ESTIMATED RADON ATTENUATION

FROM

RECLAIMED TAILINGS

AT THE

MORTON RANCH PROJECT

January 4, 1982

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^2 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.

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_3O_8 which gives a Radium 226 concentration in the tailings of 224 pCi/g.

III. Assumed Data.

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

$D_o/P_o = 0.106 \exp(-0.261(15)) = 0.0021$

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)
ρ = density of tailings solids (g/cm^3)
E = Emanating power of tailings (dimensionless)
D_o = Effective Bulk Diffusion Coefficient for radon in the tailings (cm^2/sec)
P_o = Porosity of the tailings solids (dimensionless)
λ = The decay constant for Rn-222 (sec^{-1})

1. Calculation using the site-specific and assumed data.

$J_o = (224)(1.6)(0.2)((2.1E\text{-}6)(0.0021))^{\frac{1}{2}}(1E+4)$

$J_o = 48\ pCi/m^2\ sec$

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.

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.

$$J_1 = J_o f \exp(-b_1 x_1)$$

where $b_1 = (\lambda P_1/D_1)^{\frac{1}{2}} = ((2.1E\text{-}6)(166.67))^{\frac{1}{2}} = 0.0187$

$x_1 = 422$

$J_1^o = 48$

$$f^o = \frac{2}{\left(1+\frac{P_o}{P_1}\left[\frac{D_o/P_o}{D_1/P_1}\right]^{\frac{1}{2}}\right)+\left(1-\frac{P_o}{P_1}\left[\frac{D_o/P_o}{D_1/P_1}\right]^{\frac{1}{2}}\right)\exp(-26x_1)}$$

$$= 1.4930$$

$$J_1 = (48)(1.4930)\exp((-0.0187)(422))$$
$$= 0.03\ pCi/m^2\ sec$$

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 $2pCi/m^2$ sec

Letter from the State of Wyoming

Department of Environmental Quality

Land Quality Division

August 18, 1981

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Department of Environmental Quality

LAND 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