Communicating Performance Assessments Results - 13609

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ABSTRACT

The F-Area Tank Farms (FTF) and H-Area Tank Farm (HTF) are owned by the U.S. Department of Energy (DOE) and operated by Savannah River Remediation LLC (SRR), Liquid Waste Operations contractor at DOE's Savannah River Site (SRS). The FTF and HTF are active radioactive waste storage and treatment facilities consisting of 51 carbon steel waste tanks and ancillary equipment such as transfer lines, evaporators and pump tanks. Performance Assessments (PAs) for each Tank Farm have been prepared to support the eventual closure of the underground radioactive waste tanks and ancillary equipment. PAs provide the technical bases and results to be used in subsequent documents to demonstrate compliance with the pertinent requirements for final closure of the Tank Farms. The Tank Farms are subject to a number of regulatory requirements. The State regulates Tank Farm operations through an industrial waste water permit and through a Federal Facility Agreement approved by the State, DOE and the Environmental Protection Agency (EPA). Closure documentation will include State-approved Tank Farm Closure Plans and tank-specific closure modules utilizing information from the PAs. For this reason, the State of South Carolina and the EPA must be involved in the performance assessment review process. The residual material remaining after tank cleaning is also subject to reclassification prior to closure via a waste determination pursuant to Section 3116 of the Ronald W. Reagan National Defense Authorization Act of Fiscal Year 2005.

PAs are performance-based, risk-informed analyses of the fate and transport of FTF and HTF residual wastes following final closure of the Tank Farms. Since the PAs serve as the primary risk assessment tools in evaluating readiness for closure, it is vital that PA conclusions be communicated effectively.

In the course of developing the FTF and HTF PAs, several lessons learned have emerged regarding communicating PA results. When communicating PA results it is important to stress that the primary goal of the PA results is to provide risk understanding, recognizing the magnitude of risk and identifying the conceptual model decisions and critical assumptions that most impact the results. Conceptual models that describe reality using simplified, mathematical approaches, and their roles in arriving at the PA results, must also be communicated. When presenting PA results, evaluations will typically be focused on a single baseline (or Base Case) to provide a foundation for discussion. The PA results are supplemented by other studies (alternate configurations, uncertainty analyses, and sensitivity analyses) which provide a breadth of modeling to supplement the Base Case. The suite of information offered by the various modeling cases and studies provides confidence that the overall risk is understood along with the underlying parameters and conditions that contribute to risk.

Introduction

Performance Assessments (PAs) are used to assess the long-term fate and transport of residual contamination in the environment and provide the DOE with reasonable assurance that the operational closure of the SRS Tank Farms (waste tanks and ancillary equipment) will meet defined performance objectives for the protection of human health and the environment into the future. PAs are intended to estimate consequences of facility closure over time, both chemically and radiologically. The PAs are typically most focused on determining "peak dose" or "peak concentration" (i.e., worst results over a one-year period) throughout an extended period of evaluation. PAs reflect uncertainty inherent in conceptual modeling and also identify key parameters for which the models have the greatest sensitivity (i.e., the key parameters of greatest importance).

Primary Goal when Presenting PA results

When communicating PA results it is important to stress that the primary goal of the PA is to provide risk understanding. PAs provide information regarding relative magnitudes of risks, and need to clearly articulate the expected risks under the most probable and defensible conditions. PAs should build confidence that projected doses are reasonably likely to be within a given standard of comparison.

PAs quantify the general magnitudes of risks involved and identify the conceptual model decisions and critical assumptions most impacting results, but are not typically constructed to calculate precise dose results. PA results are not meant to be a precise prediction of actual doses to real people nor an assessment of worst case scenarios. What is most important for the PA results is to provide perspective on the significance of various features captured in the conceptual model and to demonstrate an understanding of the system.

In order to best communicate results, PAs need a breadth of modeling – recognizing that there is no single "right" approach to assessing long-term fate and transport of residual contamination. Attacking the problem on multiple fronts is one way to address modeling uncertainty. PAs should concentrate on defining a most probable and defensible modeling case (i.e., the baseline modeling scenario or Base Case), but should also supplement the Base Case with a full tool box of additional models and studies. It isn't helpful to pretend the Base Case results are absolute and infallible – the uncertainty surrounding conceptual modeling and time sensitive inputs require that PA results need to be presented within their underlying context.

Role of the Base Case

The PA utilizes conceptual models that are reasonable simplifications of the closure systems being evaluated. It is not important that the model capture all design features of the closure system, but it is important that it capture features that impact results. The Base Case provides the foundation for understanding PA results. Consideration of results requires common ground for discussing risk (base case) and uncertainty. Ensuring that there is a single modeling case with well understood design elements allows for discussion of results from a common framework. Also note that while the base case captures the best knowledge available, it will still allow for introduction of new knowledge.

PA results are often used in comparison to regulatory standards or performance objectives. Establishing the Base Case as the most probable and defensible modeling case provides justification for its use as a "comparison" case. Initial modeling and research efforts should be geared towards maximizing understanding of the Base Case, thus providing confidence that the system performance is well understood. The Base Case captures system behavior in such a way that differences from expected behavior are understood and justified.

Once a Base Case is established, the most effective way to communicate PA results is to display underlying facets of the Base Case in multiple graphic and tabular formats. For example, running a Base Case model can produce a single peak radiological dose result over time (i.e., the peak all-pathways dose to a member of the public) as shown in Figure 1, but that single dose curve doesn't convey the spatial complexity involved when determining peak doses. Figure 2 shows that the location of the peak dose changes over time, with respect to the modeling sectors The various sectors, shown in Figure 3, allowed variability in peak concentration for different areas of the HTF to be more easily evaluated). Figure 4 shows that the radionuclides contributing to the peak dose also changes over time. Figure 5 illustrates which inventory sources contribute to the peak dose over time. Finally, Figure 6 shows how the water ingestion dose contribution to the peak dose changes over time, so as to help in understanding how the makeup of the dose scenario (e.g., water ingestion versus vegetable ingestion) impacts the total dose. It is important to convey and clearly explain the radiological and inventory complexity involved when determining peak doses since many of the modeling inputs and barriers to release are dependent on timing, location, source term, radionuclide contributions, or dose pathways. These figures provide better understanding of the model and where the system may be sensitive to different assumptions.

Figure 1 – Base Case Peak Dose Over Time

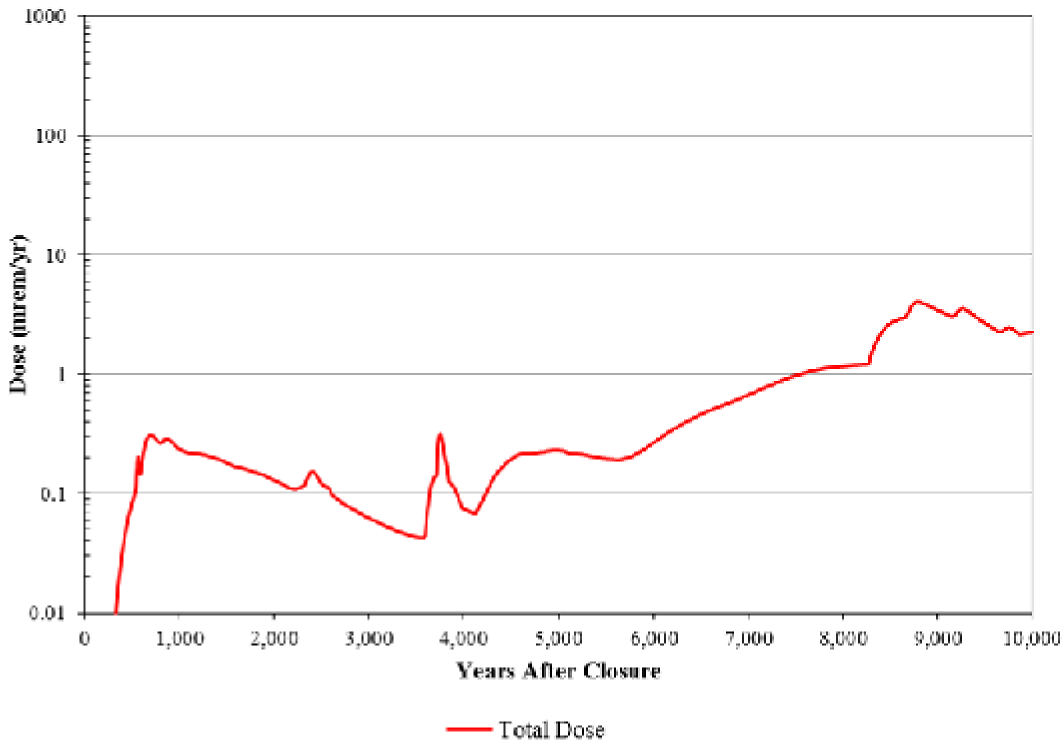


Figure 2 - Base Case Peak Dose Over Time by Sector

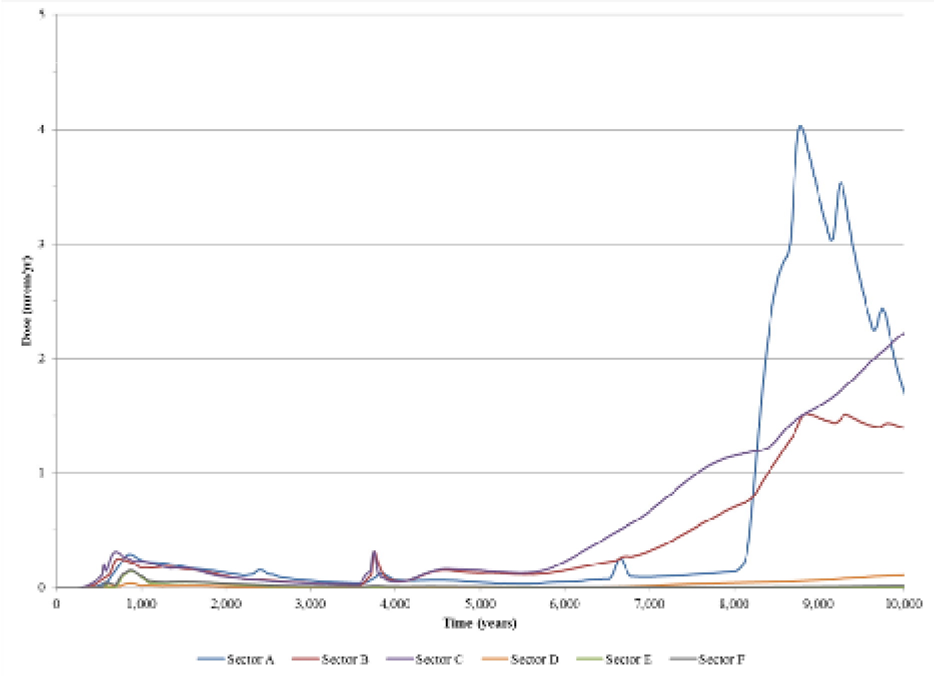


Figure 3 - Model Evaluation Sectors

Figure 4 - Base Case Individual Radionuclide Contributors to Sector A Peak Dose

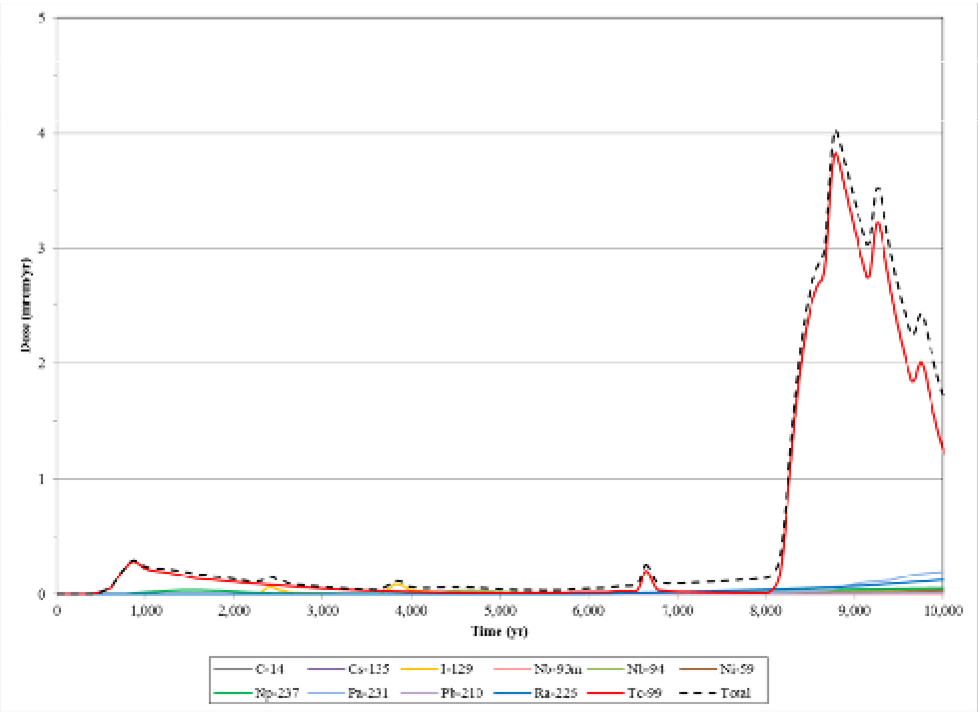


Figure 5 - Base Case Individual Source Contributors to Sector A Peak Dose

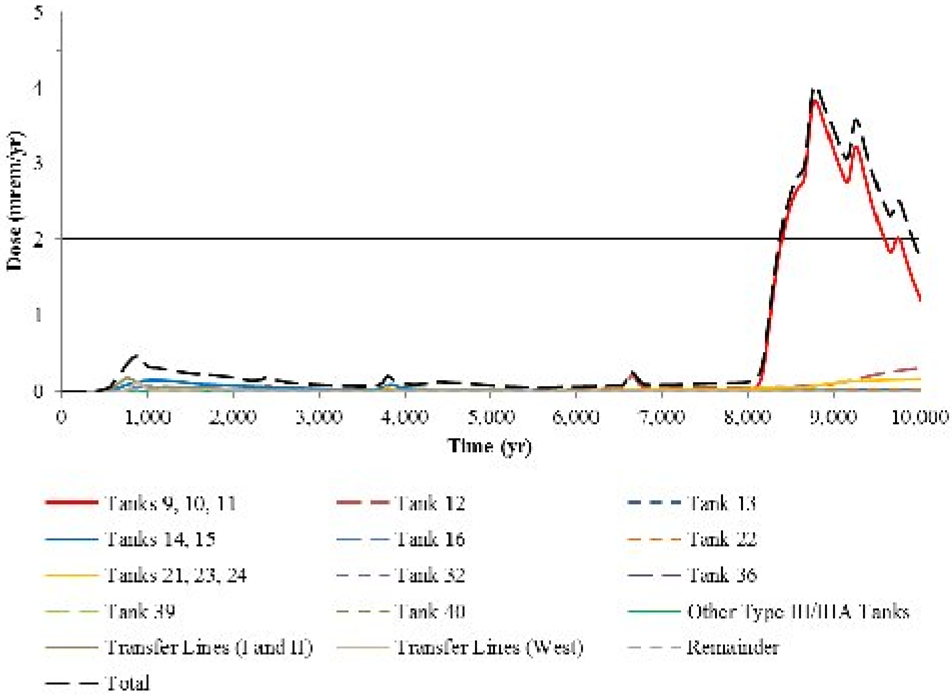
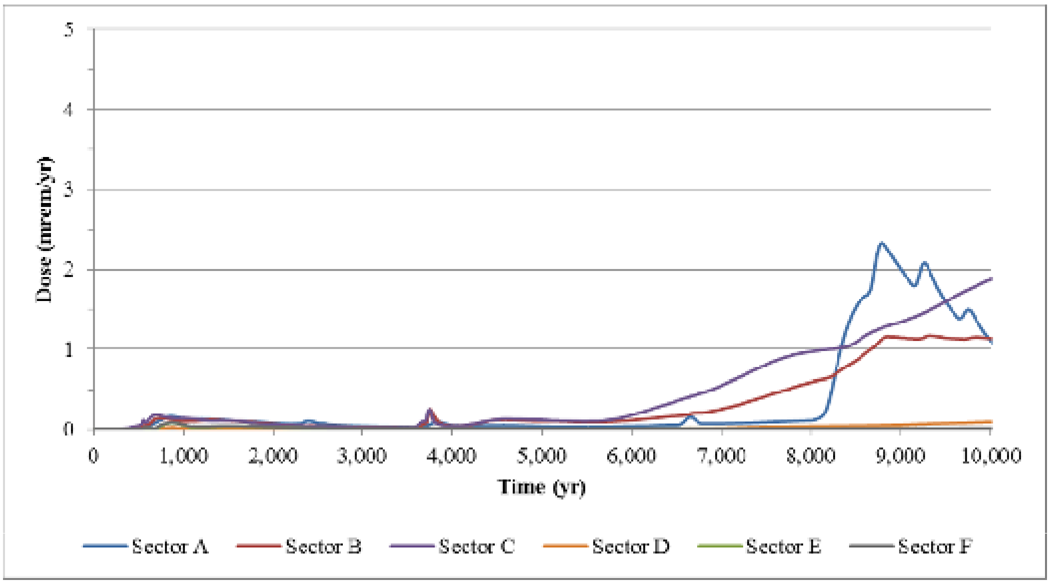


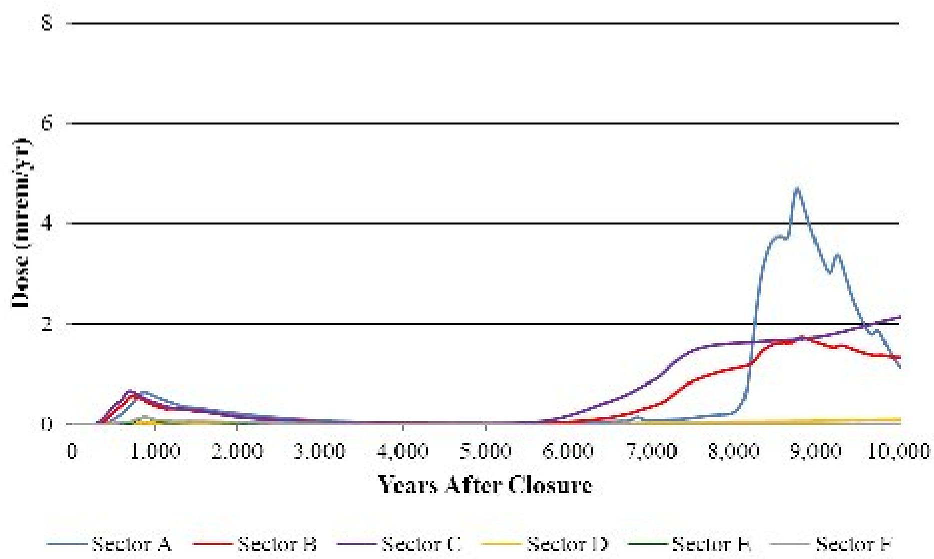
Figure 6 – Base Case Water Ingestion Contribution to Peak Doses



Role of Additional Modeling to Support the Base Case

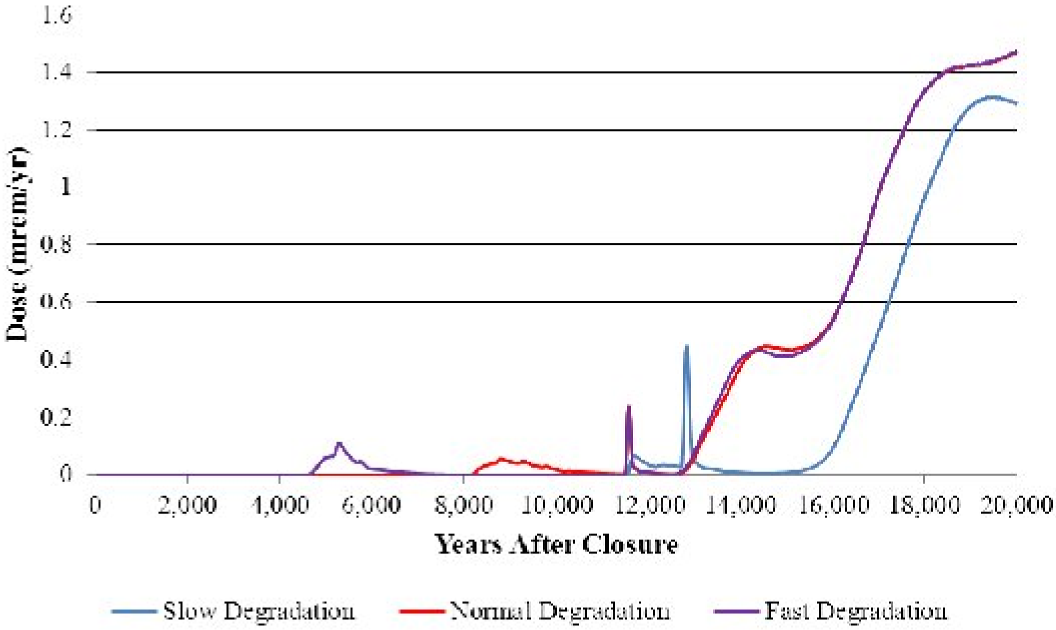
With a Base Case established as a foundation for assessment, additional modeling should be performed in support of the Base Case. These additional studies serve different purposes and can be useful in communicating different ideas. Alternate modeling configurations can be modeled to shows the impact of specific modeling choices. These alternate configurations would use the Base Case as a starting point, but would demonstrate how changes to the Base Case influence results. For example, the Base Case could be modified to show what would happen if a closure cap were not put in place (Figure 7). This analysis can then be used to facilitate discussion of the role of the closure cap and its impact on modeling results.

Figure 7 – No Closure Cap Case Peak Dose Over Time by Sector



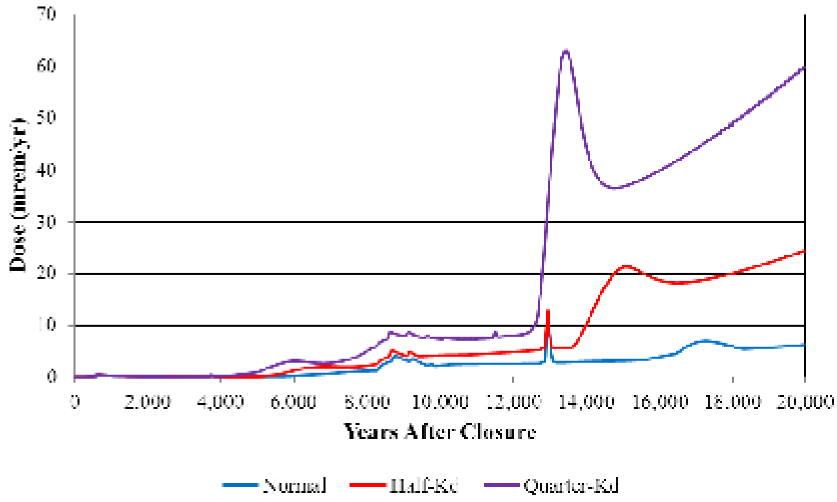
In addition to alternate configuration evaluation, sensitivity studies can aslo provide insights relative to the Base Case. Sensitivity studies should focus on areas of importance, initially informed by understanding of the Base Case, with additional understanding building iteratively through performance of multiple sensitivity studies. One area that needs to be emphasized as part of the sensitivity analyses is the performance of design elements that serve as barriers to release (e.g., waste tank steel liners, waste tank concrete basemats). Barrier analyses validate the Base Case model construction with regards to whether the Base Case captures those design features that can significantly impact results. For example, Figure 8 shows a sensitivity analysis where the Base Case was modified to show the impact on peak dose if the cementitious materials used degrade at different rates (both faster and slower).

Figure 8 – Impact of Cementitious Material Degradation Timing on Peak Dose



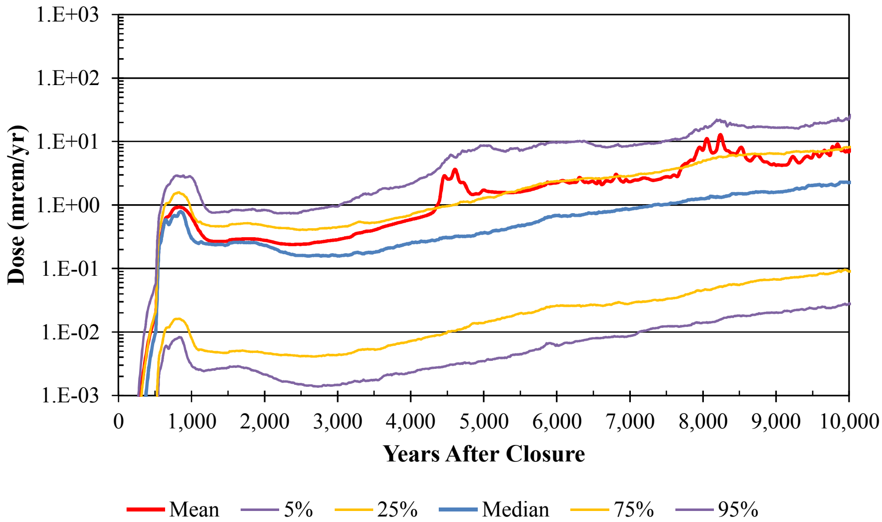
Sensitivity studies should also investigate the importance of critical modeling inputs and assumptions. For example, Figure 9 shows a sensitivity analysis where the Base Case was modified to show the impact on peak dose if soil retardation properties were varied. The sensitivity analysis in Figure 9 compares base case (normal) soil behavior to modeling where the soil is less effective by degrees (one-half and one-quarter) in retarding the movement of radionuclides through soil after release from the waste tanks.

Figure 9 – Impact of Soil K_d Variability on Peak Dose



Understanding of the PA results is further improved through uncertainty analyses. Uncertainty is inherent in simplified numeric models that attempt to replicate engineered or natural systems. Supplementing the Base Case deterministic model with probabilistic models provides a vehicle to explicitly quantify parameter uncertainty in order to bound the range of possible dose outcomes. The probabilistic model can be run multiple times to develop results to support the probabilistic analyses. The modeling runs use the Monte Carlo method to sample uncertain parameters. Each modeling run performed multiple realizations, where each realization represents a unique possible future outcome. The Monte-Carlo method samples values from each of the uncertain parameters during each realization. Collectively, the multiple runs and realizations cover a probabilistic range for each parameter. The results of the independent realizations are assembled into probability distributions of possible outcomes, which provide insight into the Base Case model. Figure 10 is a statistical time history showing peak dose variability for a set of 1,000 Base Case realizations.

Figure 10 – Statistical Time History of Base Case Doses



In addition to graphic statistical analysis, the uncertainty analysis can be used to investigate which probabilistic modeling realizations most affect the overall results. The uncertainty analyses results with the highest dose consequences can be reviewed to identify which combination of parameters, when they occur concurrently, produce dose results that are significantly higher than others. Parameters of interest are identified that have the greatest potential to influence the results. For example, a review of the peak realizations revealed that Tc-99 inventory variability was a modeling parameter that often showed up in the peak realizations. This investigation of realizations of interest provides another source of knowledge into what assumption most affect the conceptual model.

CONCLUSION

The primary goal of the PA results is to provide better understanding of the risks associated with the fate and transport of contaminant following final closure of the Tank Farms. To achieve this goal, the PA should provide results concentrating on the relative magnitude of risk while identifying the conceptual model decisions/critical assumptions most impacting these results. Having a single baseline or comparison modeling case (i.e., base case) as a foundation for discussion makes achieving the desired understanding of risk easier. The PA base case results are supplemented by other studies (alternate configuration, uncertainty analyses, and sensitivity analyses) which provide a width and breadth of modeling to supplement the base case. The suite of information offered by the range of modeling studies ties together to show which decisions/critical assumptions most impact results, providing confidence that the overall risk is understood along with the underlying contributors to risk.