nor did the applicant cite any guidance, that allows for the weighted energy averaging on a mixture basis.

As discussed above, the guidance in NUREG-1507 states the following in regard to calibration sources:

> …single point calibrations are only valid for application to field measurement energies that are greater than the calibration energy.

According to Table RAI-2-2., the applicant selected polonium-210 (Po-210) as its calibration source for determining instrument efficiency for alpha particles. Po-210 undergoes radioactive decay with a 5.3 MeV alpha particle. The NRC staff compared the Po-210 5.3 MeV alpha particle energy to the alpha particle energies in Table RAI 2-3 for the U-238 decay series. The NRC staff notes that the U-238, U-234, Th-230, and radium-226 (Ra-226) alpha particle energies are all below the Po-210 5.3 MeV alpha particle energy. Consistent with the guidance in NUREG-1507 (see the example in Table A-3), the instrument efficiency would be assigned zero for the U-238, U-234, Th-230, and Ra-226 alpha particles.

The applicant has the option of either choosing a lower energy calibration source or calculating a calibration curve with multiple alpha energy calibration sources. A typical calibration curve is demonstrated in Figure RAI-2-2. Actual alpha particle calibration curves for different alpha detection instruments are shown in Figures A-5 and A-11 of NUREG-1507 and have the same characteristics (i.e., higher instrument efficiency for higher energy alpha particles). The applicant did not address how this difference in energy response will be addressed in its calibration program.

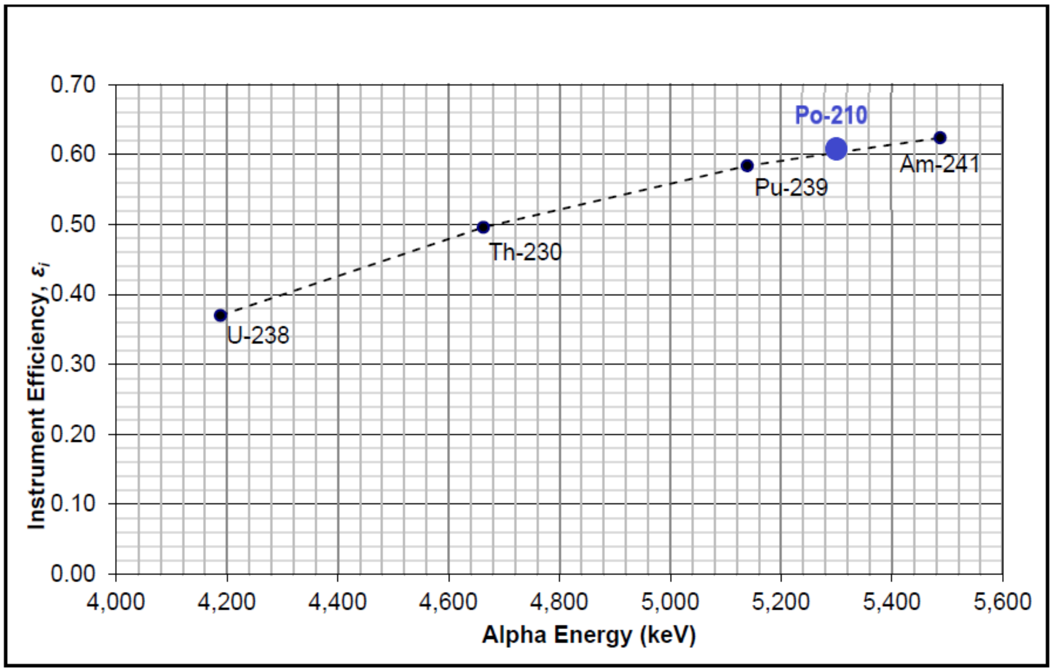

Figure RAI-2-2. Example alpha detector source calibration curve with the applicant's Po-210 calibration source added (adapted from Figure A-1 in NUREG-1507)

5. Reassess the example calculations demonstrating the radionuclide-weighted surface contamination detection capability (minimum detectable concentration (MDC)) for radiation survey instruments, including scan MDC for portable instruments, used for releasing equipment and materials for unrestricted use, personnel contamination monitoring, and other routine surveys.

Discussion

The applicant provided the results of example MDC calculations in Table 8. of the TR (RER, 2022a). These example MDC calculations incorporated instrument efficiencies based on a manufacturer-reported efficiency for a specific instrument based on the response to a plutonium-239 (Pu-239) alpha calibration source. The applicant justified the use of the manufacturer-reported efficiency by comparing the Pu-239 alpha energy to the weighted average energy for the Th-232 and U-238 radioactive decay series.

As discussed above, the NRC staff does not find the applicant's proposed averaging technique consistent with current guidance nor did the applicant provide justification for an alternate methodology. Although the energy of the Pu-239 alpha particle (5.139 MeV) is less than the Po-210 alpha particle (5.3 MeV), it is still higher than several of the alpha particles in the Th-232 and U-238 radioactive decay series. Therefore, the efficiency differences (e.g., Figure RAI-2-2) are still present and the guidance for assigning an instrument efficiency of zero to lower energy alpha particles applies.

Based on the discussion above, the NRC staff does not consider the assignment of a manufacturer-reported instrument efficiency, using a higher energy calibration source, to lower energy alpha particles to be conservative. The applicant should reassess the example calculations demonstrating the radionuclide-weighted surface contamination detection capability MDC for radiation survey instruments, including scan MDC for portable instruments, used for releasing equipment and materials for unrestricted use, personnel contamination monitoring, and other routine surveys.

This reassessment should address alpha and beta surveys. The reassessment should also incorporate any corrections to formulas for MDC and any modifications based on a review of radionuclide-specific energies and proposed calibration sources.

Lastly, this reassessment should discuss how the applicant will address situations where the calculated MDC is greater than the proposed acceptable surface contamination levels in Table 17 (as updated) of the TR (RER, 2022a). For example, the model 43-5 alpha scintillator has a calculated MDC of 721 dpm/100cm^2. The proposed acceptable surface contamination levels for alpha particles in Table 17 of the TR are 100 dpm/100cm^2 (average), 300 dpm/100cm^2 (maximum), and 20 dpm/100cm^2 (removable). At the calculated MDC, the 43-5 detector is not sensitive enough to be used for alpha surveys.

<u>Basis</u>

This information is needed to determine compliance with the following requirements:

- 10 CFR 1501(c) requires:

  The licensee shall ensure that instruments and equipment used for quantitative radiation measurements (e.g., dose rate and effluent monitoring) are calibrated periodically for the radiation measured.

- 10 CFR 40.32(c) requires:

  The applicant's proposed equipment, facilities and procedures are adequate to protect health and minimize danger to life or property.

<u>RAI-3</u>

Provide the following information on the radiological survey program:

1. Provide specific acceptable surface contamination levels (alpha and beta-gamma) for personnel monitoring.

<u>Discussion</u>

The applicant proposed acceptable levels of surface contamination at its facility and provided the values in Table RAI-3-1. The proposed levels of surface contamination will be used in the applicant’s radiation protection program for monitoring personnel, releasing material for unrestricted use, and surveys of the facility.

Use	Value	Average	Maximum	Removable
Personnel monitoring, surveys of unrestricted areas, and releasing equipment and items for unrestricted use	Alpha surface radioactivity (dpm 100 cm^{-2})	100	300	20
	Beta surface radioactivity (dpm 100 cm^{-2})	5,000	15,000	1,000
Surveys of restricted areas	Alpha surface radioactivity (dpm 100 cm^{-2})	220,000	660,000	44,000

Note: It will be conservatively assumed that all measured alpha radiation is attributable to radionuclides in the most restrictive category of Table M-2 of Appendix M to NUREG–1556, Volume 12 (NRC 2000).

dpm 100 cm^{-2} – decays per minute per 100 square centimeters

Table RAI-3-1. Proposed acceptable surface contamination levels [from Table 17. (RER, 2022a)]

However, the applicant did not specify how the surface contamination levels would be applied to personnel monitoring. It is typical to use removable surface contamination levels when monitoring personnel for contamination.

2. Provide justification for acceptable surface contamination levels for beta-gamma emitters.

Discussion

The NRC staff evaluated Table M-2 of Appendix M to NUREG-1556 (see Table RAI-3-2 below) against the applicant's statement that the proposed acceptable surface contamination levels in Table RAI-3-1 are the most restrictive surface contamination values for beta-gamma emitting nuclides.

Table M–2. Acceptable Surface Contamination Levels for Equipment

Nuclide[1]	Average[2,3,6]	Maximum[2,4,6]	Removable[2,5,6]
U-nat, U-235, U-238, and associated decay products	83.3 Bq/100 cm^2 [5,000 dpm/100 cm^2]	250 Bq/100 cm^2 [15,000 dpm/100 cm^2]	16.7 Bq/100 cm^2 [1,000 dpm/100 cm^2]
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	1.7 Bq/100 cm^2 [100 dpm/100 cm^2]	5.0 Bq/100 cm^2 [300 dpm/100 cm^2]	0.3 Bq/100 cm^2 [20 dpm/100 cm^2]
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	16.7 Bq/100 cm^2 [1,000 dpm/100 cm^2]	50.0 Bq/100 cm^2 [3,000 dpm/100 cm^2]	3.3 Bq/100 cm^2 [200 dpm/100 cm^2]

Table RAI-3-2. Acceptable surface contamination levels for equipment [excerpted from Table M-2 in NRC, 2018]

As Table RAI-3-2 indicates, there are lower values for surface contamination levels for thorium isotopes than the 5,000/15,000/1,000 dpm/100cm^2 proposed by the applicant in Table RAI-3-1. According to a previous NRC staff interpretation of thorium surface decontamination limits (NRC, 1992), the 1,000/3,000/200 dpm/100cm^2 surface contamination levels should apply to beta-gamma measurements.

3. Provide justification for acceptable surface contamination levels for surveys of restricted areas.

Discussion

The applicant provided its proposed acceptable surface contamination levels for restricted areas in Table RAI-3-1. According to the applicant, the proposed values are based on the guidance in Section 2.5 of RG 8.30 (NRC, 2002). The NRC staff notes that the guidance in Section 2.5 of RG 8.30 addresses uranium ore and uranium concentrates and does not evaluate all the materials that will be present at the applicant's facility.

The applicant proposed average, maximum, and removable surface contamination levels for restricted areas. However, the guidance in Section 2.5 of RG 8.30 provides a single value (220,000 dpm/100cm^2) to apply throughout a restricted area with no distinction between surface areas. The applicant did not discuss how it derived the proposed value for a maximum acceptable surface contamination level for restricted areas. Therefore, it is not clear what criteria the applicant used to derive a maximum value of 660,000 dpm/100cm^2 in Table RAI-3-1 for restricted areas.

The applicant did not provide a justification for applying the guidance in Section 2.5 of RG 8.30 to its facility, taking into account the expected radionuclide mixture (e.g., thorium isotopes). One of the technical basis documents (Wrixon, et al., 1979) for the recommended removable surface contamination levels for restricted areas in Section 2.5 of RG 8.30 analyzed surfaces contaminated with thorium isotopes. Moreover, this analysis used the same dosimetry that was used to derive the dose limits in 10 CFR Part 20 (i.e., ICRP-30).

The analysis by Wrixon, et al. (1979), concludes that surfaces contaminated with thorium isotopes should be controlled at one tenth the levels as natural uranium. This proposed reduction of surface contamination levels based on isotopes other than natural uranium is consistent with Table RAI-3-2 above and surface contamination limits in other NRC guidance and in use elsewhere (see, for example, Table RAI-3-3 from NRC, 2009). Regulatory Guide (RG) 8.23 was withdrawn in 2018, but the NRC staff finds the previous guidance in withdrawn RG 8.23 useful for comparison purposes.

Loose Surface Contamination Limits (dpm/100 cm²)_						
	RG 8.21	**RG 8.23**	**RG 8.24 (U only)**	**US Navy Ra Sites**	**DOE**	**RG 8.30**
Skin	ALARA (No detectable)	220 (Decon if detectable)	0	No detectable	No detectable (Decon if detectable)	1000
Personal Clothing	22	220	200	No detectable	No detectable	1000 (5000 for soles of shoes)
Restricted Area Surfaces	U-nat: 220,000, Ra-226: 22,000 <u>**NOTE:**</u> These values are for use with protective clothing	220	5000			220,000
Unrestricted Area Surfaces	U-nat: 22 Ra-226: 22	22	200			1000

Table RAI-3-3. Comparison of acceptable levels of surface contamination (adapted from NRC, 2009).

4. Provide additional information on the high-efficiency particulate air (HEPA) ventilation system associated with the main process facility.

<u>Discussion</u>

In response to a request for supplemental information (RSI) (NRC, 2022), the applicant identified that the high-efficiency particulate air (HEPA) ventilation associated with the main process facility would not have the potential for radiological releases and would not be monitored (RER, 2022b). RSI-5(3) (NRC, 2022) requested, in part, that the applicant should "…state the purpose and the associated acceptance criteria to accomplish this purpose for each proposed emission control device."

The purpose of the HEPA ventilation is unclear and therefore the NRC staff can't determine if monitoring effluent from the HEPA ventilation is appropriate.

The applicant should clarify the purpose of the HEPA ventilation system and justify why no radiological monitoring is warranted.

<u>Basis</u>

This information is needed to determine compliance with the following requirements:

- 10 CFR 20.1501(a) requires:

  Each licensee shall make or cause to be made, surveys of areas, including the subsurface, that —

  (1) May be necessary for the licensee to comply with the regulations in this part; and

(2) Are reasonable under the circumstances to evaluate—

(i) The magnitude and extent of radiation levels; and

(ii) Concentrations or quantities of residual radioactivity; and

(iii) The potential radiological hazards of the radiation levels and residual radioactivity detected.

RAI-4

Provide the following information on the baseline radiological conditions:

1. Provide data for the site-specific baseline gamma count rate data for the demonstration plant.

Discussion

In Section 3.12.2.3 of the ER (RER, 2022a), the applicant refers to a November 2021 site visit. According to the applicant, scoping gamma count rate measurements and a walkover scan were performed at the Demonstration Plant site during this site visit.

In its July 2022 request (NRC, 2022), the NRC staff requested data for all site-specific sampling performed for baseline radiological investigations for the demonstration plant. The NRC staff reviewed Table 3-32 and Appendix H of the ER, but could not find the data associated with the gamma count rate measurements or walkover scan performed during the November 2021 site visit.

Either provide the data associated with the gamma count rate measurements and walkover scan performed during the November 2021 site visit or direct NRC staff where this information exists.

2. Provide any analyses performed to compare or contrast the baseline radiological conditions of the Demonstration Project site to the Bear Lodge Project site.

Discussion

The applicant stated that “Results of this baseline radiological investigation are considered representative of the Demonstration Project site due to its physical proximity to the proposed Bear Lodge Project Upton Plant site…”. Please provide more detail on the analysis performed to compare or contrast the two sites.

Basis

This information is needed to determine compliance with the following requirement:

10 CFR 20.1402, “Radiological criteria for unrestricted use,” requires, in part –

> A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a TEDE to an average member of

the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).

Administrative issues:

- Appendix F to the ER, p. F-14, footnote 6: the applicant references Table 7 (Dose conversion factors), it appears this reference should be Table 10.
- In Table 6 of the TR, the applicant defines the acronym NVLAP as “National Voluntary Laboratory Accreditation **Provider**” (emphasis added). This appears to be a typographical error as it should be defined as “National Voluntary Laboratory Accreditation **Program**” (emphasis added).

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