Request for Additional Information

License No. SUA-1471
Homestake Mining Company of California's request for an amendment
to change the background monitoring location for radon-222 in air
at the Grants Reclamation Project,
dated September 23, 2013

NUREG-1620, Rev. 1, "Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978," (ML020320210) and draft FSME Interim Staff Guidance FSME-ISG-01, "Evaluation of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10 CFR 20.1301," (ML13310A198) provide the criteria the staff used to review Homestake Mining Company of California's (HMC's) Grants Reclamation Project license amendment request, dated September 23, 2013 (ML13281A790). The U. S. Nuclear Regulatory Commission (NRC) staff has completed a review of the request and has identified the following Request for Additional Information (RAI).

1. **Description of Deficiency**

   There is not enough quantitative detail on the strength of local sources of radon emissions and how they contribute to radon concentration at the Homestake site and site boundary.

   Basis of Request

   HMC's contractor technical report discusses that there are local sources of radon releases that may impact concentrations of radon in air around the Homestake site. In Section 2.3 of the report, HMC states that potential offsite nearby sources of radon include naturally-occurring mineralized soil and outcroppings of rock and anthropogenic waste rock piles associated with legacy uranium mines. HMC further states that it will show that the legacy mines in the area are potential contributors to radon concentrations at the site. The NRC staff acknowledges that if specific local sources contribute significantly to the radon concentration at the Homestake site and its site boundary (where most of HMC's routine environmental air monitoring is performed), then it is appropriate that the background account for such sources. HMC proposes that its background monitoring station should be relocated up-gradient of the site in low-lying areas within major drainages. However, it is important for HMC to show that local sources in the drainage contribute significantly to the concentration at the site.

   HMC performed modeling of hypothetical offsite sources, as described in Sections 3.1.2 and 4.1.2 of the report. For these calculations, HMC arbitrarily assumed emission rates of 1,000 Ci/yr at point sources. The locations of the hypothetical sources are not described in Section 3.1.2, but appear to be about 6–10 km from the site boundary air monitoring stations. In Section 4.1.2 of the report, describing the modeling results, HMC states that the magnitude of the calculated radon concentrations in air is unimportant since the source strength is unknown.

The NRC staff believes the modeled radon concentrations are important. The modeled radon in air concentrations would provide an estimate of the impact of the local off-site sources on the radon in air concentrations at the site boundary monitoring stations. Without these estimates, HMC has not provided any quantitative description of the impact of the local offsite sources on the radon concentrations at and around the site. In Figure 4-2 of the report, HMC provides a contour of predicted radon in air concentrations from the hypothetical local offsite sources, but the contours are not provided with a legend. However, the contours show that the impact of individual offsite sources decreases with distance from the source (as expected). The NRC staff notes that if the individual sources are far enough away that they do not have a significant impact on radon in air concentrations at the site, then a potential background monitoring station in the drainage areas may not be representative of the contribution of that individual source to the site concentrations. In other words, the impact of significant individual sources on the radon in air concentration at a proposed background location should be similar to the impact on the radon in air concentrations around the site. Without quantitative evaluation of the local offsite sources, the NRC staff is not able to conclude that the impact of the offsite sources on the proposed background location is similar to the impact on the site boundary locations.

Also, in Table 5-1, HMC appears to have concluded that the San Mateo Creek drainage is more important than the other drainages. Some of the reasons for the decision in the table appear to be inconsistent to the NRC staff. For example: for HMC-3Off, the decision is to exclude, in part because it does not measure the contributions from the northwestern drainage; for HMC-5Off, the decision is to exclude, in part because it is unlikely to see contributions from Lobo Creek drainage; and for HMC-4Off, the decision is to exclude, in part because it does not measure influence from San Mateo Creek drainage. The reason for HMC-4Off also states that San Mateo Creek is a much larger watershed than Lobo Canyon with more potential sources of radon and should be a primary focus for the background location. However, HMC has not provided a technical basis to support that statement. While it appears from the mapped locations of legacy uranium sites there may be more potential sources in the San Mateo Creek drainage, HMC has not provided information to substantiate that the radon emissions in the San Mateo Creek drainage are larger.

Formulation of RAI

HMC should provide quantitative information to support its conclusion that the proposed background location is representative of background radon at the Homestake site and its site boundary. In particular, HMC should address how the contribution of the local offsite sources to radon in air concentration at the proposed background location is similar to the contribution of the same sources to the radon in air concentration at the site and site boundary. In addition, HMC should provide quantitative support to its conclusion that radon emissions in the San Mateo Creek drainage are more important than emissions in the other two drainages, relative to determining in which drainage the background location should be placed.

2. Description of Deficiency

Data and/or modeling presented in the submittal is inconsistent or inconclusive with the proposed background location being representative of site background.

Basis of Request

For the proposed location for background to be appropriate, radon in air concentrations at that location should be representative of radon in air concentrations at the site and site boundary without contributions from site releases (i.e., background at the site and site boundary). HMC has performed many measurements of environmental radon in air and with this submittal has also performed modeling of releases from the site and from hypothetical local offsite sources, intended to support the proposed background location. However, HMC has not explained how the existing monitoring data are consistent with or support location HMC-1Off representing background radon concentrations at the site and site boundary. In addition, in some cases existing environmental monitoring data appear to the NRC staff to be inconsistent with the proposed location representing background radon concentration at the site and site boundary.

HMC has proposed that location HMC-1Off be the background location. Track-etch detector measurements of radon in air are presented by HMC in Table 4-1 and are plotted, normalized to the concentration at location HMC-4, in Figure 4-4. Based on these measurements, the radon in air concentration at HMC-1Off is almost the same (1.49 pCi/L) as the concentration at HMC-4 (1.53 pCi/L). If HMC-1Off represents the background radon concentration at HMC-4, this would mean that the site emissions of radon provide a very small impact to the concentration at HMC-4 (the difference being 0.04 pCi/L). However, in section 4.1.1 of the report, HMC describes the results of modeling radon releases from the site. HMC presents a contour line in Figure 4-1 and refers to it in the text stating: “where radon concentrations are expected to be less than 10 percent of the values at HMC-4 and HMC-5 (in the range of 0.1 pCi L-1 when compared to net measured values).” The NRC staff understands this to indicate that net measured values at HMC-4 and HMC-5 are roughly 1 pCi/L, so that the 10 percent is the 0.1 pCi/L stated by HMC. HMC makes a similar statement on page 25 of the report. The NRC staff notes that HMC did not provide results of the modeling calculations at the boundary air monitoring stations, so it is unclear exactly what the modeling results are. A net concentration of around 1 pCi/L would be inconsistent with the application of HMC-1 as the background location, which would imply a measured net concentration at HMC-4 of 0.04 pCi/L.

Similarly, it is unclear how the use of HMC-1Off would be consistent with the range of concentrations measured at the site boundary stations HMC-1 through HMC-7. If HMC-1Off represents background for the entire site, then the differences in measured radon concentrations for different site boundary locations would presumably be due to differences in impact from site releases. As an example, HMC-4 has a long-term measured concentration of 1.66 pCi/L, while HMC-3 has a concentration of 1.09 pCi/L (from the HMC values in Table 4 1). The difference is 0.57 pCi/L, which presumably is due to impacts from radon releases from the site. However, if HMC-1Off were the background location, the concentration at HMC-3 would appear to be lower than that (new) background (HMC-1Off had a concentration of 1.49 pCi/L from Table 4-1). In

addition, the HMC modeling of radon releases from the site appears to indicate impacts from site releases at location HMC-3 (based on Figure 4-1, although as noted above detailed modeling results were not provided). Based on HMC's modeling, and based on proximity to the tailings piles, the NRC staff considers it reasonable that HMC-3 is impacted by radon releases from the site. Thus, the NRC staff considers a result of concentrations at HMC-3 being lower than background to be inconsistent with impacts from the site releases.

In addition, the NRC staff notes that location HMC-16 is reasonably close to the Homestake site, and based on past monitoring the average radon concentration (1.05 pCi/L) is relatively similar to the lowest concentrations measured at the site boundary at locations HMC-3 (1.09 pCi/L) and HMC-7 (1.17 pCi/L) as provided in Table 4-1. Based on the limited data obtained so far (about 2 years, see table 4-1), the radon concentration at HMC-1Off is 1.49 pCi/L, which appears to be significantly higher than the concentrations at HMC-3 and HMC-7. Based on HMC's modeling of radon releases from the tailings piles, it is expected that HMC-3 and HMC-7 are somewhat impacted by releases from the site. Thus, to the NRC staff, it appears inconsistent to consider HMC-1Off as representative of the site background when the concentration at HMC-1Off is higher than the concentrations at site boundary locations.

The HMC measurements also appear to indicate significantly higher impacts to HMC-4 than to HMC-3 (difference of 0.57 pCi/L mentioned above). If this is correct, modeling should be generally consistent with the result. Because HMC has not provided detailed results of its modeling of the site releases, the NRC staff cannot determine if the modeling is consistent with that measured difference. In Section 5 of the report, HMC states that measured radon concentrations in the Lobo Creek drainage are lower than in the other drainages (based on location HMC-4Off). HMC further states that the portion of the Lobo Creek drainage that intersects the site is expected to move southward along the eastern perimeter. HMC states that that may explain the lower radon concentrations measured at HMC-3 and HMC-7. However, HMC has not provided technical support for that conclusion. In addition, the NRC staff notes that the measurements of radon in the Lobo Creek drainage are based on a single monitoring station (HMC-4) for a single monitoring period of 5 months from October 2011 to March 2012. That is a much shorter monitoring period than for locations HMC-1Off through HMC-3Off.

Based on the figures in HMC's report, it appears that all of locations HMC-1, HMC-1A, and HMC-1Off are in the same part of the San Mateo Creek drainage. Average concentrations at these three locations are provided in Figure 4-4 and Table 4-1. The average concentration at HMC-1A was 1.25 pCi/L, which is lower than the averages at HMC-1Off (1.49 pCi/L) and HMC-1 (1.43 pCi/L). Location HMC-1A is in between HMC-1Off and HMC-1. Based on HMC's modeling of radon releases from the site (Figure 4-1) and proximity of HMC-1 to the tailings piles, it appears that the concentration at HMC-1 is significantly impacted by radon releases from the site. The NRC staff considers this conclusion to be consistent with a lower concentration measured at HMC-1A, because HMC-1A is farther from the tailings piles and thus is expected to have reduced impacts from releases from the site (though this is not quantified). However, based on the locations, the NRC staff considers the lower concentration at HMC-1A to be inconsistent with HMC-1Off being representative of background at the site and site boundary.

Formulation of RAI

HMC should provide an evaluation of all the monitoring data and modeling results to address the apparent inconsistencies discussed above. HMC should provide details of its modeling results.

3. Description of Deficiency

There is insufficient justification for some modeling input and some modeling input data needed for evaluation of the request was not provided.

Basis of Request

Section 3.1.1.2 of the report describes the terrain data that HMC used in its AERMOD modeling. HMC states that the topographic features of the site (large and small tailings piles and evaporation ponds) do not appear in the dataset that HMC used or in other topographic datasets. The NRC staff considers the tailings piles to be substantially large topographic features, especially in the immediate vicinity of the site. Given the importance HMC places on modeling topographic features, it seems inconsistent to the NRC staff to model radon releases from the site and impacts to the surrounding area without including the topography of the tailings piles themselves. HMC has not provided justification for not including the topography of the tailings piles in the modeling it has performed.

Related to the lack of topographic data for the tailings piles, in Section 3.1.1.1, HMC states that it modeled release from the site as being released half from ground level and half from an elevated release at a height representative of the top of the large tailings pile. HMC states in Section 2.1 that the conceptual model of radon transport in and around the site is (1) highest radon in air concentrations occur during calm or near-calm conditions, and (2) during calm conditions, radon transport is driven predominantly by topography. If topography is the most important driver for transport of radon, then a release from an elevated height would be transported quite differently than would a release from the ground surface of a tailings pile. HMC has not justified why it is appropriate to model releases from the surface of the tailings piles as (partially) elevated releases.

In addition, HMC has not provided the topographic data used in its AERMOD modeling. It also appears that not all parameter values used as inputs have been provided (e.g., Appendix A of the HMC report does not include the elevation assumed for releases from the tailings piles). HMC has not provided coordinates for all the air monitoring stations. Without these details, the NRC staff is unable to independently evaluate the modeling that HMC has performed.

Formulation of RAI

HMC should either include the topography of the tailings piles in its modeling or provide justification for not including that topography.

HMC should provide justification for modeling releases from the surface of the tailings piles as (partially) elevated releases, or should consider modeling releases as ground level releases (especially if topography of the piles is added to the modeling).

HMC should provide all input data used in its modeling. For the topographic data, HMC should provide a map showing the topography along with locations of the pertinent site features and the air monitoring stations discussed in the report.

HMC should provide coordinates of the monitoring locations.

4. Description of Deficiency

There is insufficient justification for concluding that location HMC-16 is inappropriate to represent the site radon in air background concentration.

Basis of Request

At the beginning of Section 2.1 of report, HMC states that the location of the current background station (HMC-16) may not be the best for monitoring site background because it appears to be cross gradient from drainages with known sources of radon, whereas the site is down gradient from those sources. HMC makes a similar statement in Section 5 (page 25) of the report. HMC has not demonstrated that it is critical that a potential background location must be directly in the drainage to be representative of the site background radon concentrations. What is more important for representativeness is that the potential background location is impacted similarly as the site is impacted by the local offsite sources and by the general area radon. As an example, Figure 4-2 shows impacts of hypothetical sources in the three drainages on the various monitoring locations. From that figure, HMC-16 appears to be impacted by the sources placed in the San Mateo Creek and northwest drainages. From the same figure, HMC-1Off appears to be impacted more by the drainage sources than the site is impacted by the same sources. The NRC staff understands that HMC's modeling provided in the report is hypothetical, so the above is only intended as an example.

In addition, the NRC staff notes that location HMC-16 is reasonably close to the Homestake site, and based on past monitoring the average radon concentration (1.05 pCi/L) is relatively similar to the lowest concentrations measured at the site boundary at locations HMC-3 (1.09 pCi/L) and HMC-7 (1.17 pCi/L) as provided in Table 4 1. To the NRC staff, this similarity of the measured radon concentrations is one indication that HMC-16 may be a reasonable location to represent background radon in air at the site.

Formulation of RAI

HMC should provide a technical justification for its statement that HMC-16 may be an inappropriate location to represent the site background.

5. Description of Deficiency

There is insufficient justification for choosing HMC-1Off over HMC-6Off for the radon in air background location.

Basis of Request

In Section 5 of the report, HMC describes its decision process for determining the appropriate location to represent the site background. On page 26, HMC indicates that based on the evaluation in Table 5-1 it considered HMC-1Off and HMC-6Off to be the best candidates for a background location. HMC then states that HMC-1Off is the best location because (a) there is more data available for HMC-1Off, and (b) HMC-6Off is farther away from the site. The NRC staff does not consider the data availability to be a reasonable criterion for choosing the best location to represent background. Rather, the NRC staff considers the relative lack of data for HMC-6Off as a potential reason to obtain additional data before making a decision on the best background location. And, while distance from the site can be a criterion in determining representativeness of a background location, HMC has not justified why it thinks the distance is a significant factor in this case. Based on Figure 4-4, it appears to the NRC staff that the difference in distance for the two locations is roughly 0.5 km.

Formulation of RAI

HMC should provide justification for its statement that the additional data available for HMC-1Off is a significant reason to conclude HMC-1Off is a better location for background. HMC also should provide justification for why the relatively small difference in distance for locations HMC-1Off and HMC-6Off is a significant reason to conclude HMC-1Off is a better location for background.

6. Description of Deficiency

Other Technical Issues

(a) There is insufficient justification for treating radon in air as a heavy gas.

(b) There is insufficient justification for using hypothetical onsite radon release quantities versus release quantities based on measured values.

(c) There is a lack of explanation for why potential background locations HMC-4Off, HMC-5Off, and HMC-6Off were monitored for a shorter period than the other locations.

(d) There is insufficient support for the statement that radon concentrations trend closely to percent calm distributions.

Basis of Request

(a) In Sections 2.2, 3.1, and 5 of the report, HMC indicates that it would have modeled the radon transport using a model that assesses heavy gas transport, if such a model were available. HMC has not justified that treating the transport of radon in air as a heavy gas is appropriate. HMC did cite the United Nations report, but the NRC staff did not find support in that report for HMC's statement that the transport is due to the high density of radon. The NRC staff understanding is that once radon has

entered the air, the transport of the radon is based on the transport of the air containing the radon. The radon represents only a very small fraction of the molecular makeup of the air, so that the density of the air containing the radon is essentially the same as air not containing radon.

(b) In Section 3.1.1 of the report, HMC describes the onsite sources of radon releases. HMC indicates that the release quantities (Ci/yr) are different from the releases based on site data. The NRC staff assumes that the site data referenced is the annual measurements of radon flux on the top of the tailings piles, and understands there may be uncertainty in estimating annual releases from the short-term measurements. However, HMC did not justify why hypothetical release quantities were adequate.

(c) In Section 3.2.2, HMC states that the additional locations (HMC-4Off, HMC-5Off, and HMC-6Off) were monitored for a shorter period (5 months) than the other locations. Based on the radon data sheets in Appendix B, it appears that 5-month period was a single deployment period for the detectors. HMC did not provide an explanation for why those other locations, which were being considered as potential background locations, only had monitoring performed for a short period.

(d) In Section 5, HMC states that radon concentrations trend closely to percent calm distributions within a day. HMC did not provide justification or support for this statement.

Formulation of RAI

(a) Justify that treating the transport of radon in air as a heavy gas is appropriate.

(b) Justify why hypothetical onsite radon release quantities were adequate to describe onsite sources of radon release when site measurement data is available.

(c) Provide an explanation for why other locations being considered as potential background locations (i.e., HMC-4Off, HMC-5Off, and HMC-6Off) only had the shorter term monitoring performed and why that was adequate to determine their suitability as background locations.

(d) Provide support for the statement that radon concentrations trend closely to percent calm distributions.

7. Description of Deficiency

The licensee's rationale of sampling location HMC-16 not being the best because the Homestake site is down gradient is not clear to the reviewer.

Basis of Request

Typically, a licensee selects background-sampling locations to be representative of the licensee's site conditions and before operations begin so that the licensee can determine exposures to the public and residual radioactivity that results from the licensee's

operations. 10 CFR 20.1003 defines "distinguishable from background" as the detectable concentration of a radionuclide that is statistically different from the background concentration of that radionuclide in the vicinity of the site using adequate measurement technology, survey, and statistical techniques. Further, the Commission determined in *Hydro Resources, Inc.,* CLI-06-14, 63 NRC 510, 520 (2006) (ML062330245) that, "*for purposes of calculating the TEDE* for an NRC-licensed activity, radiation from pre-existing, conventional mining spoil is not included."

Section 2.1 – Conceptual Model, Page 3, the licensee's rationale for describing sampling location HMC-16 as not being the best because the Homestake site is down gradient is not clear to the reviewer. The licensee's statement that location HMC-16 is cross gradient from drainages with potential natural and anthropogenic radon sources and that the site is down gradient from these sources, does not provide proper rationale for describing location HMC-16 as a poor background sampling location for Homestake.

Formulation of RAI

Provide additional information explaining why sampling location HMC-16 is cross gradient of radon sources and why its location up gradient of the site affects its ability to be representative of background conditions at Homestake.

8. Description of Deficiency

There is no explanation in the text or figure for the term "LLD".

Basis of Request

In Section 2.3 – Sources of Radon, Pages 5 and 6, the licensee refers to offsite sources of radon near the site, such as the legacy uranium mines that are listed in the EPA Uranium Locations Database (ULD). However, Figure 2-3 cites EPA LLD sites.

Formulation of RAI

Provide additional information to explain the term LLD or correct the citation in the figure.

9. Description of Deficiency

Radioactivity produced from mining and milling at legacy uranium mines are anthropogenic sources of radioactivity; however, Section 2.3 – Sources of Radon, Figure 2-3, describes the drainage lines from the EPA LLD sites as natural U.

Basis of Request

There is no explanation in the text or figure for the term LLD, however it appears to the reviewer that these sites are legacy uranium mines. Although uranium, and its progeny contained in ore from these sites, are natural sources, any radioactivity produced from mining and milling at the legacy uranium mines are anthropogenic sources of radioactivity.

Formulation of RAI

Provide additional information to explain the rationale for describing the drainages from the EPA “LLD” sites as natural U versus anthropogenic sources of radioactivity.