Review of the Continued Analysis of Supplemental Treatment of Low-Activity Waste at the Hanford Nuclear Reservation

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Remarks from Maxwell Woods and Jeff Burright, Oregon Department of Energy

Max Woods

Good morning, and thank you for inviting us here today to provide the perspective from Oregon. My name is Maxwell Woods, I am assistant director for nuclear safety and emergency preparedness at the Oregon Department of Energy. I have a few opening remarks and then will pass to my colleague Jeff Burright, who will provide Oregon's specific comments.

During the kickoff to the Phase 1 study a few years ago, the committee heard from my predecessor, Ken Niles. Today, you will hear similar positions from myself and Jeff, as you did from Ken, particularly around the importance and value of ensuring that the Hanford cleanup is protective of the Columbia River and the groundwater that feeds the river. A core principle of Oregon's policy position is that when the stakes involve the potential for irreversible harm to an irreplaceable resource like the Columbia River, as it does with the tank waste mission at Hanford, a wise course of action is one that incorporates precaution.

Oregon can get behind Hanford tank waste treatment options that demonstrate long-term protection of the Columbia River. And, to that end, we hope this study will focus on developing models of grout performance that account for what is known, and what is unknown, about the performance mechanisms, the complex interactions between grout formulas and Hanford tank waste, and the confounding factors that come from real-world conditions. While I recognize this may take time, to help us understand the likely trade-offs involved in Hanford tank waste treatment options, we think it is necessary. I would also add that the assessment should consider waste disposal at locations other than Hanford, which may lead to a different set of study outcomes and results. Finally, we want the study to consider issues related to nitrate and nitrite, and how those constituents perform in grout.

We, and I believe many other parties, are placing a high level of trust in the federal research and the National Academies to provide answers to our many questions. Oregon is committed to following the scientific process, but we also bear in mind how strong *perceived* risk is when it comes to radiation, how highly the people in our state value the Columbia River, and how little Oregonians would support exposing the river and by extension ourselves, to *avoidable* risk.

The results of your study are likely to have a factor of uncertainty, and as such, will be open to interpretation with regard to policy direction. We request that you acknowledge that uncertainty to help inform the policy decision makers who may ultimately be relying upon the results of your study to make decisions on Hanford waste disposal.

And with that, I will turn over to my colleague Jeff Burright.

Jeff Burright

Hello, and thank you for the opportunity to speak to you again as you kickoff this next round of study. My name is Jeff Burright with the Oregon Department of Energy, and my focus is the Hanford tank wastes. I was following the last study closely and I did my best to contribute to forward progress from my position on the boat. Like Max said, I'm here today because Oregon has an enduring interest in the long-term safety and value of the Columbia River, and I mean value in all the ways you can mean it. My goal here today is to review the major aspects of our previous review, to call attention to some new questions that have arisen in the intervening time, and maybe to leave you with some food for thought as you design your inquiry this time around.

I want to start by acknowledging some of the key points that we gathered from the first study. You can see that most of our attention was focused on the questions surrounding grout.

As we stated in our letter, "The revised cost comparison between vitrification and grout appears to provide significant incentive to find an acceptable disposal context for a grouted waste form as a way to respond to the rising lifecycle costs at Hanford."

One of the phrases that stuck with me from the last time was this term, "disposal context", which encompasses the interconnected system of the specific waste constituents, the waste form, the interactions with the disposal environment, and location-specific uncertainties and resources at stake. We have tried to add to that context in our participation.

Now because our interest is focused on the fate of the groundwater at Hanford and the river it feeds, our participation in the previous study was really focused on that first assertion that grouted LAW would be adequately protective if disposed either onsite or offsite.

Most of you were here for this too, but I'll repeat it to jog all our memories and describe what I learned last time around, just in case I got any of this wrong and am due for correction.

The big idea that opened the door to revisiting grout performance is that if you have a reducing environment within the grout, then Technetium-99 becomes less soluble and stays in the grout longer.

The 2012 tank closure EIS assumed the use of reducing grout, but it turns out the modeled grout performance was based on a formula that didn't include a blast furnace slag reductant. This lent some credence to some of the new performance expectations, but we also discovered that it's not so simple as just this. For one, the research I've seen suggests that a reducing grout doesn't slow down iodine-129, which is another one of our key benchmark constituents.

When the FFRDC modeled the performance of a waste form at Hanford, they built on the efforts of the still-draft performance assessment for the IDF landfill that's slated to accept the vitrified low activity tank waste. Their performance evaluation, or "mini-PA" looked at a range of grouted waste form leachability based on laboratory experiments and an observation-based metric dubbed an "effective diffusion coefficient". The three categories were low, based on essentially the worst of the new data, high, based on more recent lab experiments of cast stone and similar reducing grouts, and a projected best case based on recent research into grout containing "getters" that are intended to hold the long-lived mobile constituents longer in the grout.

This is a good approach to understand the sensitivity of the overall safety case to waste form performance, but unfortunately there doesn't seem to be a firm sense regarding the probability of falling within one performance envelope versus another.

Here you can see again the essence of the "new grout" argument upon which the previous study built. This figure shows research results on Tc-99 effective diffusivity over the years. The newer data is based on reducing grouts, and the range of results is reflective of the importance of the chemistry of the water that comes into contact with the future waste form.

Here is the performance figure for iodine-129. For reference, borosilicate glass performance is expected to be in the range of a 10-7 fractional release rate for both Tc and Iodine. As part of their performance evaluation, the FFRDC team turned the data on the screen into a fractional release rate for grout, and they came up with roughly 10-4 for the low and high cases and got down to 10-7 for the "best case" assuming the use of getters, actually putting it on par with glass. For Technetium, the grout fractional release rate ranged from 10-4 for the low, to 10-7 for the high performing and even down to 10-8 for the best case performance with getters.

A large part of our review was focused on kicking the tires on these results and trying to understand the significance of the uncertainties associated with these research findings, to give that uncertainty its due. As we stated in our letter, because getters represent a "sub form" to a larger grout waste form, we think their long-term performance should be evaluated with the same rigor and scrutiny as the primary waste forms in the study before they are endorsed as a viable option.

Again, as you may recall, these slides were shown to the committee by the FFRDC team and I am shamelessly appropriating them here. The major finding of the Performance Evaluation was the assertion that onsite grouted SLAW could meet performance objectives for Tc-99 if we assume we can attain high or best performing results over time.

And here for the iodine case, the result indicated that the performance objectives for the IDF would only be maintained if we assume best case performance with getters. The figure on the bottom right further highlights that the glass from the first half of LAW will also be a significant contributor to future dose because of the secondary wastes that will contain an unknown but expected to be significant portion of the iodine that volatizes into the vitrification offgas system. The plan right now is to grout those secondary wastes and dispose of them onsite.

As an aside, I wonder what kind of risk budget we could buy if those secondary wastes had a better disposal context, and I hope the committee can find it within the scope of this study to entertain some holistic thoughts that look at Supplemental LAW in the context of the larger mission.

So now, finally, I get to Oregon’s review from the previous study. In case you haven’t read it, a shortened link is on the screen. The topics of our letter were focused on the potential impacts to Hanford gw and the Columbia river, which in large part depend on the integrity of the waste form in the presence of water, chemistry, and time.

If I had to pick one potent quotable from that letter, it would be this:

The FFRDC report becomes a rumination on what could be accomplished if the many assumptions underlying the analysis are true. The key question is whether they are in fact true and reliable over long time periods. If we treat the analysis as a thought experiment and ask whether Oregon could accept grouted LAW disposal at Hanford under the best-case performance scenario, then we would likely answer yes. Our review of the state of the science, however, would suggest that such an assertion cannot be made with sufficient certainty yet, nor is the path of technology development to get us to that point certain to succeed within an expedited timeframe.

This figure is a simplification of our areas of technical comment, and it’s an even grosser simplification of the diverse variations and combinations of grout formulas and additives that have been studied to address different problems posed by the wastes. It turns out that grout performance is a complicated dance of redox chemistry and waste handling process logistics.

For just a few examples, a paper from last year suggested that Silver ought to go in an oxidized grout, but Tc needs to go in a reduced grout. For another, it seems that the prime candidate getter for Tc-99 interferes with the prime getter candidate for iodine and makes it unstable. We also noted instances where researchers acknowledged that we aren't sure what the exact mechanisms of waste retention are, and further if we use silver as the iodine getter, there is uncertainty how long it will remain stable. There's also the idea that if the waste needs to be treated for organics to meet land disposal restrictions, that waste would then need to be brought back to a redox state that is compatible with the new reducing grouts. Finally, we noted that at the time of the prior study, the IDF Performance Assessment was not yet available for review. If we are looking at the entire disposal context for this study, I hope that the committee will carefully consider how the PA addressed the effects of uncertainty and the sensitivity of the results to multiple compounding unexpected conditions in the future. What's really lacking for me is a grand unified conceptual model of grout performance considering all the variables, uncertainties, and sensitivities.

As I said to this committee last time, our letter was not meant to be a condemnation of grout outright, although our assessment was that the state of the science had not yet reached a level of certainty that we were comfortable with. I asked the committee and those involved with this topic to consider our letter an invitation, that if you want to manage the perceived risks and uncertainties associated with grout performance, this might be a place to start the conversation with us.

I also want to call attention to something that has been percolating around the edges and which could challenge our assumptions and potentially the premise of this study. Those of you who were here last time may recall hearing from Al Kruger, the chief glass scientist for DOE, who provided a highly technical discussion of the recent advancements in the vitrification program at Hanford. Some of the implications of what he said are downright enticing, and I think this committee has an opportunity to really investigate how fast we can make the horse we've got. Just imagine if we could increase our glass production rate more than three-fold and also reduce the total mission by 20%. Is there a future in which Supplemental LAW isn't even needed, or are there fatal flaws? I for one think this is a stone worth turning over.

Somewhat related, but I'll also say I thought the committee had a pretty good idea last time around when it recommended a "hybrid approach" of essentially glassing the hard stuff and grouting the less complicated stuff. I hope we see that idea fleshed out too, including the logistical challenges of characterizing the tank waste well enough to know which path it needs to take.

Next, in the previous study, the FFRDC asserted that pretreatment for Tc and iodine is not necessary for onsite disposal of grout, yet they state that in order to obtain best results (or even acceptable results for iodine), getters must be added to the mixture. These getters perform a similar function to pretreatment – separating the long-lived constituents into a sub-form within the larger waste form structure of grout. The difference I see between pretreatment and getters is the final resting place.

So, on the one hand you have the notion that additional pretreatment is not necessary if getters can be believed to provide adequate waste form performance for onsite disposal in grout. However, the opposite is also true: getters are not necessary if additional pretreatment of technetium and iodine is pursued. We are pleased to see included in the scope of this new analysis a greater emphasis on pretreatment of these risk-driving long-lived and mobile radionuclides, and through this study we would like to better understand the potential benefits and challenges associated with further separation and treatment of these.

As our agency has stated in other position letters, we view Technetium-99 (Tc99) and Iodine-129 (I-129) to be “key radionuclides” that should be removed from low activity wastes to the extent practical. These constituents were listed as “radionuclides of interest” in the original NRC-DOE discussions of classifying LAW as incidental, but it was determined in 1997 that no technically or economically practical separation process for these constituents existed at that time.

Nearly three decades of technological advances have been realized since that analysis. We note that the 200 West Pump and Treat facility has reportedly been successful at removing both constituents simultaneously from site groundwater using a Purolite ion exchange resin, but we have seen no analysis of the potential to transfer this technology for tank waste treatment.

Our understanding of the prior agreement between DOE and the State of Washington, memorialized in the 2012 Tank EIS, was that a Tc-99 pre-treatment capability was originally included in the WTP design but was later removed with the understanding that LAW would be vitrified, and the Tc and I would be retained in the glass. If this waste is instead retained in secondary wastes and encapsulated in grout, then the basis for not including an additional separation technology should be revisited.

I’ll also note that NRC staff observed recently, and rather cleverly, that the volatilization and offgassing of Tc and I from the vitrification system also serves as a de facto separation treatment method, opening the potential to dispose of these offgassed constituents into a HLW stream or potentially offsite.

Now unfortunately I have a curveball for you.

In a recent tour of the history of the prior grout program at Hanford, and I came across something that made me concerned there might have been an important shortcoming in the Phase 1 study. After the grout program failed at Hanford in the 90s, one of the concluding analyses stated that the key obstacles for grouted waste at Hanford weren't limited to Tc-99 and I-129, but also included nitrate and nitrite. This got me thinking about how little I've been thinking about nitrate.

I went back to the FFRDC report from the prior study to see how nitrate was evaluated. What I realized was that it wasn't calculated for the grout case performance evaluation, but the steam reforming and vitrification cases did both acknowledge qualitatively the benefit of destroying the nitrate. However, the analysis doesn't provide an estimate of the concentration of nitrate and nitrite in groundwater if SLAW were to be disposed in the IDF as grout, like it did with the radionuclides. The analysis did assume a chemical oxidation pretreatment step would destroy organics prior to grouting, but it doesn't appear to me that this would apply to nitrate. Maybe I'm missing something.

Next, I went to the IDF PA source term and it hit me – the PA is based on vitrified LAW, so it assumes the nitrate is destroyed! Rather than the 56 million kilograms of nitrate in the BBI, it assumes the IDF only contains around 164,000 kilograms. In fact, the IDF PA doesn't include any results for nitrate or nitrite migration to groundwater.

After running this past colleagues at WA Ecology, they reminded me about the recent IDF Risk Budget Tool report that was developed at their request. Based on the closest analogue waste from the vitrified LAW secondary wastes, you can see on the screen that the limiting constituents for onsite grout disposal might not be the radionuclides after all, but the nitrate and nitrite that would not be destroyed via a thermal process.

I don't know how to look at this information and conclude that grout is as good as glass. This seems like a pretty important consideration for future SLAW technology decisions, and again maybe I missed it, but I did not see this addressed in the FFRDC's prior analysis. It is my hope that by bringing this to your attention early, it can be included within the scope of the analysis going forward.

While I have you, I'd like to offer some closing thoughts.

The energy right now coming off the first study is to pursue off-site disposal of grouted LAW with all appropriate speed. We got a good enough look at it last time that the hope of it made people excited. Can this be the answer to DOE's prayers for an achievable cleanup? It would be such a convenient thing for this mission and for the country's treasure which must be spent wisely given many oncoming calamities in our future. However, this is when it's important to be even more careful - when trying to prove something you want to believe.

As I've acknowledged here, there is real data from reputable grout scientists showing performance that might be as good as glass (if you discount the nitrate question). But there are things we do not know. How long will the effect last? What will cause it to undo, and what is the rate of undoing? We are focusing so much on the leading edge, but it's the long tail that worries me. We need real world leaching data from representative wastes, some with getters and some not. The unfortunate thing it needs is time. If we rush it, that becomes another risk we need to manage. The problem is we might not know we made the wrong call until we've taken irreversible action. When do you know enough to take a risk? It depends on what you're risking.

Here I feel an obligation to put in a word for precaution. The precautionary principle is predicated on the idea that when there is a threat of irreversible harm to an irreplaceable resource, you should take all reasonable measures to prevent that harm. It encourages you to go the extra mile, and importantly it does not require proof of a negative effect in order to act to forestall it. The problem with precaution though is that it's nigh impossible to prove the absence of risk. The fashionable counter-argument lately has been that if you try to avoid all risk, you'll never leave your house, and that has risks of its own. We are in a sea of risk. Some is voluntary and some not. Some is well understood, and some is just our best guess. And yet, we have to pick a direction and row.

However, I think the precautionary principle is highly applicable to the unique challenges of radioactive waste management and compatible with other risk management schools of thought such as robustness and adaptive management.

Robustness I would characterize as closest to the DOE philosophy – try to anticipate all the things that could go wrong, then overbuild. The problem with that approach is that it's limited by our imaginations for misfortune and complex failures, and also if you pay attention you might notice how prone to overuse the term has become to whitewash over all manner of uncertainties.

Adaptive management says to take a small step and watch it carefully, and always leave yourself room to maneuver and a capacity to respond to the unexpected. Unfortunately, there isn't much room for nimbleness when you're talking nuclear waste forms. Grout for Hanford could be not good enough only we wouldn't know it until it's long past too late. The way it tends to work with radiation risk is everything will be humming along fine for who knows how long, then suddenly oops oh jeez we've got a problem. What if we make a million bricks of grout and an offsite disposal plan falls through? What mess will we be in then? What actions could we take today to lessen the consequences of those potential future states?

Even if offsite disposal becomes the preferred solution, I believe there will come a day when the pendulum swings again toward further expediency and thrift, and someone someday will ask a room of their staff "why can't we just bury this stuff where it was made? Why is this a necessary cost?" This study could illuminate the answer to that question. It could emphasize the importance of putting the constituents that matter in the right disposal context.

You the Committee are here to be a part of this story as we collectively try to navigate the human drama of risk and threat and value, of technical understanding and consent. You wear a mantle of perceived trust and objectivity. Of commitment to the scientific process and to giving the appropriate weight to the things we do not know, when a decision is due. To report truthfully absent politics, yet objectivity acknowledging the importance of the political because we have all been here long enough. We know that perceived risk affects real value. My expectation and my charge to you is to please live up to that trust. Thank you, and I look forward to learning alongside you again.

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