

Tank Farm Closure - A New Twist on Regulatory Strategies for Closure of Waste Tank Residuals Following NUREG

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

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Tank Farm Closures – A New Twist on Regulatory Strategies for Closure of Waste Tank Residuals Following NUREG – 1854 – ABST # 8434

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ABSTRACT

Waste from a number of single-shell tanks (SST) at the U.S. Department of Energy's (DOE) Hanford Site has been retrieved by CH2M HILL Hanford Group to fulfill the requirements of the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) [1]. Laboratory analyses of the Hanford tank residual wastes have provided concentration data which will be used to determine waste classification and disposal options for tank residuals. The closure of tank farm facilities remains one of the most challenging activities faced by the DOE. This is due in part to the complicated regulatory structures that have developed. These regulatory structures are different at each of the DOE sites, making it difficult to apply lessons learned from one site to the next. During the past two years with the passage of the Section 3116 of the *Ronald Reagan Defense Authorization Act of 2005* (NDAA) [2] some standardization has emerged for Savannah River Site and the Idaho National Laboratory tank residuals. Recently, with the issuance of *NRC Staff Guidance for Activities Related to U.S. Department of Energy Waste Determinations* (NUREG – 1854) [3] more explicit options may be considered for Hanford tank residuals than are presently available under DOE Orders.

NUREG – 1854, issued in August 2007, contains several key pieces of information that if utilized by the DOE in the tank closure process, could simplify waste classification and streamline the NRC review process by providing information to the NRC in their preferred format. Other provisions of this NUREG allow different methods to be applied in determining when waste retrieval is complete by incorporating actual project costs and health risks into the calculation of "technically and economically practical." Additionally, the NUREG requires a strong understanding of the uncertainties of the analyses, which given the desire of some NRC/DOE staff may increase the likelihood of using probabilistic approaches to uncertainty analysis. The purpose of this paper is to discuss implications of NUREG – 1854 and to examine the feasibility and potential benefits of applying these provisions to waste determinations and supporting documents such as future performance assessments for tank residuals.

INTRODUCTION

DOE plans to close their Hanford tanks and ancillary equipment in compliance with RCRA [4] and relevant chapters of DOE M 435.1-1. [5] It is expected that residual waste will be present at closure. The present plans for closure involve

- 1) retrieving as much waste from the tanks as is technically and economically practical,
- 2) preparing closure plans, performance assessments and waste determinations as described by DOE M 435.1-1, and
- 3) implementing the closure plans.

Once the waste determinations have been issued by the Secretary of Energy, plans are to close tanks and ancillary equipment with residuals in place, by first grouting and then covering them with an infiltration/intruder barrier and maintaining institutional controls for an as yet unspecified period of time.

Tank farms at DOE sites other than Hanford, i.e., Savannah River, Idaho, and West Valley, have specific legislation that covers tank closures and those laws allow DOE somewhat more flexibility than currently available under DOE M 435.1-1. For example, specific language in the West Valley License Termination Rule [6] eliminates the need for waste to be less than Class C low-level waste, as long as the performance objectives of 10 CFR 61 Subpart C [7] are demonstrated with reasonable assurance. Likewise, the NDAA of 2005 allows waste that may be classified as greater than Class C, such as transuranics in amounts greater than 100 nCi/g, to be closed in place provided the performance objectives of 10 CFR 61 Subpart C can be demonstrated and provided DOE consults with the NRC on Closure Plans. This increased flexibility in the waste determination process was needed at these sites in order to move forward with tank closures. Additionally, the S3116 of the NDAA [2] creates a uniform approach to classification to widely varying residual constituents and one that has increased confidence with state regulators, as they learn to work with the NRC.

Disposal Pathways for Residuals under DOE M 435.1-1

Fig. 1 illustrates the disposal pathways for various types of waste residuals as defined in DOE M 435.1-1. This figure starts with waste streams that are presently managed by DOE-ORP as high-level waste (HLW) or as other waste needing disposal. This waste must be sampled and its waste classification determined.

The WIR process of Chapter II allows waste to be classified as low-level waste (LLW) or transuranic waste (TRU) if certain criteria are met. For transuranics, Chapter III allows disposal under 40 CFR 191 [8] or an equivalent process with DOE self-regulating.

There are three exceptions to the definition of transuranic waste: the high-level waste exception; the degree of isolation exception; and the NRC-approved disposal exception.

- **High-Level Waste Exception.** The definition of transuranic waste includes exceptions for some (i.e., high-level) wastes that would otherwise be considered transuranic waste.
- **Degree of Isolation Exception.** The second exception to the definition of transuranic waste is waste that is determined to not need the degree of isolation that is provided by implementation of the disposal requirements of 40 CFR Part 191. This allows the Secretary of Energy to make a determination to remove these wastes from the transuranic waste definition based on an evaluation of a proposed disposal concept. Such a determination would have to be submitted to and concurred with by the EPA Administrator in a multi-step process.
- **NRC-Approved Disposal Exception.** The exception to the definition allows NRC to authorize such waste to be disposed without necessarily invoking the additional

requirements of 40 CFR Part 191. While existing guidance indicates that this option would be for NRC licensed facilities, the passage of the NDAA has shown that DOE is willing to consult with NRC in matters of disposal of tank wastes, so this option is listed as a possibility.

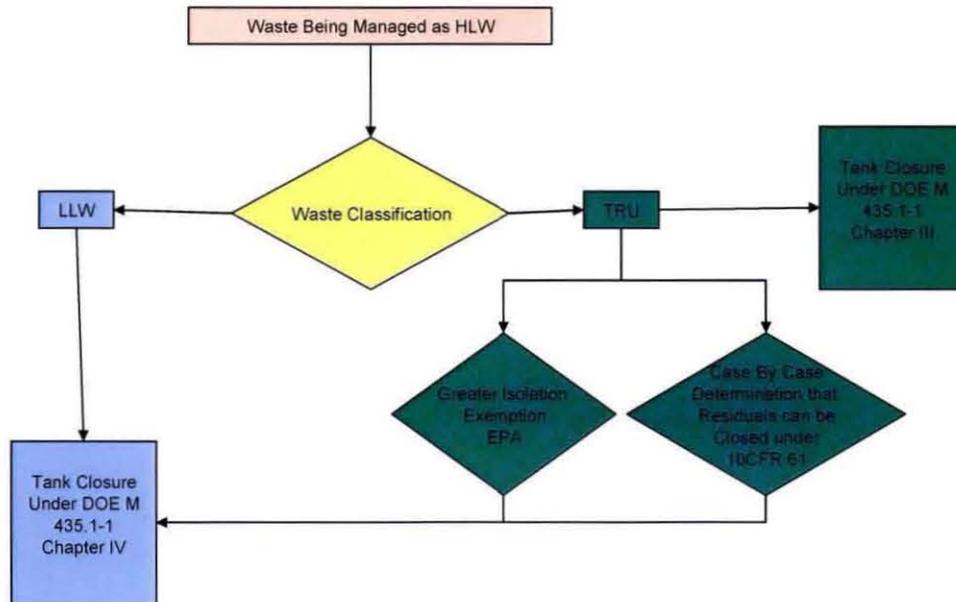


Fig. 1. Classification Options Under DOE M 435.1-1

In contrast, if after a WIR Evaluation residuals can be shown to meet Class C concentrations as defined in Tables 1 and 2 in 10 CFR 61.55, after adding a stabilizing grout, the LLW disposal route is much less complicated. In this circumstance, disposal as LLW under Chapter IV would be regulated by DOE.

A complication arises under DOE M 435.1-1 when waste residuals are deemed to be transuranics by process history and therefore, not HLW. In this case, Chapter II requirements for WIR do not apply and this waste must be disposed under Chapter III. While this may not appear significant, it becomes problematic in terms of compliance. For example, in a given tank farm some tanks may be closed under the LLW provisions of Chapter IV and other tanks within the same farm would be closed under Chapter III provisions. Performance assessments under Chapter III and Chapter IV may be quite different. Assessments under Chapter III require probabilistic analyses while, to date Chapter IV assessments at Hanford have been deterministic. Further, probabilistic analyses can not be used as the basis for RCRA compliance under Washington Administration Code WAC-173-340-708, Section 11, thus severely restricting the use of probabilistic analyses to make Hanford Site decisions. Having two performance assessments addressing two different regulations will confuse and complicate an already complicated closure process. A systematic and consistent approach to closure that can handle a wide range of contaminants and concentrations needs to be developed. This could be accomplished by Washington being included as a “Covered State” under S3116 or developing a Site-Specific waste classification based on the NUREG – 1854 methodologies.

NUREG – 1854 and Impacts to DOE ORP

The U.S. Nuclear Regulatory Commission (NRC) expects the NDAA enactment to increase the number of waste determinations submitted for review. The technical aspects of the NRC waste determination reviews are expected to be similar for all four sites (i.e., Savannah River, Idaho, West Valley and Hanford), regardless of whether the site is covered by the NDAA. A thorough review of NUREG – 1854 gives the DOE Office of River Protection (ORP) insight into the NRC technical review priorities; so that performance assessments and future waste determinations may be better directed toward addressing these NRC priorities.

Key Topics: The NUREG – 1854 addresses three topics considered important to Hanford tank closure under DOE Order 435.1.

- Waste Incidental to Reprocessing (WIR) Criterion 3 (DOE M 435.1-1 Chapter II B (2)(a) (3)) Waste classification
- WIR Criterion 1 (DOE M 435.1-1 Chapter II B (2)(a) (1)) Removal of key radionuclides to the maximum extent that is technically and economically practical.
- Uncertainty analyses (DOE M 435.1 Chapter IV B (2)(e))

WIR Criterion 3

DOE M 435.1-1 defines a process whereby waste that is currently managed as HLW can be determined to be not HLW by meeting 3 criteria, termed the WIR Criteria. WIR Criterion 3 states that [wastes]:

“Are managed, pursuant to DOE’s authority under the Atomic Energy Act of 1954, as amended, and in accordance with the provisions of Chapter IV of this Manual, provided the waste will be incorporated in a solid physical form at a concentration that does not exceed the applicable concentration limits for Class C low-level waste as set out in 10 CFR 61.55, Waste Classification: or will meet alternative requirements for waste classification and characterization as DOE may authorize.”

Typically, the DOE follows guidance in the NRC Branch Technical Position (BTP) on Concentration Averaging and Encapsulation (January 17, 1995) [9] to calculate waste classifications. For tank residuals, the BTP allows concentration averaging over the volume of waste and stabilizing material if the waste is reasonably well mixed, as follows.

“In most cases, the ratio of the unstabilized to stabilized radionuclide concentrations would not be significantly greater than a factor of 10 for waste classification purposes.”

In other words, the BTP allows a mixing credit (dilution)—not to exceed a factor of 10—for adding a stabilizing grout when determining waste classification of tank residuals. Waste adhering to vertical tank walls may be averaged over the volume or mass of the structure in direct contact with the contamination plus a layer of stabilizing material. Example 2-2 in the

BTP indicates the concentrations of a thin layer of waste on a vertical tank wall would be reduced by a factor of 20 for estimating waste classification, if a volume basis were used.

In NUREG – 1854, the NRC has taken a different approach to waste classification for tank waste residuals to better reflect actual conditions in tank farms. The guidance provided in NUREG – 1854 is applicable to tank farms including residuals and infrastructure related to the tanks. NUREG – 1854 is clear that the methodology provided is to be used by NRC staff as a check on DOE calculations. DOE is expected to utilize their own site-specific methodology to arrive at waste classifications. The NRC also states that other provisions for the classification of residual waste may be acceptable, if the performance objectives of 10 CFR 61 Subpart C can be demonstrated with reasonable assurance.

NUREG – 1854 presents three categories of calculations to determine waste classification for residuals. The first two categories are the same approach as put forth in the BTP; the third category is new.

- Category 1 – for waste that can be mixed and is fairly homogenous.
- Category 2 – for waste that cannot be well mixed and is stabilized in place.
- Category 3 – a risk informed approach to provide flexibility recognizing site-specific conditions.

Given current tank closure plans, Category 3 analyses are appropriate at Hanford.

Four examples were provided in NUREG – 1854 within the Category 3 approach. These examples are for wastes that are either near surface (< 5 meters) or deeper (>5 meters) and considers whether the facility has a robust intruder barrier or not:

- Waste > 5 meters with a robust intruder barrier
- Waste > 5 meters without an intruder barrier
- Waste < 5 meters with a robust intruder barrier
- Waste < 5 meters without an intruder barrier

For Hanford SST residuals, the Category 3 calculations for waste deeper than 5 meters with a robust intruder barrier are most applicable to current closure plans for tank farms and associated equipment. Under Category 3, the DOE may develop site-specific scenarios. The example calculation shown in NUREG – 1854 for deeper waste with a robust intruder barrier is given below as equation 1.

$$RC_i = \frac{WC}{Conc.Limit} * \frac{WasteThickness}{DrillDepth} * 7 \quad \text{Eq. 1}$$

where:

RC_i is utilized in 10 CFR 61.55 table 1 or 2 and the Sum of the Fractions Rule applied. (To be Class C waste, the sum of the fractions cannot exceed 1.)

WC = actual waste concentration

Concentration limit * is taken from Tables 1 or 2 of 10 CFR 61.55

Waste Thickness is actual waste thickness

Drill Depth is depth to the water table or resource

7 = factor applied by NRC to address differences in dose calculations and uncertainty

The existing basis for waste classification at Hanford is that of the NRC BTP on concentration averaging, which allows a factor of 10 dilution in concentration using stabilizing grout. DOE may want to pursue a slightly different calculation as the basis of an alternate waste classification. The intruder calculations in the Single-Shell Tank System Performance Assessment (SST PA, DOE/ORP-2005-001) [10] are done in using a similar philosophy to that which created equation 1. For reference case analyses, the intruder analyses performed by the SST PA indicate that both chronic and acute dose limits are achieved and that performance objectives comparable to 10 CFR 61 Subpart C can be demonstrated. Therefore, DOE could utilize a similar approach to that of NUREG – 1854 Category 3, to develop a site-specific waste classification at Hanford and still meet the performance objectives of 10 CFR 61 Subpart C.

Impacts to DOE ORP

If the methodology of NUREG – 1854 were applied to classify tank residuals, a much larger dilution factor could be realized; i.e., greater than the factor of 10 currently utilized. Fig. 2 illustrates the different methodologies employed at Hanford. The first methodology is a direct comparison against the Class C tables of 10 CFR 61.55 which is done for LLW disposal facilities and no concentration dilution is applied. The second method is that of the NRC BTP and shows the concentration dilution factor of 10 applied to account for grout addition. The third example shows the potential dilution that may be gained by applying the methodology of NUREG – 1854 to Hanford tank wastes and utilizing the factor of 7 in the NRC NUREG. For purposes of this illustration, a residual waste thickness of 1 inch and a well depth of 300 ft were assumed. For actual waste determinations, waste distributions and assumptions regarding borehole depths will likely need to be based on tank specific conditions.

For information purposes, the NUREG – 1854 equation 1 was applied to Hanford SST projected waste residual volumes, i.e., 360 ft³ and 30 ft³, projected waste residual inventories and for actual depths to the water table at each tank farm location. The results are shown as Figs. 3 and 4. Fig. 3 represents tanks in the 200 East Area and Fig. 4 represents tanks in the 200 West Area. If DOE chooses to apply this type of methodology directly for waste classification, it would result in all but four tanks meeting the criteria for Class C low level waste. The four tanks that fail the Class C tables do so in the sum of the fractions for Table 1, i.e., long-lived transuranics.

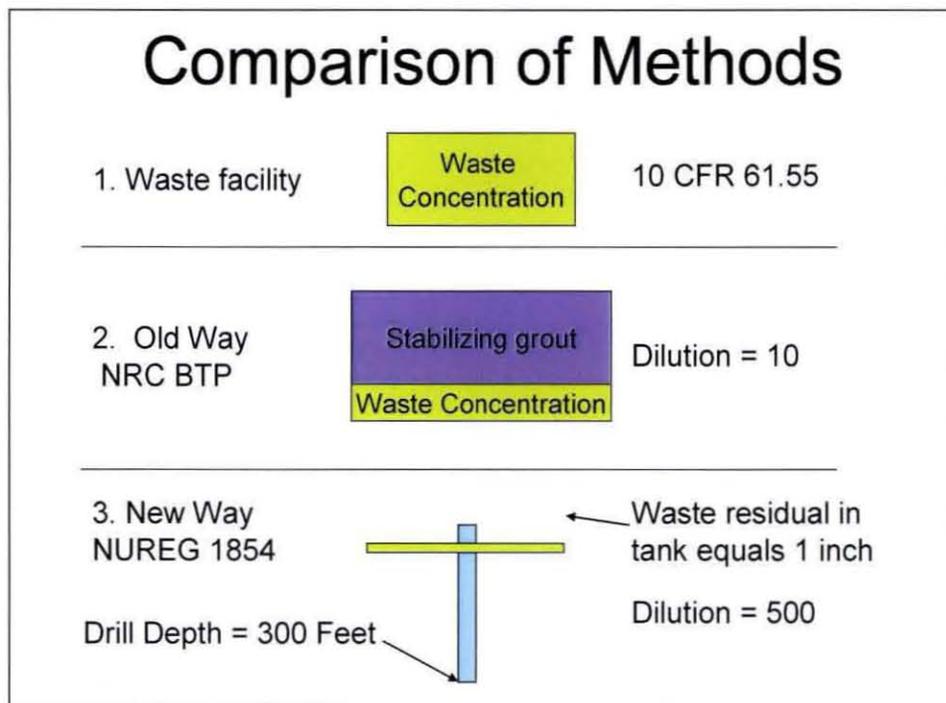


Fig. 2. Concentration Limits – Comparison of Methods

WIR Criterion 1

DOE M 435.1-1 Chapter II b (2)(a) states that [waste]: will be managed as low-level waste and meet the following criteria

1. Have been processed or will be processed, to remove key radionuclides to the maximum extent that is technically and economically practical;

Regarding analyses of “removed to the extent technically and economically practical,” the NRC states that the decision to terminate removal activities should be based on a demonstration that additional removal would be impractical.

“In general, the decision to terminate removal activities should be based on a demonstration that additional removal would be impractical. For example, a statement that 99 percent of waste has been removed from a tank is not a sufficient basis for stopping removal, but a demonstration that removing the remaining waste would not substantially reduce risks and would cause excessive worker dose would be sufficient.”

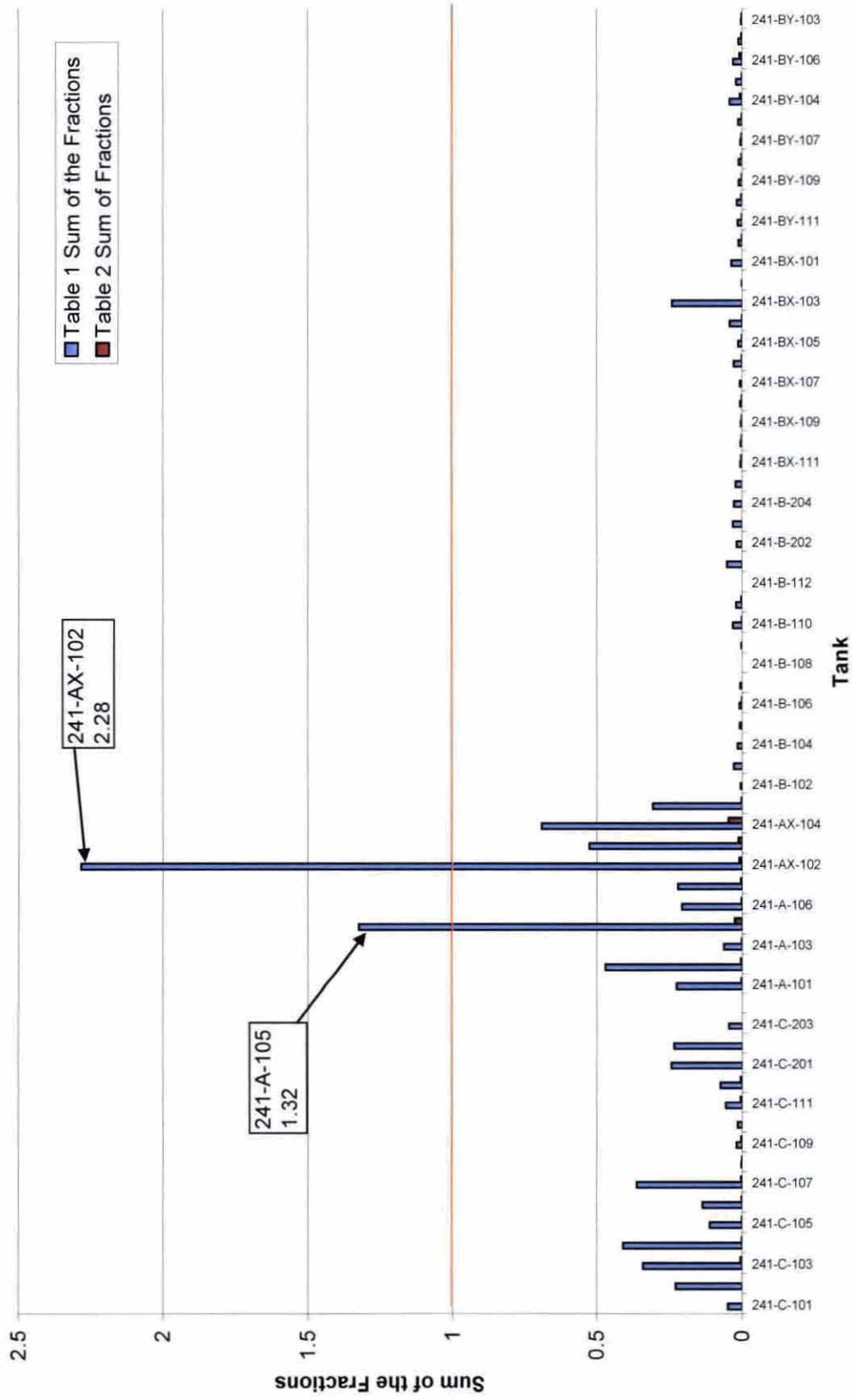


Fig. 3. East Area Tanks Calculated by NUREG – 1854 Methodology Comparison to NRC Class C Tables.

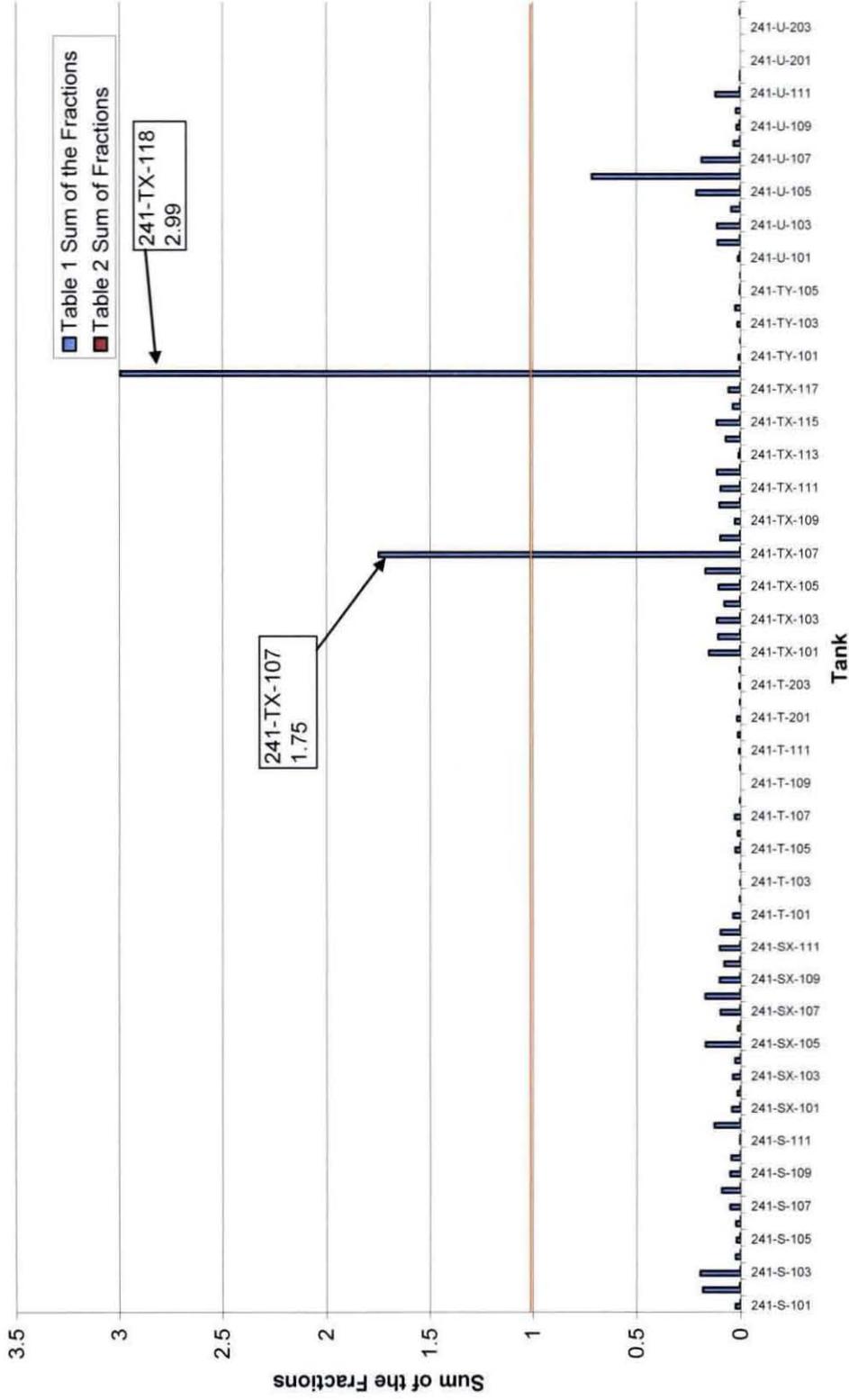


Fig. 4. West Area Tanks Calculated by NUREG – 1854 Methodology Comparison to NRC Class C Tables.

The NRC is attempting to “risk-inform” the analysis of technically and economically practical by allowing a quantitative demonstration of risk into the analysis. Previously, most demonstrations of sufficiency were based primarily on waste removal efficiencies. What is new is that these demonstrations may also include not only direct but also indirect costs and worker risks from schedule impacts. NUREG – 1854 states the following:

“The comparison of potential costs and benefits should be quantitative to the extent practical. For example, if DOE indicates that additional radionuclide removal is impractical because it would significantly delay its tank closure schedule, the reviewer should evaluate any increases in dose or financial cost that DOE expects to result from the schedule delay. In reviewing the waste determination for salt waste disposal at the Savannah River Site, NRC staff considered the potential costs of schedule impacts, facility slowdown, and tank space issues in evaluating the practicality of additional removal of highly radioactive radionuclides (NRC, 2005).”

Impacts to DOE ORP

The definition of indirect costs needs to be clarified with Headquarters or the NRC, to distinguish between project costs and schedules, such as QA, safety, etc, amounting to about 10 – 20 million dollars annually, and mission impacts, (retrieval, treatment and closure) amounting to approximately one million dollars per day.

The ability to include increased costs and risk to workers due to schedule delays into calculations of technical and economic practicability will allow DOE to better quantify the actual costs of performing additional retrieval. The HFFACO retrieval goals would still have to be demonstrated at Hanford.

Uncertainty Analyses

NRC emphasis on uncertainty is not new, but its importance is underscored in NUREG - 1854 in all aspects of analysis. Thus, NUREG – 1854 gives DOE advance warning and the opportunity to prepare or plan for development of uncertainty information to support PA and any future WIR analyses.

Impacts to DOE ORP

With respect to uncertainty, the NRC wants to have a clear understanding of all the uncertainties involved in any analysis supporting a waste determination.

Although NUREG – 1854 allows deterministic analyses (with sufficient sensitivity and uncertainty analyses), conversations with NRC and DOE staff indicate that probabilistic analyses may receive more support. As the GoldSim[®] Monte Carlo simulation software

system is widely used in DOE and NRC, its use should be considered. However, Washington Administration Code WAC-173-340-708, Section 11 severely restricts the use of probabilistic analyses to make decisions.

“Probabilistic Risk Assessment. Probabilistic risk assessment methods may be used under this chapter only on an informational basis for evaluating alternative remedies. Such methods shall not be used to replace cleanup standards and remediation levels derived using deterministic methods under this chapter until the department has adopted rules describing adequate technical protocols and policies for the use of probabilistic risk assessment under this chapter.”

There are additional costs that need to be considered in developing a probabilistic approach to uncertainty analyses, such as cost of proprietary software and training for a few PA team members. Another consideration is the extensive time that will be required to develop distributions for input parameters to a probabilistic analysis. This means key parameters such as inventory of residuals, may require more sampling of tank residuals. Additional laboratory work may also be required to develop distributions for other key parameters such as distribution coefficients (Kds) for certain contaminants of concern, or for release rates.

SUMMARY

A number of methodologies within NUREG – 1854 would be advantageous for DOE to consider when implementing future tank closures, if Washington cannot be included as a “Covered State” under S3116. Should DOE continue with NRC consultation during tank closures, these methodologies have the potential to save considerable time and money when classifying wastes or deciding when to stop retrieval operations.

While it is clear that inclusion in S3116 may be the preferred route for Hanford because all activities and reviews are formalized in law, approaches such as NUREG – 1854 should also be considered. It should be noted that if DOE decides to apply NUREG – 1854 approaches to classify waste residuals, there still needs to be discussion with the regulators regarding contaminants containing transuranic radionuclides.

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