## ESTIMATED RADON ATTENUATION

FROM

RECLAIMED TAILINGS

AT THE

MORTON RANCH PROJECT

January 4, 1982

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The attenuation of radon from reclaimed tailings, outlined elsewhere in this response (Volume II, Fourth Edition) Permit 230C Reclamation Plans for Morton Ranch Operations, January 31, 1979, Section 9 Mill Reclamation) is based on estimates because site-specific data was not available. While certain site-specific data is not yet available, it is possible at this time to make a better estimate.

The following calculation, using currently available data and the radon attenuation formulae presented in Appendix P of the Final Generic Environmental Impact Statement on Uranium Milling (NUREG-0706 Volume III), shows that the proposed tailings disposal area reclamation plans for the Morton Ranch Project meet the required reduction of radon emanation to less than 2 pCi/m<sup>2</sup> sec.

I. Proposed Tailings Reclamation Plan.

The tailings reclamation plan for the Morton Ranch Project proposes that the tailings be disposed of in mined-out pits. When tailings disposal is completed the tailings disposal area will be reclaimed as follows:

- A: A first layer composed of 8 feet (244 cm) of unclassified overburden
  - B. A second layer composed of 2 feet 6 inches (76 cm) of compacted clay.
  - C. A third layer composed of 4 feet (122 cm) of compacted overburden.
  - D. A final layer composed of a minimum of 8 inches (20 cm) of topsoil.

Compaction of the clay and overburden will be by the ASTM 1557 Method to 90% density.

II. Site-Specific Data.

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- A. The moisture content of the tailings, after dewatering, is 15% by weight.
- B. The moisture content of the overburden and clay is 11% by weight.
- C. The average ore grade is 0.080% U<sub>3</sub>0<sub>8</sub> which gives a Radium 226 concentration in the tailings of 224 pCi/g.

III. Assumed Data.

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- A. The porosity of the tailings is 0.25 (from the GEIS).
- B. The porosity of all cover layers is 0.3 (from the GEIS)
- C. The density of the tailings solids is 1.6  $g/cm^3$  (from the GEIS).
- D. The Emanating Power of the tailings is 0.2 (from the GEIS).
- IV. Equations and Calculations.
  - A. Calculation of D/P for each layer.

D/P = 0.106 exp (-0.261M)
where D = Bulk Diffusion Coefficient
 P = Porosity
 M = Weight percentage of moisture

1. Tailings

 $D_{P_{e}} = 0.106 \exp(-0.261(15)) = 0.0021$ 

2. Overburden

 $D_1/P_1 = 0.106 \exp(-0.261(11)) = 0.0060$ 

3. Clay

 $D_2/P_2 = 0.106 \exp(-0.261(11)) = 0.0060$ 

B. Calculation of Base Tailings Radon Flux.

 $J_{o} = [Ra] \rho E (\lambda D_{o}/P_{o})^{\frac{1}{2}} \times 10^{4}$ where [Ra] = concentration of Ra-226 in tailings solids (pCi/g) = density of tailings solids  $(q/cm^3)$ Ø = Emanating power of tailings E (dimensionless) = Effective Bulk Diffusion Coefficient D for radon in the tailings (cm<sup>2</sup>/sec) Po = Porosity of the tailings solids (dimensionless) = The decay constant for Rn-222 (sec<sup>-1</sup>) λ Calculation using the site-specific and

 Calculation using the site-specific and assumed data.

$$J_{0} = (224)(1.6)(0.2)((2.1E-6)(0.0021))^{2}(1E+4)$$
  
$$J_{0} = 48 \text{ pCi/m}^{2} \text{ sec}$$

C. Calculation of cover thickness and average D/P.

Because the moisture content of all cover layers (with the exception of topsoil) is the same, the cover layers may be considered to be a single layer. The topsoil layer is excluded from this calculation because the moisture varies greatly with weather conditions.

1. Total Depth of Cover.

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1st overburden layer 244cm (8 feet) Clay layer 76cm (2 feet 6 inches) 2nd overburden layer 122cm (4 feet) Total Depth 422cm (14 feet 6 inches) Therefore  $D_1/P_1 = 0.0060$  for the entire cover layer.

D. Calculation of Attenuation.

$$J_{1} = J_{0}r \exp(-D_{1}x_{1})$$
where  $b_{1} = (\lambda P_{1}/D_{1})^{\frac{1}{2}} = ((2.1E-6)(166.67))^{\frac{1}{2}} = 0.0187$ 
 $x_{1}^{1} = 422$ 
 $J_{1}^{0} = 48$ 
 $f^{0} = \frac{2}{(1+\frac{O}{P_{1}} \left[\frac{D_{0}/P_{0}}{D_{1}/P_{1}}\right]^{\frac{1}{2}}) + (1-\frac{P_{0}}{P_{1}} \left[\frac{D_{0}/P_{0}}{D_{1}/P_{1}}\right]^{\frac{1}{2}}) \exp(-26x_{1})$ 
 $= 1.4930$ 

 $J_{1} = (48) (1.4930) \exp ((-0.0187) (422)) \\= 0.03 \text{ pCi/m}^{2} \text{ sec}$ 

The attenuation produced after reclamation of the proposed in-pit tailings disposal area at the Morton Ranch Project, therefore, exceeds the required reduction of radon flux to 2pCi/m<sup>2</sup> sec

Letter from the State of Wyoming Department of Environmental Quality Land Quality Division August 18, 1981

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ED HERSCHLER GOVERNOR

Department of Environmental Quality

LAT'D QUALITY DIVISION

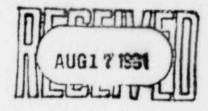
401 WEST 19TH STREET

TELEPHONE 307-777-7756

CHEYENNE, WYOMING 82002

August 18, 1981

C.E. Wolff Resident Manager - Morton Ranch Silver King Mines, Inc. PO Box 560 Casper, WY 82602-0560



RE: Morton Ranch Revised Bonding Calculations (Permit No. 230C)

Dear Mr. Wolff:

The bond revisions proposed by Silver King Mines, Inc. on August 18, 1981 which incorporate additional disturbances within the operation, are acceptable. The bond of \$5,225,140.00 as proposed in the revisions is adequate under the provisions of W.S. 35-11-411(d).

The bond for Silver King Mines, Inc. must be submitted with the permit transfer application from UNC Mining and Mining Services.

Sincerely,

Philip R. Ogle District I Environmental Compliance Specialist

PRO:vjm