

TECHNICAL EVALUATION OF THE SOIL DECOMMISSIONING PROGRAM
AT THE QUIVIRA URANIUM MILL SITE

DOCKET NO.: 40-8905 LICENSE NO.: SUA-1473

SITE: Quivira Mining Company's uranium mill site at Ambrosia Lake, New Mexico

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SUMMARY: During the soil decommissioning program review held at the Quivira mill site on November 8 to 10, 1999, the Nuclear Regulatory Commission (NRC) staff mentioned various short-comings or questions concerning the soil decommissioning being performed at the Quivira site. The confirmatory survey (gamma scans and soil sample analysis) by the NRC contractor supports this lack of confidence in the decommissioning procedures. The licensee should be required to submit a detailed decommissioning plan for the windblown tailings cleanup as soon as possible.

BACKGROUND: Cleanup of windblown tailings and some of the tailings evaporation ponds was being completed at the Quivira site in the fall of 1999. Because of staff concerns about the 1988 cleanup of pond 8 and the soil radium (Ra-226) background value in use for the site (licensee aware of these concerns since June of 1997), NRC management agreed that a program review and confirmatory survey should be done at this time (before submittal of the soil decommissioning report). A contract task for assistance from the Oak Ridge Institute for Science and Education (ORISE) was approved October 29, 1999. The program review and confirmatory survey were conducted November 8 to 10, 1999.

Of the tailings evaporation ponds around the tailings disposal area (ponds 4-10), only pond 9 is still being used for ground water corrective action. Pond 3 is being used to dispose of windblown tailings. Soil cleanup areas consist of 325 acres northeast of the tailings piles, 20 acres to the southwest (around ponds 7 and 8), and 95 acres for ponds 4-10 (ponds 11-21 are not on site and were not addressed at this time). Most of these areas are being cleaned and verified (decommissioned) using 1998 procedures that include a global positioning system. These procedures have not been reviewed and approved by NRC staff and the license does not reflect that the 1987 soil decommissioning procedures used for pre-1998 cleanup were approved (although implied by NRC approval of the pond 8 cleanup). Therefore, Quivira is not in compliance with License Condition 29 that requires submittal of a detailed decommissioning plan at least 6 months prior to the start of decommissioning activities.

EVALUATION:

Soil Cleanup Before 1998

During the program review, Quivira staff indicated that all the windblown tailings area and some ponds were being verified as meeting the Ra-226 standard by the 1998 procedures. The exceptions are pond 8 that was verified in 1988 and pond 10 that was cleaned and backfilled before 1998 (the verification data has not been submitted to the NRC). On November 9, 1999, the NRC health physicist indicated to Quivira staff that even though an NRC letter dated December 28, 1988, states that pond 8 meets criteria for unrestricted release, much of that decision was based on faulty or inadequate information from Quivira and NRC staff at that time apparently didn't consider the high residual Th-230 levels (to 2200 pCi/g). Also, the NRC values for several of the five split samples from pond 8 were significantly higher than the Quivira sample results (6 vs. 12, and 14 vs. 26 pCi/g Ra-226, October 18, 1988). No follow-up on the Ra-226 results disparity was documented.

In order to meet the criteria for license termination in 10 CFR 40.42(k)(2), it must be demonstrated that reasonable effort was made to eliminate residual radionuclides. Therefore, the areas verified only under the 1987 procedures will have to be addressed before license termination. The soil decommissioning procedures presented in the December 7, 1987, Quivira submittal are questionable because:

- 1) The Ra-226 soil background value of 3 pCi/g is based on six samples from a borrow area off the south edge of the tailings pile. This Ra-226 value is apparently not representative of the site or windblown areas and all samples may not be from the surface.
- 2) The soil Ra-226-gamma correlation (Appendices A and B) indicates that the gamma readings do not reliably distinguish background Ra-226 levels (13-25 uR/hr) from background plus 5 pCi/g (15-17 uR/hr) or from about 15 pCi/g (14-31uR/hr), but Quivira stated that there was a 1 to 1 ratio of soil radium content and gamma intensity.
- 3) The proposed final gamma scan on 25 ft grid lines with a Ludlum 19 scintillameter is not adequate to detect gamma levels representative of the Ra-226 standard within 100 sq. meters.
- 4) No quality assurance/quality control (QA/QC) program for the final status survey (cleanup verification) and no proposed measurements of unaffected area (buffer zone bordering the excavated areas) were proposed.
- 5) No detailed procedures on gamma scanning or soil sampling/preparation were provided. No indication of what percentage of the grids would be verified only on gamma levels was provided or justified.
- 6) The proposed Ra-226 analysis (and currently used procedure) involved drying the soil sample for 24 hrs at room temperature and then analysis of the Bi-214 (a radium/radon daughter) peak with gamma spectrometry within a day or two. However, the drying would allow radon gas to escape and lower the radon daughter content. Counting the sample within a day or two of drying would not allow reestablishment of equilibrium (in-growth) of the radon daughters. Also, staff mentioned that the Bi-214 peak tends to under-estimate the Ra-226 level

so some labs use the Pb-214 peak. [An Oak Ridge study found that for soil samples dried at 100 degrees F, the Bi-214 peak reflected 82 percent of the true value within 3 days. The recommendation is to wait 10 days before counting the sealed sample. Another paper (Health Physics 67(3):238, 1994) indicated that a minimally disturbed sample with low moisture content (< 15 percent) could provide good results using both the Bi and Pb peaks without delaying the counting.]

Soil Background Radium

On October 19, 1999, the Quivira radiation safety officer (RSO) provided NRC staff with 1997 data on 27 soil Ra-226 background values taken within 4 miles of the site. The average of these samples was 3.1 pCi/g but included results of samples that appear to be taken near uranium ore haul roads and one near a trailer park. The NRC staff indicated that use of these samples needed to be justified, i.e., show not influenced by ore and indicate how far from the haul road that the sample was taken. Also, 14 of the samples were from west of the site and 13 from the east, but the windblown area is east of the site so the average is not likely to be representative of the windblown area.

The facility manager suggested removing the values for three samples taken south of the site from the average because they are from an up slope that has different geology than the windblown area. Eliminating the eight questionable values results in a background value of 1.8 pCi/g. Staff suggested that the Ra-226 soil background value for the near-by Ambrosia Lake (Title I) mill site be mentioned in the revised Decommissioning Plan under the discussion of soil background values.

While on site, NRC staff also questioned why the four "background" values from one lab averaging 1.4 pCi/g (March 5, 1987 Appendix C) were ignored while results of duplicate samples provided by another lab averaging 2.8 pCi/g were used in the background average. The Quivira RSO indicated that the chosen lab was more experienced in this type of analysis.

New Radium-Gamma Correlation

The NRC staff commented that the correlation should be done only with the data obtained using procedures that are the same as those being used for cleanup verification. Also, a correlation with data obtained during verification should be calculated and any samples exceeding the Ra-226 criterion when the gamma level was acceptable, would need to be reported and addressed. Cleanup of only the grids with elevated Ra-226 was not enough since elevated levels indicate that the gamma guideline was not a reliable indication of the Ra-226 level. It appears that no conservatism was applied to the correlation to address ALARA and the measurement uncertainty e.g., using the lower 95 percent confidence level.

The Quivira RSO did a revised correlation using only the data obtained using procedures similar to those used for verification (final status survey) and the gamma action level decreased. He indicated that this should not have a significant impact on the soil cleanup results. The NRC staff stated that the correlation should be checked with data pairs (Ra-gamma) of verification data.

New Gamma Scan and Gamma Spectrometer Procedures

The NRC staff performed mark-ups of some procedures, indicating where more information should be provided and suggesting that they should include how checks were made of gamma scan speed, meter height, computer average gamma calculations. It was noted that there were no gamma scan maps of the area around ponds 7 and 8. The RSO later indicated that the area was considered windblown and would be addressed. Some staff comments were also made on data management and on graphs comparing data from various labs and techniques. As indicated earlier, the NRC staff considers that the gamma spectrometer analysis performed within a day or two of drying the sample would underestimate the Ra-226 level.

Soil Decommissioning Plan

Since the windblown area and some of the ponds are being verified under new procedures not yet submitted for approval by NRC, staff suggested that a revised soil decommissioning plan should be submitted soon. It should comply with 40.42(g)(4) and include detailed procedures, a justified background soil Ra-226 value, appropriate Ra-226-gamma correlation, justify the number/percentage of grids to be verified by gamma only, justify why some grids have one sample and not 5-composited, propose measurements for the unaffected areas, adequate QA/QC program (including surveys and data management, acceptance criteria, etc), and it should include any data substantiating the accuracy and precision achieved using their measurement procedures.

The plan should include the detailed soil sample preparation procedure (particle size after crushing, mixing and splitting methods, size limit for included stones, and drying technique, i.e. resulting moisture range), a description of the proposed measurements to be done in the buffer zone (unaffected area adjacent to windblown areas) and the zone's width, as well as justify the location and number of verification soil samples. The plan should address the area cleaned by Homestake Mining Company and the archeological site (contamination level, size, justify why no remediation done by Quivira). Staff also suggested that for some grids near the Ra-226 limit, a comparison be made of the average gamma readings provided by the new procedure to the 1.5 minute integrated reading used by some licensees, as a way of demonstrating the sensitivity of the new procedure.

Alternative Criteria for Th-230 in Ponds

Because the Th-230 contamination extends deeper than 4 ft under the ponds, Quivira staff is considering alternative criteria as allowed in Part 40, Appendix A Introduction. If a demonstration of no health or environmental effects can be made, the deep (buried) thorium could remain on land deeded to the Department of Energy (DOE), with both agencies' approval. The NRC staff suggested that the dose assessment model include the worse case pond (average values) to estimate potential dose to a DOE worker on site for 2 weeks/yr and for a resident at the fence line, as part of the cost-benefit analysis. Staff also discussed site-specific values for several of the important dose code parameters and referred to draft guidance on dose modeling that is on the Uranium Recovery website. If an alternative criteria proposal is submitted, it must address the potential for ground water contamination and regional ground water use.

Issues Based on the ORISE Report

The final report on the confirmatory survey performed by ORISE staff indicates that the Ra-gamma correlation used a minimum of nine soil samples but the final status survey (cleanup verification) apparently didn't. If five samples per grid were taken (composited) for the final Ra-226 value (results in a less precise correlation), a new Ra-gamma correlation using five samples and/or additional verification soil sampling would be required.

The ORISE report states that eight soil samples taken at the Quivira site were sealed and counted after processing and then again in 20 days. The Ra-226 levels at 20 days were 22 to 58 percent higher than the initial values with an average increase of 38 percent. This supports the NRC staff position that counting the samples within one day of preparation leads to underestimation of the Ra-226 level.

The report indicates that it was not evident that potential subsurface contamination was addressed. The soil decommissioning plan should state that any potential buried tailings (pipelines, posts, filled ravines, etc) were explored.

The three background samples taken by ORISE average 5.3 pCi/g Ra-226 but the U-238 averages only 2.1 pCi/g instead of the expected value similar to the Ra-226 value. It is possible that these sample sites have been impacted by windblown tailings from one or both near-by uranium mill sites.

The ORISE samples from windblown areas 1 and 2 have Th-230 levels at 5 to 23 times the corresponding Ra-226 value. Also, sample 32-CC-B (from windblown area between pond 4 and ORISE area 1 taken by Quivira staff and analyzed by ORISE shows a Th-230/Ra-226 ratio of 51 instead of the expected value of approximately 1. Because the site does not have an NRC-approved final decommissioning plan, the June 1999 version of 10 CFR Part 40, Appendix A, Criterion 6(6) would apply (62FR39093, April 12, 1999, or see the NRC Uranium Recovery website). This means that the licensee would do radium benchmark dose modeling to derive a dose and then a concentration criterion for thorium (Th-230 and Th-232 or Ra-228), as needed.

Of the 15 samples taken by ORISE in the windblown areas that were indicated by the RSO as meeting the 8 pCi/g Ra-226 site criterion, 8 samples exceed the limit. This could indicate problems in the site measurement procedures.

The Th-230 levels in the pond samples were elevated (5340 pCi/g in pond 4) as expected. However, the Ra-226 level in 6 of the 8 pond samples are elevated above the 18 pCi/g limit set by Quivira. In fact, pond 8 that should be covered with at least 6 inches of clean fill, had a surface sample values of 43.6 pCi/g Ra-226 and 2197 pCi/g Th-230.

CONCLUSIONS:

1. The licensee should submit, as soon as possible, a detailed soil decommissioning plan including all procedures and data (Ra-226 and Th-230 soil background, Ra-gamma correlation, etc.) related to the final status survey plan.

2. If the elevated Th-230 in some windblown areas is likely to be due to byproduct material, a Th-230 cleanup criterion must be presented in the soil decommissioning plan (see Appendix H in final NUREG-1620 or draft guidance on the NRC Uranium Recovery website).
3. Given the questions and staff concerns with the procedures being used for the final status survey (as discussed above) and the analytical data from ORISE, the windblown area appears to require additional cleanup and verification using improved procedures.
4. Pond 8 should not be released for unrestricted use or deeded to the Department of Energy without additional cleanup and NRC-approved verification.