**Hanford Vitrified Low-Activity Waste (VLAW) Draft WIR Evaluation**
**9/14/2021 DOE-NRC Teleconference Summary**

By letter dated November 6, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20311A546), the Nuclear Regulatory Commission (NRC) issued a Request for Additional Information (RAI) to the Department of Energy (DOE) regarding its Draft Waste Incidental to Reprocessing (WIR) Evaluation for Vitrified Low-Activity Waste Disposed Onsite at the Hanford Site, Washington. The DOE provided its responses to these RAIs by letter dated June 21, 2021 and July 29, 2021 (ADAMS Accession No. ML21194A032 and ML21194A033).

On August 26, 2021 the DOE held a virtual public meeting with its contractors and the NRC to discuss its responses to the NRC RAI. During this meeting, the NRC identified RAI responses that would need further discussion, and as a result, the DOE established multiple public teleconferences to continue these discussions. The teleconference described below was the second of those teleconferences. Call-in information was posted on the DOE Hanford VLAW webpage (https://www.hanford.gov/page.cfm/VitrifiedLowActivityWaste) prior to the call.

The following attendance was observed for the teleconference:

- NRC Attendees: David Esh, Karen Pinkston, Maurice Heath
- DOE Attendees: Sherri Ross, Ingrid Milton, Gary Pyles, Kearn Lee, Buddy Cunningham, Dana Gribble, Jennifer Colborn, Rodney Skeen, Grace Chen, Randy Arthur
- Public Attendees: There were no public participants identified during this meeting

**Discussion**

The RAI responses discussed during this call were 2-3, 2-4, 2-12, and 2-21. These topics were associated with discretization used in the numerical modeling, near-field flow conditions, sensitivity and uncertainty analyses, and releases from the cementitious wasteform. A summary of the key points of the discussion is provided below.

**RAI 2-3 (Performance Assessment (PA) Modeling Discretization)**

NRC stated that DOE indicated that the modeling with the discretization artifacts were only used for boundary conditions for flow and transport modeling. The NRC asked if the boundary conditions were affected, would it also affect the flow and transport modeling. How much of an effect would there be?

- DOE responded that modeling for near-field flow was used to evaluate how much saturation there would be in the system and if partially saturated backfill would saturate. The modeling was used to evaluate how flow could get distributed through facility itself. However, when they modeled release, flow, and transport in the system they used boundary conditions (such as 0.5 mm per year and then 3.5 mm per year). The release modeling was independent from near-field flow modeling. An important aspect of flow within the disposal system is how flow comes through liner, if it gets redistributed through facility, and then how it gets redistributed by the liner. The boundary condition for the next part of the flow model is what comes through liner.

NRC asked if the discretization used in the modeling created smearing of moisture in the system. The NRC noted that the cap modeling has an area where the cap touches the ground surface and has high flow. Also, the NRC noted that there are drainage points under the waste that have increased infiltration and saturation when the drain is functioning. The NRC asked if there were artifacts in the near-field modeling from the discretization. The NRC also asked what the discretization looked like in the modeled release (e.g., was it continuous or stair-stepped?).

- DOE indicated that in the release modeling, releases were simulated out of the bottom of 1 m of compacted backfill separately from flow and transport modeling. DOE scaled up the modeled release from this 1 m point by the number of packages and used that as the input into the unsaturated zone model. DOE stated that their release model ignored transport between the backfill layer and the sump.

NRC asked about DOE's distributed and focused flow cases and if the discretization artifacts impacted those results. NRC stated it looked like the discretization artificially increased the amount of moisture above the facility and would artificially decrease the amount of water that flows through the drainage layer and the sumps under the waste.

- DOE indicated that in their terminology distributed and focused were the same thing, but they did look at cases where the flow was uniform (drainage lines were not working) and cases where drainage lines were working. DOE stated that the focused flow in the sumps was assumed in the compliance case. DOE indicated that the boundary condition in the vadose zone is from the near-field modeling. Discretization would impact that, but the results are more impacted by the presence of the liner. The liner itself was modeled as a continuous layer. In DOE's model, flux was prescribed at the top of the vadose zone (0.5 mm/y for the period from 100 to 500 years and 3.5 mm/yr after 500 years). The impact on performance between the uniform and focused flow (by drainage lines) cases was not significant.

NRC stated that the reports provided in the RAI response (for glass modeling) to address the impacts of discretization did not provide data, rather they only provided verbal statements about the impact of discretization. This is a potential source of bias in the results. Usually, discretization is addressed by refining the grid until the results are no longer changing

significantly. A 30% change between two different grid spacings may not seem large but there is not a good way of knowing intuitively the magnitude of the effect overall. NRC asked DOE if they have any other information about the impacts of finer grid discretization on glass release rates. For example, could DOE run more simulations with coarser grid spacings to at least define the shape of the curve?

- DOE agreed with NRC's characterization of the references provided. In the two Pacific Northwest National Laboratory (PNNL) reports cited the calculations went from a coarser grid to a finer grid such as 1 or 2 cm. In the PA modeling a 10 cm grid was used. The PNNL reports stated there was not a significant change in results due to grid spacing, so DOE used a 10 cm grid spacing in the PA because the 2 cm spacing models were taking a very long time to run. DOE initiated some 1 cm spacing runs while preparing the RAI response, but storms knocked out power during runs twice (in Austin, TX) and they lost the results after the model had been running for a week. During this week the model had only completed 14 days of simulation time and they needed the calculations to get to 300 days. Based on this, it was clear that it was going to take a very long time for the 1 cm spacing model to run, even when running parallel versions of Subsurface Transport over Multiple Phases Simulator (STOMP). Because the runs had not finished when the RAI response was needed, DOE decided to send the response without it. DOE stated that they could possibly run some simulations with coarser discretization to help define the shape of the curve.

- NRC and DOE discussed whether the dimensionality could be reduced to improve execution time. DOE indicated that the models were already 2D and by going to 1D models they would probably miss important phenomena that occur at the interfaces.

- DOE indicated that they had some very recent results from models with a 1 cm grid spacing and that the fractional release rates were an additional 20% higher than those found with the 2 cm spacing (which were 26% higher than the 10 cm spacing).

**RAI 2-4 (Near-Field and Unsaturated Zone Modeling Approach)**

NRC stated that the response to RAI 2-4 was reasonable overall, but the response did not really address the appropriate hydraulic conditions inside the fractured glass. NRC asked how DOE would know if their modeled flow through the fractured glass is reasonable. NRC noted that the modeling has a capillary barrier type effect of about an order of magnitude for the infiltration to the surface of the glass compared to what flows through the glass and that only about 10% of the water reaching the glass flows through it. NRC asked DOE what its plans were for the model validation of this result.

- DOE indicated they have plans for lysimeter experiments that will help to provide this

information. Those experiments will help to validate the models (gross validation) and release rates.

NRC expressed concern that DOE could be double crediting the reduction in flow through the glass because a reduction in transport within fractured glass was credited in the response to the RAI on glass cracking. NRC stated they may have a recommendation in this area to do full-scale testing of flow through cracked glass using glass samples produced by DOE prior to "hot" operations.

- DOE acknowledged the uncertainty in the moisture characteristic curves (MCCs) of fractured glass. DOE has some information on the MCCs, but it is uncertain. DOE stated that they performed additional sensitivity analyses for different moisture profiles and MCCs in glass, but they did not evaluate the uncertainty in MCCs directly. DOE said that they did not rerun STOMP for these calculations but instead used GeoChemist's Workbench. DOE indicated that these results were used to identify the potential magnitude of the impact of this uncertainty. DOE stated that this topic had been previously identified as a maintenance activity and that it continues to be a maintenance activity.

**RAI 2-12 (Sensitivity and Uncertainty Analyses)**

NRC stated there may be somewhat of a disconnect between the NRC and DOE on this question. NRC said that they realize that DOE has done sensitivity and uncertainty evaluations, but, similar to Waste Management Area-C (WMA-C), information derived from the hybrid approach (combining deterministic analyses plus sensitivity analyses plus uncertainty analyses) gives a complex picture with respect to risk. NRC is interested in the risk triplet – What can happen? How likely is it? What are the consequences? The hybrid approach can give mixed messages in terms of risk as the likelihood is mainly unknown for the combined uncertainty cases. The combined uncertainty cases for glass are good, but the results are hard to interpret without knowing the probability of the cases occurring. NRC asked what DOE's position is on the probability of the combined uncertainty cases.

- DOE stated that for the most part DOE did not derive probability distributions from laboratory experiments. The assumed probability distributions were typically triangular and were used to represent all sources of uncertainty.

NRC stated the challenge with the hybrid approach (using the system model and what if calculations) is the interpretation of results in a risk context. If the list of things that are evaluated using "what if" calculations is large, what do the results mean in risk space with respect to the significance of uncertainties? NRC would like to see these system uncertainties included in system model and possibly include alternate scenarios within the system model. If these what ifs are left out in the overall conclusions, interpretation of the results get muddied.

- DOE indicated they tried to include uncertainty in parameters and in what was developed for the “expected conceptual model”. DOE said that they have not included alternative conceptual models in the system model evaluation. DOE included the uncertainties they could in the system model and used alternative analyses otherwise.

NRC asked if DOE has compiled a list of everywhere that they have identified that changing x results a change in y in the one-at-a-time analyses. If only a few uncertainties are evaluated using the one-at-a-time analyses and there is a large margin between the results and the standard, then there is no issue taking this approach. However, if there is a long list of issues and uncertainties, the model results including full uncertainty could be significantly different. Has DOE compiled a list of all things addressed by local sensitivity analysis?

- DOE indicated that their deterministic result is about the 75$^{th}$ percentile value of their system model probabilistic result, which suggests that the deterministic result leans toward pessimistic side. DOE did not believe they had a compiled list in one place. DOE noted that it is difficult because different issues can move the results in different directions.

NRC is interested in the global combined uncertainty cases similar to what was done with glass and asked where that information be found. NRC discussed an example of uncertainties that were evaluated separately and were not evaluated in a combined case: uncertainties associated with the moisture characteristic curve for fractured glass, the bathtub effect, and inventory uncertainty (especially uncertainty from the splits of Tc and I between glass and the secondary wastes).

- DOE stated that they did not generate any new uncertainty analysis for RAI response and that they did not combine the evaluation of new uncertainties with previously assessed uncertainties.

NRC asked about an issue related to quality assurance and the performance assessment. In the RAI response, DOE indicated that an upstream error of the riex coefficient caused an overestimate of glass release (doses) by a factor of 7. This is a significant error in terms of magnitude (and a source of bias). Is there a need to trace the key inputs used in the PA back to the source and verify that the inputs are correct?

- DOE indicated that this error arose almost 15 years ago in analysis performed by a contractor. It is very difficult for PA modelers to pull this information from such a long time ago. DOE is now including the verification of historical information when pursuing new research. DOE said that they look at the research reports to make sure the information is consistent, but unfortunately in this case the inconsistency was not caught. DOE noted that they are always looking at ways to improve their quality

assurance processes. DOE is also looking into use of external reviews for reports and peer review from subject matter experts.

**RAI 2-21 (Releases from Cementitious Wasteforms)**

NRC stated that the response provided information about specifications, but the response did not describe how the performance of the wasteforms with those specifications is tested and verified.

- DOE indicated that the grout formulations presented in the response to RAI 2-21 were tested at the Savannah River Site (SRS) for development of the data package. DOE said that they had significant interaction with SRS in terms of contact with the vendor, appropriate cure times, etc, to ensure they understand the process in order to design laboratory experiments to develop grout formulations.

NRC stated that doing laboratory experiments ahead of time is good, but it is not as useful as measuring performance of actual wasteforms. Cements can be complex, and the presence of organic matter and other components can affect its performance. NRC said that not performing verification testing of wasteforms DOE makes is a risky proposition. NRC stated that DOE should do some verification at the beginning of operations and after any big process changes occur. NRC has not seen a robust argument that the development of specifications for cements/grouts accounted for composition variances and scale-up.

- DOE stated they do some leach and compressive strength testing when evaluating formulations and that those tests must show the performance is acceptable. DOE indicated they have a similar program for testing glasses. For simple things like encapsulation of debris, this is maybe not necessary, but they do have a design program for developing and quantifying the information needed for solidified waste forms.