Nuclear Regulatory Commission (NRC) Staff Comments on "Crescent Junction Disposal Site Alternative Final Cover System 60 Percent Design Report"

By letter dated August 30, 2021, the U.S. Department of Energy, Office of Environmental Management (DOE-EM) and Moab Uranium Mill Tailings Remedial Action Project submitted for the U.S. Nuclear Regulatory Commission (NRC) staff's review and comment, a report titled, "Crescent Junction Disposal Site Alternative Final Cover System 60 Percent Design Report," (Design Report) (NRC Agencywide Documents Access and Management System Accession Number ML21243A286). Consistent with the approach used in the review of the 2008 Remedial Action Plan (RAP) (ADAMS Accession Number ML080920459), the NRC staff's review process was informed by the "Final Standard Review Plan (FSRP) for Uranium Mill Tailings Radiation Control Act Title I Mill Tailings Remedial Action Plans" (ADAMS Accession Number ML110190562) and more recent applicable technical guidance in NUREG-1620, "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," Revision 1 (ADAMS Accession Number ML032250190).

In its comments below, the NRC staff uses the terms "existing cover" and "proposed cover." The term "existing cover" refers to the rock cover approved in 2008 (and shown in Figure 1 of the Design Report). The term "proposed cover" refers to the evapotranspirative (ET) cover profiles shown in Figure 5 of the Design Report.

General Comment

In the Design Report, the DOE identified two potential cover profiles for Crescent Junction. One, or both, profiles will be installed on the top slopes (i.e., the north facing 2% slope and the south facing 2.5% slope) and DOE stated it will make this decision later in the design process. The Design Report does not discuss alterations to the cover system on the 5H:1V side slopes. Therefore, for the purposes of its comments provided below, the NRC staff assumes that the existing design will be maintained for those slopes. It appears that the proposed design alters the rock sizing at the toe of the slopes. The NRC staff has comments about this approach in the Section on surface water hydrology and erosion protection.

Comments Related to Geotechnical Stability

1. In Section 6 and Appendix B of the Design Report, DOE discusses unsaturated modeling of the proposed cover. The Design Report describes the input parameters used in UNSAT-H and provides a summary of the output. The NRC staff appreciates the extent of the modeling that has been done to support the 60% design and understands the approach taken to design the proposed cover. ET covers rely on storage of water within the cover and removal of the water by evaporation and transpiration to limit percolation through the bottom of the cover. Conventional covers rely on a low permeability layer to limit percolation through the bottom of the cover. Because of these fundamentally different processes for management of water, the NRC staff offers the following comments for DOE's consideration.

    a. As currently presented, the UNSAT-H model is challenging for the NRC staff to verify. DOE could consider either providing input files, output files, or some type of combination to facilitate the NRC staff's future review.

b. The UNSAT-H model considers multiple scenarios in an attempt to account for different vegetation and climate conditions that could exist over the 1,000-year performance period. To provide confirmation that the cover will function as intended, DOE should consider monitoring sensitive and important design parameters before and after turnover of the site to DOE-Legacy Management (DOE-LM). It may be possible to perform monitoring in the standpipes along the southern edge of the disposal cell. Alternatively, remote sensing technologies could be used to infer water storage in the ET cover system.

c. The UNSAT-H analysis is based heavily on the moisture retention properties of the cover soils as well as the properties of the vegetation. The UNSAT-H modeling shows that the ET cover appears be effective at limiting percolation through the cover system. It is unclear to the NRC staff how the information in the design calculations relates to the technical specifications. One example is with the soil used in the surface admixture. The design is based on the van Genuchten properties, but the technical specifications only limit the maximum particle size and state that the soil should be a uniform, fine-grained, dry material free of roots, debris, organic, or frozen material. The NRC staff recognizes that the technical specifications have not been as refined as the design and that the relationship between the design calculations and technical specifications may become more apparent at the 90% design.

2. The Design Report presents an updated settlement analysis in Section 7, with detailed calculations included in Appendix D. The calculation methodology in Appendix D appears reasonable. However, it is not clear if the settlement calculation is based just on the settlement of the residual radioactive material (RRM) under its own self weight, or if the influence of the cover system is accounted for in the calculation. The settlement calculation is based on a peak elevation of 5,000 ft, but engineering drawing E-02-C-301 shows that peak elevation of the RRM being at 5,000 ft and the top of the final cover system being above that.

3. DOE-LM and NRC have observed (and are dealing with) settlement challenges at several Title I and Title II disposal cells, especially those with relatively long and shallow top slopes. These challenges have become more of an issue since the NRC's concurrence on the 2008 RAP. The settlement analysis approach used in Appendix D is reasonable but may not completely consider variability in the material properties that could become apparent over longer distances. The NRC staff recognizes that DOE-EM has significantly more control over the mixing of RRM in Moab and placement of RRM at Crescent Junction when compared to past practices at other Uranium Mill Tailings Radiation Control Act Title I and Title II sites. This aspect of operations at Crescent Junction may be sufficient to minimize the potential for differential settlement at the site. The NRC staff is not asking for a new or additional analysis at this time; this comment is intended to highlight the need to remain focused on proper mixing and placement of the RRM. It may also be useful to discuss long-term settlement challenges with DOE-LM staff.

4. Section 9 of the Design Report addresses the potential for liquefaction in the disposal cell at Crescent Junction; the liquefaction analysis from the 2008 RAP was included in Appendix J. In reviewing the 2008 analysis, the NRC staff recognizes that DOE considered a scenario in which the RRM become saturated and determined that liquefaction is not a concern. The proposed change to the cover system does not alter

the placement methods for the RRM. Additionally, the ET cover is anticipated to improve the hydraulic performance of the cover system. If both of these statements remain true, the 2008 liquefaction analysis does not necessarily need to be updated.

5. Section 10 of the Design Report addresses slope stability. The Design Report states that the slope geometry and materials are those described in the 2008 RAP and that the existing slope stability analysis will not be changed or amended. The slope stability analysis in the 2008 RAP is included as Appendix I to the Design Report. The NRC staff recognizes that the while the cross section of the final cover system will change, the slope length and angle will remain the same. As long as DOE can demonstrate that the existing slope stability analysis is representative of the critical cross section with the revised cover system, it does not necessarily need to be updated. However, if the design of the ET cover is modified in a manner that is not consistent with the 2008 analysis (i.e., thicker, heavier soils are used, or the cover system on the 5H:1V side slopes is modified), the slope stability analysis should be updated.

Comments Related to Surface Water Hydrology and Erosion Protection

1. The NRC staff reviewed the erosion calculations in Section 3 and Appendix F of the Design Report. The NRC staff is familiar with the methodology used to design the surface admixture. However, the NRC staff is not able to verify the calculations presented in Appendix F. To facilitate the NRC staff's review, it would be helpful to include a sample calculation with parameter values, not just formulas, in the 90% design. Alternatively, Tables F-4, F-5, F-6, and F-7 could be modified to include the calculated value for each formula used in Appendix F. Either method would improve transparency in the calculations and allow the NRC staff to verify that the appropriate parameters were used and check that correct unit conversions were made. Specific examples where the NRC staff was not able to verify the calculations are identified below.

    a. Using equations F-2 and F-3, the NRC staff was able to confirm the calculations in Table F-2. However, when using equations F-2 and F-3 to confirm the calculations in Table F-3, the NRC staff arrived at different values for the time of concentration. It is not clear to the NRC staff whether a different methodology was used to calculate the time of concentration for the north slope.

    b. For Equation F-6, the unit weight of the soil is not stated. Also, shear stress is typically reported in pounds per square foot (psf), instead of pounds per cubic foot (pcf).

    c. In Equation F-8, the value of P_c is not stated. It is not clear how the calculated value of Y_s in Equation F-8 factors into the design.

2. The Design Report does not discuss the potential for the presence of dispersive soils within the cover at Crescent Junction. Dispersive soils can be more susceptible to erosion. The presence of dispersive soils in covers can result in removal of soil from the cover and lead to the formation of erosion rils or voids. Therefore, the presence of dispersive soils represents a long-term maintenance concern for DOE-LM. It is not clear if the dispersion characteristics for soils at Crescent Junction have been evaluated. A joint discussion between DOE-EM, DOE-LM, and NRC may be helpful in addressing this issue.

3. The NRC staff reviewed the drainage rock calculations in Appendix C of the Design Report. As presented in the Design Report, the NRC staff understands that the rock cover on the 20% (5H:1V) side slope is not being altered, but DOE plans to modify the rock contained in the drainage trenches at the base of the side slopes. Please confirm that DOE intends to resize the rock for the trenches at the base of the side slopes.

4. Similar to comment 1 in this Section, the NRC staff is familiar with the calculations and methodology to size rock for side slopes and perimeter trenches. Please clarify the following with respect to these calculations:

    a. Is Equation C-1 or C-2, (or both) used to size rock in this calculation? Note that Equation 1 points to Table 8 for results, but there is no table in this package that pertains to rock size.

    b. If Equation C-2 is used, please identify the value used for the flow concentration factor, C_f.

    c. It is not clear what length is used to convert from the peak flow Q (in cubic feet per second, cfs) to the unit flow of q (cfs/ft).

Comments Related to Radon Attenuation

1. The NRC staff evaluated the alternative cover design described in Chapter 5, "Radon Attenuation," and Appendix H, "Radon Flux Calculations." The alternative cover would modify the existing design from a 4-foot thick radon barrier covered by 4 feet of rock armoring, frost protection, and biointrusion layers to a 3-foot thick radon barrier covered by 2 feet of gravel/soil admixture and alluvium. Given the reduced margin in the alternative cover design, the NRC staff used the procedures in NUREG/CR-3533, "Radon Attenuation Handbook for Uranium Mill Tailings Cover Design," to determine the sensitivity of the design to changes in long-term soil moisture content, a critical parameter in determining radon diffusion coefficients and cover effectiveness. The value of long-term soil moisture content assumed in the DOE's calculation is 12 dry weight percent (dry wt. %). The NRC's confirmatory analysis indicated that the cover performance would not be acceptable if the long-term moisture content of the radon barrier (shale soil layer) was 11 dry wt. % or lower, which may indicate relatively little margin in the selection of this parameter value. Furthermore, the *in situ* moisture content of weathered Mancos Shale is 7 dry wt %, over 5 dry wt % lower than the value assumed in the DOE's analysis, which may raise a question of whether the DOE's value is representative of long-term conditions at the site. For these reasons, the NRC staff suggests that the DOE provide additional justification for the assumed long-term moisture content of the shale radon barrier.

    In Section 6.2.3, "Conclusions," of its 2008 Technical Evaluation Report on the 2008 RAP (ADAMS Accession Number ML082060216), the NRC staff stated, "NRC noted that DOE [sic] choice of mean long-term moisture content of the radon barrier is based on calculated and measured 15-bar moisture content rather than the *in situ* moisture content of the Mancos Shale. NRC ran the RADON computer code using an additional value for mean long-term moisture content of five percent and the radon barrier thickness was sufficient to meet the Environmental Protection Agency radon flux standard." This statement explains that in 2008, the NRC staff evaluated whether a value for long-term moisture content of 12 dry wt. % measured in the laboratory was sufficiently conservative by evaluating the design using a lower value of 5 dry wt. %, and determined that the design would meet the EPA's radon flux standard using either a value of 5 dry wt. % or 12 dry wt. %. As explained above, a value of 5 dry wt. % in the alternative cover design, which would be representative of *in situ* moisture content of the Mancos Shale, would not meet the EPA's radon flux standard.

In Appendix H, "Radon Flux Calculations," Section H.1.1.5, "Moisture Content," the DOE should provide additional justification for the 12% mean laboratory measured value (i.e., using method ASTM D3152) of the long-term moisture fraction of remolded Mancos Shale. The mean long-term gravimetric moisture content in 16 *in situ* samples of weathered Mancos Shale was 7% (2008 Final Remedial Action Plan [FRAP]), Addendum D, Calculation C-5, Table B-2, Radon Barrier Design). As noted in FSRP, Section 5.3.1.1, "Evaluation of Parameters," estimated values of the long-term moisture content will be compared to present *in situ* values to assure that the long-term value does not exceed the present field value derived from samples taken at a depth of 120 to 500 cm (but not close to water table).

2. In Appendix H, "Radon Flux Calculations," Section H.1.1, "Input Data for Radon Flux Modeling," if a portion of the modeled cover could be affected by freeze-thaw events, that portion should be represented in the model with lower density and corresponding higher porosity values than the unaffected portion (see Criterion 5.1.3.1(5) of NUREG-1620). In the 2008 FRAP, the freeze-thaw depth was estimated to be 43 inches, with a recurrence interval of 200 years, and the thickness of the rock armoring, frost protection, and biointrusion layers of four feet was deemed sufficient to ensure the freeze/thaw cycle would not affect the radon barrier. However, the surface admixture thickness above the radon barrier in the alternative cover design is less than or equal to 24 inches.

3. Section 5.1.1, "Cover Thickness and Layer Data," states, "Two different surface admixture thicknesses (18 inch and 24 inch) were computed dependent on the slope lengths (Figure 5)." Consider adding a figure similar to FRAP Figure 7-8, "Transition of Disposal Cell Top Cover to Side Slopes," to show the final alternative cover profile where the top cover transitions to the side slopes.

Technical Specifications

No additional comments beyond what was mentioned in comment 1c above.

Post Construction Monitoring Plan

In addition to the comment on post construction monitoring mentioned in Geotechnical Stability comment 1b above; the NRC staff offers the following comments on the post construction monitoring plan.

1. In Appendix F, it is recognized that some winnowing or movement of fines in the ET cover may occur. Therefore, it may be helpful to identify a threshold limit for when maintenance or repair is needed. This would allow DOE to focus on the overall performance of the cover.

2. Will DOE-LM have a role in post construction monitoring prior to turn over of the site for long-term care and maintenance?

3. How will the post construction monitoring plan be incorporated into the long-term surveillance plan? Will all items from post construction monitoring be performed in the long-term, or will the observed performance and experience developed during post construction monitoring inform what activities are included in the long-term surveillance plan?

National Environmental Policy Act

1. While not necessary at this stage of the review process, the NRC staff is interested in understanding how DOE plans to comply with the National Environmental Policy Act (NEPA) for this action. Are the activities proposed in the Design Report within the scope of what was considered in the 2008 Environmental Impact Statement (EIS)? Or does DOE plan to supplement the EIS to address the changes to the design? The NRC staff was a cooperating agency on the 2008 EIS, so understanding DOE's plan will inform the NRC staff's NEPA related activities going forward.

Administrative Items

In Table 7, "Profile 1: Radon Flux," there appears to be a typographical error in the value provided for the radon diffusion coefficient for the top layer (admixture) of cover. The value should be 820.7E-09, and not 872.0E-09.

In Section H.1.1.5, "Moisture Content," there is no discussion of the assumed moisture content for the interim cover material.