HOMESTAKE
Grants Reclamation Project

Homestake Mining Company of California

Thomas Wohlford
Closure Manager

August 20, 2018

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Mr. Jeffrey Whited, Project Manager
Reactor Decommissioning Branch (Mailstop T-8F5)
Division of Waste Management and Environmental Protection
Office of Federal and State Materials and Environmental Management Program
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Re: Reply to "Request for Additional Information – Compliance of Homestake Grants, New Mexico Site with 10 CFR 20.1301 and 10 CFR 20.1302." Docket No. 040-08903, License No. SUA-1471

Dear Mr. Whited:

Homestake Mining Company of California (HMC) has prepared this response to a Request for Additional Information (RAI) by the Nuclear Regulatory Commission (NRC) (letter dated July 31, 2018) concerning "Compliance of the Homestake Grants, New Mexico Site with 10 CFR 20.1301 and 10 CFR 20.1302" (ML18159A366). The basis for this RAI stems from an earlier RAI from NRC dated December 16, 2015 (ML15264B052) concerning public dose estimation in the 2014 2nd Half Semiannual Environmental Monitoring Report (ML15068A205). By letter dated January 19, 2016, HMC responded to the original RAI (ML16033A407). NRC indicates that completion of the review of HMC's response to the original RAI, and in general HMC's method for estimation of public dose from radon in semiannual reports, requires additional information from HMC. This letter responds to the additional RAI dated July 31, 2018.

Should you have any questions or comments regarding the attached RAI responses, please contact me at twohlford@homestakeminingcoca.com or (505) 290-2187.

Sincerely,

Thomas P. Wohlford

Thomas P. Wohlford
Closure Manager
Homestake Mining Company, Grants, New Mexico

cc: M. McCarthy, Barrick, Toronto, Ontario (electronic copy)
C. Burton, Barrick, San Francisco, California (electronic copy)
G. George, Davis Wright Tremain, San Francisco, California (electronic copy)
R. Whicker, ERG, Albuquerque, New Mexico (electronic copy)
G. Hoffman, Hydro-Engineering, Casper, Wyoming (electronic copy)

NMSS01

Preface

The following presents HMC responses to RAIs from NRC concerning "Compliance of the Homestake Grants, New Mexico Site with 10 CFR 20.1301 and 10 CFR 20.1302" (ML18159A366). Each RAI from NRC is shown in italics, followed by HMC's response.

RAI #1

The NRC staff requests that HMC no longer report comparisons of measured concentrations in air at perimeter monitoring stations to effluent concentration values from 10 CFR Part 20 Appendix B, Table 2 and use the dose method consistent with 10 CFR 20.1301 and 10 CFR 20.1302.

HMC Response

HMC has identified that since the RAI-related commitment by HMC in the January 19, 2016 response submittal to "no longer report comparisons of measured radon concentrations in air at perimeter monitoring stations to ECs in Appendix B, Table 2 of 10 CFR 20" (ML16033A407), the table of semiannual radon values provided in Semiannual Environmental Monitoring Reports (routinely provided in Attachment 2) has inadvertently continued to include a column with fractional comparisons to 10 CFR 20 Appendix B Effluent Concentrations (ECs) for radon without decay products present. In response to RAI #1 as shown above, the template table used to compile radon monitoring data for semiannual reporting has been revised to eliminate the subject table column and associated footnote. This corrective action will prevent any comparisons of this nature in future Semiannual Environmental Monitoring Reports as required by 10 CFR 40.65 (referred to herein as "40.65 Reports").

RAI #2

The NRC staff requests that HMC commit to computing the dose limit where the dose conversion factor is based on the air radon concentration of 10 CFR Part 20 Appendix B, Table 2, with daughters and appropriate equilibrium ratios or provide justification as to why radon concentration without daughters is acceptable. Additionally, it is requested that HMC provide equation(s), equilibrium ratios, occupancy factors, and any other factors it considers appropriate to the NRC staff to demonstrate compliance with the public dose limits and provide any justifications for any changes for future submittals of environmental monitoring reports. These parameters, along with calculated radon release rates from the tailings, can be used in the MILDOS program to compute radiation doses to members of the public.

HMC Response

HMC does not assume that decay products of radon gas are absent when estimating public dose from radon. As noted in response to original RAIs on this issue in the January 19, 2016 HMC submittal (ML16033A407), the comparison of radon-222 concentrations in air to Appendix B, Table 2 ECs "...was done simply to compare them to historic data and to be consistent with the recommendations regarding the reporting of data in Table 3 of U.S. NRC Regulatory Guide 4.14 (NRC, 1980)...". As noted in response to RAI #1 above, the table of radon monitoring results provided in Attachment 2 of semiannual 40.65 Reports has been revised to eliminate such comparisons.

Based on this RAI, along with RAI #4, HMC has re-evaluated the dose-based method and associated parameters that have historically been used to demonstrate compliance with the annual public dose limits given in 10 CFR 20.1301. In accordance with RAI #2 specifications, annual estimation of public dose associated with radon in the 2nd half 40.65 Report will be based on modeling with the MILDOS-AREA (MILDOS) code (ANL, 2016), and the radon equilibrium ratio and occupancy factor to be used in this modeling will be revised as described below. The source term for MILDOS modeling will be based on annual radon flux measurements for the Large and Small Tailings Piles (LTP and STP).[1] The technical and regulatory basis for radon selection of equilibrium ratios and occupancy factors to be used in future annual modeling is described below.

Radon Equilibrium Ratio

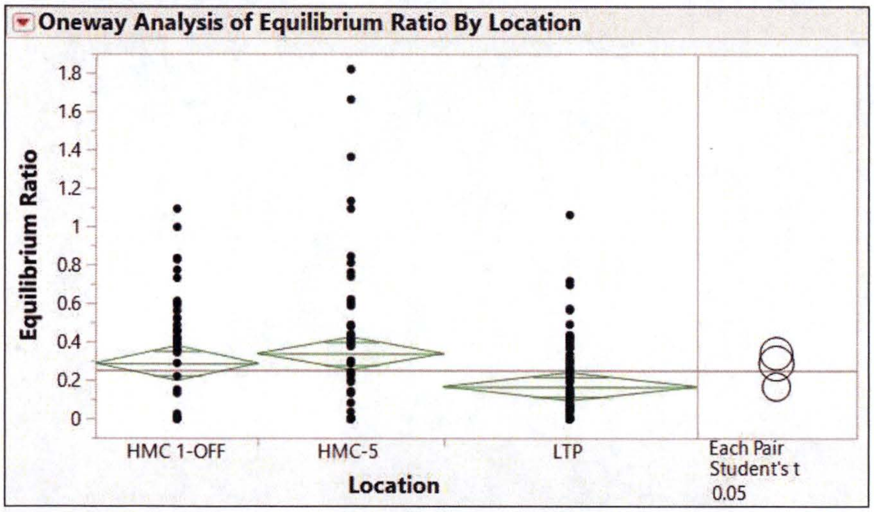
Interim Staff Guidance (ISG) from the NRC concerning "*Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301*" (NRC, 2014) was reviewed for guidance on selection of an appropriate equilibrium ratio to use in annual MILDOS modeling to demonstrate compliance with 10 CFR 20.1301. The ISG provides the following relevant information:

- The most simplistic and conservative approach to determining the equilibrium ratio is to assume that radon progeny are present at 100% equilibrium with radon gas (i.e. an equilibrium ratio of unity). However, the licensee does not need to assume 100% equilibrium.
- If direct and representative measurements of radon progeny are not practicable, estimates of average radon progeny levels, expressed in units of radon equilibrium equivalent concentration (EEC), can be estimated based on measurements of long-term average radon gas concentrations and conservative assumptions regarding the radon progeny/gas equilibrium ratio as noted below.
- Indoor exposures: For indoor exposures, it is generally acceptable to NRC staff to assume an equilibrium ratio of 0.5.
- Outdoor exposures: For outdoor exposures, it is generally acceptable to NRC staff to assume an equilibrium ratio of 0.7.
- Combined Indoor/Outdoor residential exposures: For combined indoor and outdoor exposures, and assuming the majority of time is spent indoors under a residential scenario at locations relatively close to the facility, it is generally acceptable to NRC staff to assume an equilibrium ratio of 0.5.
- Equilibrium factor by measurement: Direct, site-specific measurements of radon gas and radon progeny EEC can be made at each receptor location of interest (e.g. nearest public residence), with the results used to calculate the equilibrium ratio at each location. Due to temporal and spatial variability in both radon gas and progeny levels, site-specific measurements of paired radon gas and radon progeny levels at each location should be made at the same time. This method may be conservative as such measurements will reflect the equilibrium ratio for radon from all sources (including background), not just facility-related radon.

In the Basis for Request provided by NRC for RAI #4, the NRC cites an equilibrium ratio of 0.34 at air monitoring station HMC-5 based on calculations using MILDOS modeling output data provided by HMC. HMC recently conducted a study with direct measurements of radon equilibrium ratios at select

[1] Note in the response to RAI #3 that releases from other potential source terms associated with water treatment systems (RO plant and ponds) that the LTP and STP are the only significant sources of effluent radon releases at the HMC Grants site.

locations, including the LTP, HMC-5, and HMC-1OFF (an upgradient air monitoring location assumed representative of background conditions along the floor of the San Mateo Creek drainage). Respective measurements included short-term grab sampling for radon gas (with a Durridge RAD7 instrument) and measurement of radon progeny based on air grab sampling and analysis of sample filters using the modified Kusnetz method. These paired measurements, co-located in time and space, were scheduled twice per day (morning and afternoon) three days per week over a study period of approximately 4 months. Details of the methods and sampling design were provided in an associated Study Plan (ERG, 2017). Interim study results were provided to NRC for review during the March 2018 Site Inspection (ERG, 2018). Complete study results are currently being compiled in a final report that will be available for NRC review at the September 2018 Site inspection (as requested by NRC at the March 2018 inspection). The distribution of calculated equilibrium ratio results reveals a mean value of 0.34 at HMC-5, coincidentally matching the value calculated by NRC for this location (see NRC Basis for RAI #4). As might be expected, measured equilibrium ratios on top of the LTP are statistically lower than other locations as radon emissions from the LTP are "fresh", consisting only of radon gas when first released from the soil surface.



Parametric Comparisons by T-test

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
HMC-5	LTP	0.1731004	0.0566086	0.061427	0.2847739	0.0026*
HMC 1-OFF	LTP	0.1222980	0.0591087	0.005692	0.2389036	0.0399*
HMC-5	HMC 1-OFF	0.0508024	0.0630712	-0.073620	0.1752250	0.4216

Nonparametric Comparisons by Wilcoxon Method

q*	Alpha
1.95996	0.05

Level	- Level	Score Mean Difference	Std Err Dif	Z	p-Value
HMC-5	HMC 1-OFF	-0.5301	5.871764	-0.09028	0.9281
LTP	HMC-5	-8.0985	6.727344	-1.20382	0.2287
LTP	HMC 1-OFF	-10.1140	6.632661	-1.52487	0.1273

Because measured equilibrium ratios vary considerably (temporally and spatially) and the Study period was limited (about 4 months), and since there is uncertainty in both direct measurement and modeling of equilibrium ratios, HMC proposes to use conservative generic values specified by NRC to be generally acceptable as noted above. The nearest member of the public represents a residential scenario with combined indoor/outdoor exposures, and a radon equilibrium ratio of 0.5 will be used in MILDOS modeling for future estimation of public dose from radon gas/progeny. Results will be reported annually in 2nd half semiannual 40.65 reports.

Occupancy Factors

As indicated in the Basis of Request for RAI #4, and consistent with NRC guidance provided in the ISG (NRC, 2014), HMC will conservatively assume an occupancy factor of unity (1) for MILDOS modeling to determine annual dose from radon gas/progeny as part of annual demonstration of compliance with public dose limits specified in 10 CFR 20.1301. Because of this assumption, along with the assumed radon equilibrium ratio of 0.5 for combined indoor/outdoor exposures as noted above, partitioning of exposures between indoor and outdoor occupancy is not necessary as the resulting public dose estimate would be identical to that generated for 100% outdoor occupancy and an equilibrium ratio of 0.5 (the latter assumption will be used to simplify parameters for future MILDOS modeling).

REFERENCES

Argonne National Laboratory (ANL). 2016. MILDOS-AREA – A computer program for estimating the radiological impacts from airborne emissions from uranium milling facilities. Version 4.01. September 2016.

Environmental Restoration Group, Inc. (ERG). 2017. Occupational radiation exposure study for the HMC Grants Reclamation Project. Internal Technical Memorandum to the Closure Manager, December 4, 2017.

Environmental Restoration Group, Inc. (ERG). 2018. Occupational Radiation Exposures Study – Interim Data Transmittal. March 24, 2018.

U.S. Nuclear Regulatory Commission (NRC). 2014. Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301. FSME Interim Staff Guidance FSME-ISG-01. March 2014.

RAI #3

The NRC staff requests that HMC demonstrate, preferably by measurements from the main release point of the water treatment system, and not at some distant environmental monitoring station receptor point that the radon releases are insignificant.

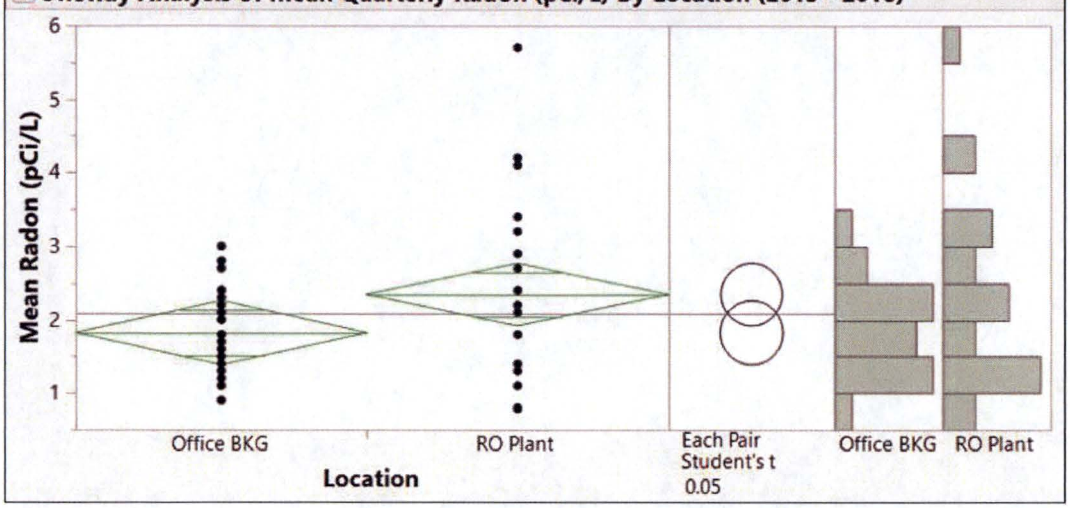
HMC Response

As indicated in the 1st half 40.65 report for 2018, estimated annual releases of radon gas from the LTP and STP are 694 and 88.7 Ci, for a total of 783 Ci. For the RO plant, an estimate of the release of radon to the outside atmosphere due to groundwater treatment in the RO building can be calculated as follows:

$$\text{Rn-222 release (Ci/yr)} = (\text{net Rn-222, Ci/L})(\text{ventilation rate, L/yr})$$

The total annualized ventilation rate for the RO building is estimated to be 1.12E+12 L/yr (based on summation of flow rates for all exhaust fans). A statistical comparison of quarterly average radon gas concentrations measured in the main office building and in the RO building over the past 5 years is shown in the below figure. The main office is considered representative of background indoor radon levels for onsite buildings. The net difference in these average values (0.52 pCi/L) is assumed due to RO treatment of groundwater containing 11e.(2) byproduct material. Based on these parameters, the calculated release of radon gas from the RO plant is 0.6 Ci/yr, less than 0.1% of total radon effluent releases from the tailings piles in 2018.

Oneway Analysis of Mean Quarterly Radon (pCi/L) By Location (2013 - 2018)



t Test

RO Plant-Office BKG
Assuming equal variances

Difference	0.5207	t Ratio	1.726906
Std Err Dif	0.3015	DF	41
Upper CL Dif	1.1297	Prob > |t|	0.0917
Lower CL Dif	-0.0882	Prob > t	0.0459*
Confidence	0.95	Prob < t	0.9541

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
Office BKG	21	1.82381	0.21569	1.3882	2.2594
RO Plant	22	2.34455	0.21073	1.9190	2.7701

Nonparametric Wilcoxon Test

q*	Alpha
1.95996	0.05

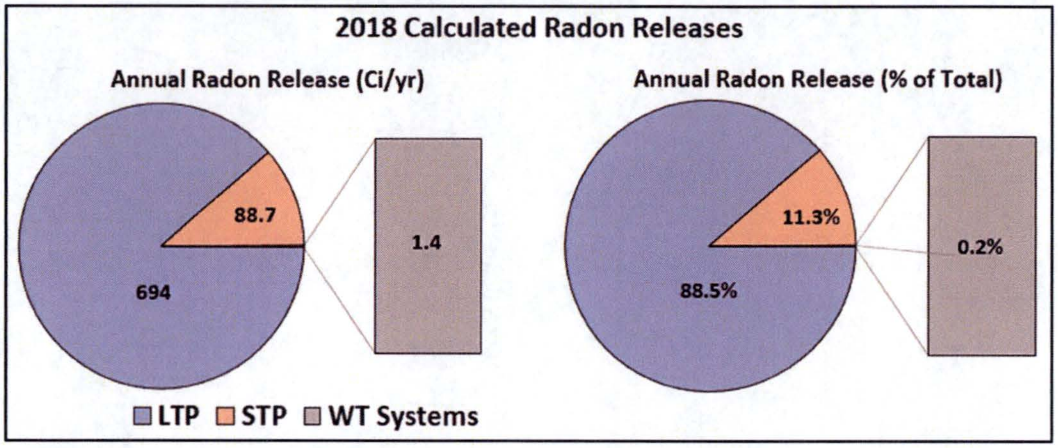
Level	- Level	Score Mean Difference	Std Err Dif	Z	p-Value
RO Plant	Office BKG	4.281385	3.823941	1.119626	0.2629

With respect to the ponds that receive waste streams from the RO water treatment system, radon releases to the atmosphere can be estimated based on previous studies on this issue as presented at annual Uranium Recovery Workshops hosted by the NRC and National Mining Association (NMA). One study (Baker, 2010) specifically involved determination of radon flux from Evaporation Ponds 1 and 2 at the HMC Grants site as a function of Ra-226 concentration in pond water. This study included both theoretical modeling of transport of a gas across an air-water interface using a stagnant film model (Schwarzenbach, 2002), and direct measurements of radon flux on Evaporation Ponds 1 and 2 using charcoal canisters consistent with EPA Method 115 specifications. In this case, the canisters were suspended above the air/water interface with a special floating foam platform, and a study conclusion was that modeled results (1.6 pCi/m^2-s) compared well with measured results (1.13 pCi/m^2-s).

A comparison of similar factors for release of radon from water containing Ra-226 based on results of additional studies (as presented at NRC/NMA annual workshops) is as follows:

- Chambers (2009): 0.001 pCi/m^2-s Rn-222 per pCi/L Ra-226 (for 50-cm turbulent mixing layer)
- Baker (2010): 0.01 pCi/m^2-s Rn-222 per pCi/L Ra-226 (site-specific modeling and measurements)
- Paulson (2012): 0.0004 pCi/m^2-s Rn-222 per pCi/L Ra-226 (controlled bench tests)

The site-specific release factor modeled by Baker (2010) (0.01 pCi/m^2-s Rn-222 per pCi/L Ra-226) is conservative, one to two orders of magnitude higher than radon release factors reported in the other studies referenced above. Using the conservative site-specific radon release factor from Baker (2010), along with measured Ra-226 concentrations in water contained in Evaporation Ponds 1-3 and the East/West Collection ponds in 2018, the flux from each pond (pCi/m^2-s) was calculated along with total radon release for each source term (Ci/yr), including the LTP, STP and Water Treatment Systems (representing combined releases from the RO Plant and all ponds). These values, compared in the following charts, demonstrate that radon releases from water treatment systems at the HMC Grants site (RO plant and ponds) is negligible relative to releases from the tailings piles.



REFERENCES

Baker, K.R. and A.D. Cox. 2010. Radon Flux from Evaporation Ponds. Presented at National Mining Association (NMA) / Nuclear Regulatory Commission (NRC) Uranium Recovery Workshop, Denver, CO, May 26-27.

Chambers, D.B. 2009. Radon Emissions from Tailings Ponds. Presented at NRC/NMA Uranium Recovery Workshop 2009, Denver, CO, July 2.

Schwarzenbach, Rene P., Philip M. Gschwend, and Dieter M. Imboden. 2002. Environmental Organic Chemistry. 2nd Edition.

Paulson, O. 2012. Experimental Determination of Radon Fluxes over Water. Presented at NRC/NMA Uranium Recovery Workshop, Denver, CO, May 3.

RAI #4

Please provide further justification for using an occupancy factor of 0.75 for residence and an equilibrium factor of 0.2.

HMC Response

These parameter values will be replaced with more conservative values as detailed in HMC's response to RAI #2.