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June 16, 1995

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U.S. Nuclear Regulatory Commission
Division of Waste Management, MS5E2
Attn. Mr. Joseph J. Holonich, Chief
High Level Waste and Uranium
Recovery Projects Branch
11555 Rockville Pike
Rockville, MD 20850

Re: Docket No. 40-8903
License No. SUA-1471
Final Radon Barrier Design for the Large Tailings Facility

Dear Mr. Holonich:

Homestake Mining Company completed the final radon barrier design document. Three copies are enclosed for your review. During our design we addressed radon flux, freeze/thaw, root penetration and infiltration. Although infiltration is not an NRC issue for this site, it was included in our design. The document also notes conservatism used in the design process and how it effects the radon barrier design.

During your review should you have any questions please contact me at (505) 287-4456.

Sincerely,

HOMESTAKE MINING COMPANY OF CALIFORNIA

F. R. Craft
Resident Manager

FRC:jg
Enclosures (3)

xc: H. Barnes w/1 enclosure
S. Collins, NRC w/1 enclosure

Final Radon Barrier Design for the Large Tailings Pile
Homestake Mining Company of California

Grants Operations

License No. SUA-1471

June 1995

Prepared for:

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Grants Operations
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Prepared By:

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Final Radon Barrier Design for the Large Tailings Pile
Homestake Mining Company of California

ES.1 Executive Summary

Homestake Mining Company of California (HMC), owner of the Grants Uranium Mill, is in the final stages of reclamation of the Large Tailings Pile at the site located near Grants, New Mexico. This work has been conducted according to the NRC-approved Reclamation Plan (HMC, 1993). The final tailings configuration has been achieved and the placement of interim cover on the top of the pile and radon barrier material on the side slopes began early in 1994. Cleanup of windblown material, mill yard surface soils, and other off-pile miscellaneous contaminated soils has continued since early summer of 1994 with these materials being placed on the East Side Slope of the pile and on areas near the north and south toe of the pile (aprons). The combination of off-pile contaminated material with the Large Tailings Pile has been completed.

An open design issue remains regarding the quality and quantity of radon barrier that is to be placed on the pile to limit the radon flux to the 10 CFR Part 40, Appendix A limit of 20 pCi/m²s under long-term moisture conditions. In order to resolve this last remaining issue, HMC developed and implemented a work plan to collect all data necessary for doing the final radon barrier design. An extensive tailings coring program was undertaken to accurately characterize the Ra-226 concentrations and the moisture in the tailings down to a depth of 10 feet in order to define the source term. Previous measurements of the tailings emanating fraction and diffusion coefficients by Rogers and Associates were accepted for use in the final design.

A borrow source study was done that identified large quantities of available radon barrier that would be used to complete the placement of radon barrier on the pile. This new borrow source is referred to as the North Borrow Area and will be used for all subsequent radon barrier placement on the Large Tailings Pile. Samples were taken of the North Borrow Area material, the interim cover material, and the existing radon barrier material. These samples were analyzed in the laboratory for clay and organic content which led to an accurate prediction of long-term moisture using a correlation developed by Rawls and Brakensiek (NRC, 1989). Conservative long-term moisture contents were assigned to the interim cover, existing radon barrier, and radon barrier material from the North Borrow Area. Samples of the existing radon barrier and the radon barrier from the North Borrow Area were taken and sent to an off-site laboratory for radon diffusion coefficient measurements made at the conservatively assigned long-term moisture content.

In order to assure that the parameters chosen for the model used to calculate the required thickness of the radon barrier were appropriately chosen, a radon flux study was conducted to compare the measured flux from various cover systems to that calculated by the model. The tailings sands on the side slopes had been configured and had reached the anticipated long-term moisture conditions. Flux measurements were made at each tailings coring location and at the base of three radon barrier test pads to be constructed on the North Side Slope. The correlation between the measured flux from the tailings sands and that calculated using measured parameters was excellent, indicating that the calculational model accurately predicts the flux from the tailings sands using the data collected to conduct the final radon barrier design.

Three radon barrier test pads of 1-ft, 2-ft, and 3-ft thickness were constructed on the North Side Slope and allowed to equilibrate before making radon flux measurements on top of the pads. Moisture and density measurements were made on each 6-inch lift for input into the model. Using diffusion coefficients calculated by the code for the corresponding moisture, density, and specific gravity, the measured flux was again found to agree well with the calculated flux.

The measured radon diffusion coefficients at the long-term moisture for the existing radon barrier material and for the North Borrow Area material were within narrow ranges and agree well with the values calculated by an empirical correlation between diffusion coefficient and the parameters, porosity and moisture saturation. Radon diffusion coefficients were made on a set of ten samples for three different moisture and compaction conditions. The diffusion coefficients for the set of measurements made at one moisture and compaction condition was adjusted to that of another set of conditions and compared to the measured values. The results show that the average of the results agreed to within ten percent which is normally within the precision of the measurements. Therefore it was concluded that no accuracy was lost in making this adjustment.

The radon flux for the side slopes was calculated by breaking the side slopes into three different areas, the South and West Side Slope, the North Side Slope, and the East Side Slope. The South, West, and North Side Slopes currently have 3.8 ft of radon barrier (existing radon barrier). An interim cover (top of pile) and a temporary cover (East Side Slope) currently exist to eliminate the wind erosion of contaminated materials.

Measured parameters for the radon barrier and source terms for the respective areas were used to prepare a design that would limit the average flux to 20 pCi/m^2s. The proposed additional radon barrier that will be applied to the East Side Slope, the top of pile, and the aprons will result in an area-weighted-average flux for the Large Tailings Pile, under long-term moisture conditions, of 19.4 pCi/m^2s.

Several conservative assumptions were used in developing the cover design. First, the radon flux from the top of the pile was calculated assuming that the top 20 feet had diffusion properties similar to tailings sands at a long-term moisture of eight percent. The actual Ra-226 concentration was measured and used in the calculations for the top ten feet of the pile. However, the use of the eight percent long-term moisture and the diffusion coefficient for sands is highly conservative since it is known that a slimes-sand mixture and slimes lenses exist beneath the first few feet of the top of the pile surface for a large portion of the top surface. Slimes tailings act to limit the diffusion of radon through these high moisture materials to a small fraction of the flux that exist for tailings sands. Secondly, the higher clay content radon barrier materials were assumed to be degraded from the freeze-thaw cycle in the top 24 inches of the pile for approximately 60 percent of the pile area. While it is unlikely that these materials will experience frost-heave, this provision in included in the design for conservatism. Lastly, parameters necessary for predicting long-term moistures for materials and measured diffusion coefficients at those moistures were not available for the interim cover, temporary cover, and off-pile contaminated material. In those situations, a very conservative long-term moisture of eight percent was assumed and the diffusion coefficient was calculated. This along with using a Ra-226 source term for the top 19-20 feet in the radon flux model added to the conservatism of the model. Eliminating the conservatism in the long-term moisture for the top 18 inches of cover for the top of the pile and the aprons was shown to reduce the area-weighted-average flux to 18.2 pCi/m^2s. Similar conservatisms have been assumed in the selection of several other parameters.

HMC has expended considerable effort in demonstrating that the method for designing the radon barrier accurately predicts the radon flux for the tailings and materials used at the Grants Site. This was done by measuring the parameters necessary to model the flux at the current moisture and other physical conditions of the tailings and radon barrier test pads. A good agreement between calculations and measured flux was observed which assured HMC that additional conservatism was unnecessary to allow for any inaccuracies of the mathematical model.