Basis for Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site - 11177

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ABSTRACT

To proceed with closure of F-Tank Farm at the Savannah River Site (SRS), the United States Department of Energy (DOE) plans to determine, in consultation with the United States Nuclear Regulatory Commission (NRC), whether the waste remaining in the waste tanks or ancillary structures following successful completion of waste removal activities and subsequent stabilization, the waste tanks, and the ancillary structures (including integral equipment) at the time of F-Tank Farm closure meet the criteria set forth in Section 3116 of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA) [1] and thus are not high-level radioactive waste. To demonstrate and document that the criteria will be met, DOE has completed development of the *Draft Basis for Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site* [2] (hereinafter referred to as Draft F-Tank Farm 3116 Basis Document) and has entered into the consultation process with the NRC. The purpose of this paper is to discuss the approach that DOE is utilizing to demonstrate that the criteria set forth in Section 3116 of the NDAA have been met.

INTRODUCTION

The SRS is a DOE facility located in south-central South Carolina, approximately 161 kilometers (100 miles) from the Atlantic Coast. The major physical feature at SRS is the Savannah River, approximately 32 kilometers (20 miles) of which serves as the southwestern boundary of the site and the South Carolina-Georgia border. The SRS includes portions of Aiken, Barnwell, and Allendale Counties in South Carolina. The SRS occupies an almost circular area of approximately 803 square kilometers (310 square miles). The facility began operations in the 1950s with the mission to produce nuclear materials for national defense, research, medical and space programs. Today, the primary focus at SRS is environmental restoration with the highest priority being removal, treatment and disposal of the radioactive waste in two radioactive waste storage facilities, the F- and H-Tank Farms.

The F-Tank Farm is an active radioactive waste storage facility operated by Savannah River Remediation, LLC, the Liquid Waste Operations contractor at SRS. The F-Tank Farm is in the north-central portion of the SRS and occupies approximately 8.9 hectares (22 acres). The F-Tank Farm consists of 22 carbon steel underground radioactive waste storage tanks and supporting ancillary structures (e.g., transfer lines, evaporators, pump tanks). There are three major waste tank types in F-Tank Farm (Types I, III/IIIA and IV) with nominal operating capacities ranging from approximately 2,840,000 to 4,920,000 liters (750,000 to 1,300,000 gallons). Two of those waste tanks were cleaned and operationally closed in 1997, prior to enactment of NDAA Section 3116. Waste removal and closure preparations are in progress for a number of other F-Tank Farm waste tanks and ancillary structures. Figure 1 provides an aerial view of the F-Tank Farm at SRS.

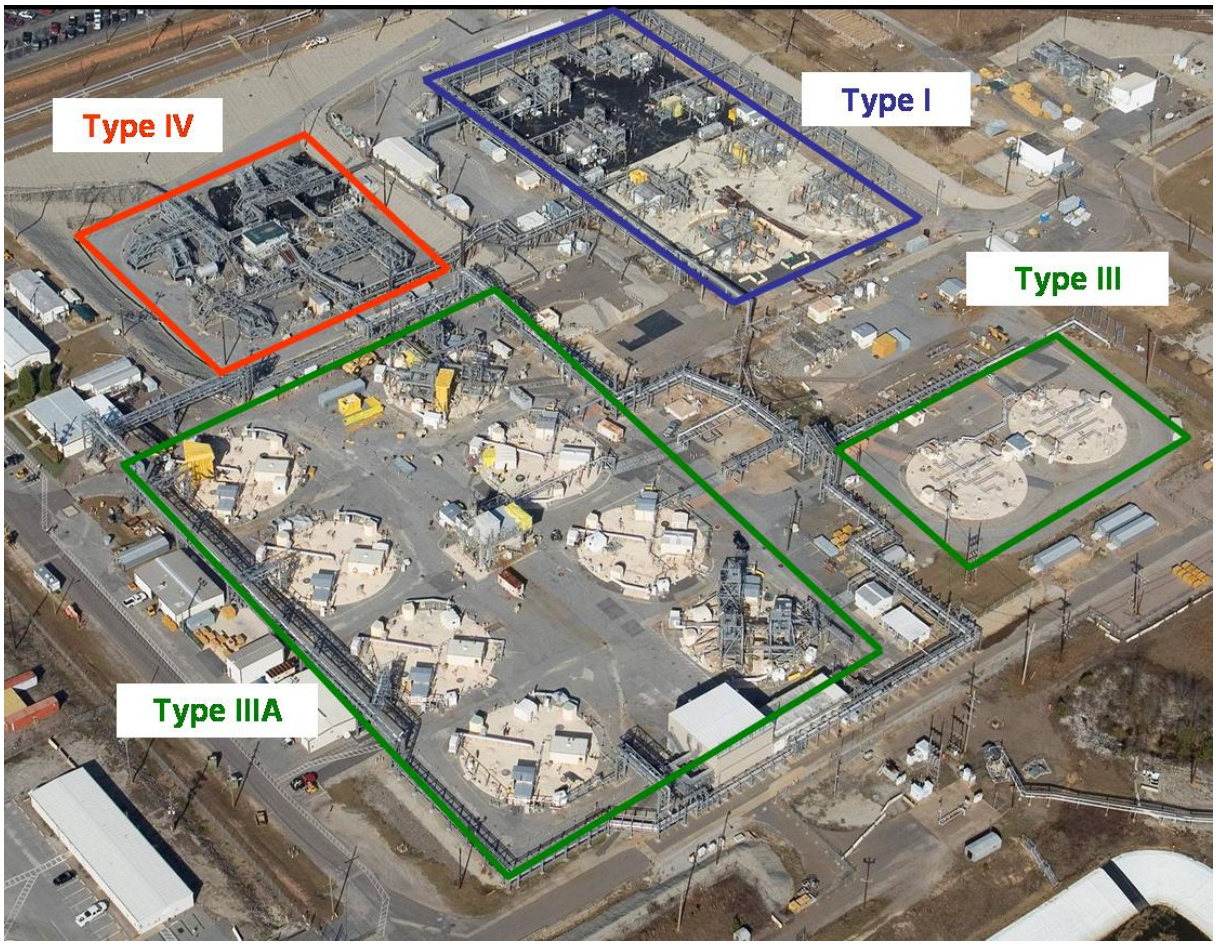

Figure 1. Aerial view of the F-Tank Farm at SRS.

To proceed with closure of F-Tank Farm at the SRS, the DOE plans to determine, in consultation with the NRC, whether the waste remaining in the waste tanks or ancillary structures following successful completion of waste removal activities and subsequent stabilization (i.e., stabilized residuals), the waste tanks, and the ancillary structures (including integral equipment) at the time of F-Tank Farm closure meet the criteria set forth in Section 3116(a) of the NDAA and thus are not high-level radioactive waste.

WASTE DETERMINATION PROCESS

Section 3116 of the NDAA provides the Secretary of Energy a methodology to determine that certain waste resulting from prior reprocessing of spent nuclear fuel are not high-level radioactive waste if it can be demonstrated that the waste meets the criteria set forth in Section 3116(a) of the NDAA. The Secretary of Energy, in consultation with the NRC, has made two previous determinations pursuant to Section 3116(a) of the NDAA, one for salt waste disposal at the SRS Saltstone Disposal Facility [3] and the second for disposal of the stabilized residuals and tank system at the Idaho Nuclear Technology and Engineering Center Tank Farm Facility at the Idaho National Laboratory [4].

To demonstrate and document, in support of a potential NDAA Section 3116 determination by the Secretary of Energy, that the stabilized residuals within the waste tanks and ancillary structures, the waste tanks, and the ancillary structures (including integral equipment) located at the SRS F-Tank Farm at the time of closure meet the criteria set forth in Section 3116(a) of the NDAA, DOE developed the Draft F-Tank Farm 3116 Basis Document which will serve as the basis for a determination by the Secretary of Energy.

To gain early consensus and understanding of the content to be included in the Draft F-Tank Farm 3116 Basis Document, DOE and Savannah River Remediation, LLC conducted a public scoping meeting with the NRC. The process was intended to expedite the identification of issues and the NRC's views on the reasonability of DOE's approach to demonstrating compliance with the Section 3116(a) criteria, thereby allowing for a more informed and efficient consultation with the NRC and a more informed draft document for public comment [5]. Taking into consideration the input provided by the NRC during the public scoping meeting, as well as public comments provided at the meeting, DOE completed development of the Draft F-Tank Farm 3116 Basis Document and has provided the document to the NRC for review and comment under their consultative role within Section 3116 of the NDAA. Although not required, DOE also issued the document for public review and comment [6]. The Draft F-Tank Farm 3116 Basis Document will be finalized after DOE completes consultation with the NRC and the Secretary of Energy has made a determination pursuant to Section 3116(a) of the NDAA.

SECTION 3116 OF THE NDAA

Section 3116(a) of the NDAA provides that radioactive waste that results from reprocessing is not "high-level radioactive waste" if the Secretary of Energy determines, in consultation with the NRC, that the waste meets certain specified criteria.

The NDAA Section 3116(a) provides in pertinent part:

In General – Notwithstanding the provisions of the Nuclear Waste Policy Act of 1982, the requirements of section 202 of the Energy Reorganization Act of 1974, and other laws that define classes of radioactive waste, with respect to material stored at a Department of Energy site at which activities are regulated by a covered State pursuant to approved closure plans or permits issued by the State, the term "high-level radioactive waste" does not include radioactive waste resulting from the reprocessing of spent nuclear fuel that the Secretary of Energy (in this section referred to as the "Secretary"), in consultation with the Nuclear Regulatory Commission (in this section referred to as the "Commission"), determines –

(1) does not require permanent isolation in a deep geologic repository for spent fuel or high-level radioactive waste;

(2) has had highly radioactive radionuclides removed to the maximum extent practical; and

(3)(A) does not exceed concentration limits for Class C low-level waste as set out in section 61.55 of title 10, Code of Federal Regulations, and will be disposed of –

(i) in compliance with the performance objectives set out in subpart C of part 61 of title 10, Code of Federal Regulations; and

(ii) pursuant to a State-approved closure plan or State-issued permit, authority for the approval or issuance of which is conferred on the State outside of this section; or

(B) exceeds concentration limits for Class C low-level waste as set out in section 61.55 of title 10, Code of Federal Regulations, but will be disposed of –

(i) in compliance with the performance objectives set out in subpart C of part 61 of title 10, Code of Federal Regulations;

(ii) pursuant to a State-approved closure plan or State-issued permit, authority for the approval or issuance of which is conferred on the State outside of this section; and

(iii) pursuant to plans developed by the Secretary in consultation with the Commission.

F-TANK FARM PERFORMANCE ASSESSMENT

The SRS has developed an F-Tank Farm Performance Assessment [7] which provides the technical basis, analyses and results which serve as the main technical reference for demonstrating that the criteria in Section 3116(a) of the NDAA will be met after F-Tank Farm closure. These analyses were performed using a variety of modeling codes including the PORFLOW deterministic code and GoldSim probabilistic code. Individual F-Tank Farm system behaviors are evaluated within the F-Tank Farm Performance Assessment for various waste tank and ancillary structure configurations, including a base (expected) case, which provides results reflecting the closure system behavior. The F-Tank Farm Performance Assessment provides, among other analyses, the development and calculation of the potential radiological doses to a hypothetical member of the public and a hypothetical inadvertent intruder. These calculations were performed to provide information over a minimum of 10,000 years. In addition, uncertainty and sensitivity analyses were used to ensure reasonably conservative information is available to develop risk-informed conclusions related to the closure of F-Tank Farm. As required by the DOE Order 435.1, [8] maintenance of the F-Tank Farm Performance Assessment will include future revisions to incorporate new information, update model codes, etc., as appropriate.

DRAFT F-TANK FARM 3116 BASIS DOCUMENT

The following sections outline the approach that has been taken within the Draft F-Tank Farm 3116 Basis Document to demonstrate compliance with the criteria set forth in Section 3116(a) of the NDAA.

Waste Does Not Require Permanent Isolation in a Deep Geologic Repository for Spent Fuel or High-Level Radiological Waste

As shown above, the NDAA Section 3116(a) sets out three criteria. Criterion (1) is a broad criterion that allows the Secretary of Energy, in consultation with the NRC, to determine whether waste that meets the other two criteria may need permanent isolation in a deep geologic repository in light of these considerations. Generally, such considerations would be an unusual case because waste that meets the other two criteria would be waste that will be disposed of in a manner that meets the 10 CFR 61, Subpart C performance objectives and either falls within one of the classes set out in 10 CFR 61.55 that the NRC has specified are considered “generally acceptable for near-surface disposal” or for which the Secretary of Energy has consulted with

NRC concerning DOE's disposal plans. Normally, it follows that if disposal of a waste stream in a facility that is not a deep geologic repository will meet these objectives, in the ordinary case, that waste does not "require permanent isolation in a deep geologic repository" because non-repository disposal will be protective of public health and safety.

However, it is possible that in rare circumstances a waste stream that meets the second and third criterion might have some other unique radiological characteristic or may raise unique policy considerations that warrant its disposal in a deep geologic repository. For example, the waste stream could contain material that, while not presenting a health and safety danger if disposed of at the near- or intermediate-surface, nevertheless presents non-proliferation risks that the Secretary of Energy concludes cannot be adequately guarded against absent deep geologic disposal.

This is not the case with the stabilized residuals within the waste tanks and ancillary structures, the waste tanks, and the ancillary structures (including integral equipment) located at F-Tank Farm at the time of closure. As discussed in the following sections, the waste will meet the other two NDAA Section 3116(a) criteria so as to provide for the protection of the public health and the environment. Accordingly, the waste does not require disposal in a deep geologic repository due to the risk to public health and safety. Furthermore, the waste does not raise any unique considerations that, notwithstanding these demonstrations, require permanent isolation in a deep geologic repository.

Waste Has Had Highly Radioactive Radionuclides Removed to the Maximum Extent Practical

Based on consultation with the NRC, DOE views "highly radioactive radionuclides" to be those radionuclides that, using a risk-informed approach, contribute most significantly to radiological risk to workers, the public and the environment. Radionuclides determined to be highly radioactive radionuclides for F-Tank Farm may not be listed in other 3116 Basis Documents if such radionuclides are not present in the waste or do not contribute significantly to dose to the workers, the public or the inadvertent intruder.

The list of highly radioactive radionuclides for F-Tank Farm was developed beginning with an initial listing of 849 radionuclides compiled from a variety of published resources (such as National Council on Radiation Protection and Measurements information). This initial list was reviewed and those radionuclides that were present in the waste and may be important in meeting performance objectives in 10 CFR Part 61, Subpart C because they contribute to the dose to the workers, the public and/or the inadvertent intruder in the F-Tank Farm Performance Assessment were identified. This approach results in a risk-informed list of highly radioactive radionuclides that includes: those short-lived radionuclides that may present risk because they produce radiation emissions that, without shielding or controls, may harm humans simply by proximity to humans without inhalation or ingestion; and those long-lived radionuclides that persist well into the future, may be mobile in the environment or may pose a risk to humans if inhaled or ingested.

Based on a methodical screening process, the initial list of 849 radionuclides was reduced to 54 radionuclides for which an initial inventory value was developed and was used as input into the

F-Tank Farm Performance Assessment modeling. The results of the F-Tank Farm Performance Assessment analyses were then evaluated to determine which of the 54 radionuclides would be considered highly radioactive radionuclides for F-Tank Farm.

To determine which radionuclides are highly radioactive radionuclides, the doses estimated in the F-Tank Farm Performance Assessment, as well as the NRC guidance in NUREG 1854 [9], the NRC guidance in Volume 2 of NUREG 1757 [10], and recommendations by the NRC during the public scoping meeting were considered. The guidance and general approach in Volume 2 of NUREG-1757 explains that "NRC staff considers radionuclides and exposure pathways that contribute no greater than 10% of the dose criteria to be insignificant contributors." The above-referenced NUREG, which applies to NRC licensees, is used only as general guidance, and use of this NUREG is not a requirement under NDAA Section 3116. The highly radioactive radionuclides for F-Tank Farm were determined based on an evaluation of results calculated in the F-Tank Farm Performance Assessment for 100-meter groundwater dose, 100-meter dose from airborne radionuclides, inadvertent intruder dose and uncertainty and sensitivity analyses.

The resulting dose contributions to the groundwater analysis from all individual radionuclides in the F-Tank Farm Performance Assessment initial inventory at the time of closure were examined. Those radionuclides which, in aggregate, would not contribute greater than 12.5 microSv/year (1.25 mrem/year) were not considered highly radioactive radionuclides. The 12.5 microSv/year dose level, 5% of the dose criteria when compared to the 250 microSv/year (25 mrem/year) all-pathways dose limit, was considered sufficiently low to capture all risk-significant radionuclides in those that remain. Of the remaining radionuclides, for those radionuclides with a relatively insignificant initial inventory the associated decay chains were examined. Reduction of these radionuclides is accomplished through the removal of the respective parent radionuclides, therefore the parent radionuclides, not the daughters, were considered highly radioactive radionuclides.

In a similar manner, radionuclides were evaluated for inclusion on the highly radioactive radionuclide list based on the F-Tank Farm 100-meter dose from airborne radionuclides, using the air pathway dose results calculated in the F-Tank Farm Performance Assessment. The F-Tank Farm Performance Assessment shows that the air pathway is not a significant contributor to dose. Therefore, for the purpose of the Draft F-Tank Farm 3116 Basis Document, no radionuclides were included in the highly radioactive radionuclide list based on the air pathway.

Several radionuclides were included on the highly radioactive radionuclide list based on an evaluation of the F-Tank Farm inadvertent intruder dose, using the intruder dose results calculated in the F-Tank Farm Performance Assessment. The resulting dose contributions to the inadvertent intruder analysis shown in the F-Tank Farm Performance Assessment were examined and those radionuclides which, in aggregate, would not contribute greater than 250 microSv/year (25 mrem/year) were not considered highly radioactive radionuclides. The 250 microSv/year dose level, 5% of the dose criteria when compared to the 5000 microSv/year (500 mrem/year) peak intruder dose recommended in NRC guidance [9], was considered sufficiently low to capture all risk-significant radionuclides in those that remain. Of the remaining radionuclides, for those radionuclides with a relatively insignificant initial inventory the associated decay chains were examined. Reduction of these radionuclides is accomplished through the removal of

the respective parent radionuclides, therefore the parent radionuclides, not the daughters, were considered highly radioactive radionuclides.

Some radionuclides were included on the highly radioactive radionuclide list based on an evaluation of the uncertainty and sensitivity analyses included in the F-Tank Farm Performance Assessment. The F-Tank Farm Performance Assessment uncertainty and sensitivity analyses were reviewed to identify those radionuclides shown to have the most influence on the model results. Those radionuclides considered to have the most influence were included as highly radioactive radionuclides even if their contribution to dose did not exceed the thresholds discussed above.

For the purposes of the Draft F-Tank Farm 3116 Basis Document, based on the evaluations and considerations discussed above, Sr-90, Tc-99, I-129, Cs-137, U-234, Np-237, Pu-238, Pu-239, Pu-240 and Am-241 are considered the highly radioactive radionuclides in the F-Tank Farm stabilized residuals, F-Tank Farm waste tanks and F-Tank Farm ancillary structures at the closure of F-Tank Farm.

Extensive waste removal operations have occurred at SRS and specifically within F-Tank Farm. Based on waste removal experience to date and anticipated new technologies, F-Tank Farm waste removal activities will result in significant collective removal of all waste including highly radioactive radionuclides. Removal of highly radioactive radionuclides begins with the removal of the solids and liquid from a waste tank or ancillary structure in a bulk waste removal phase. Following bulk waste removal, heel removal is performed using a mix of technologies, as appropriate, accounting for the physical configuration of the tank and the chemical characteristics of the waste.

Throughout the waste removal process, the ongoing effectiveness of the technology being implemented is continually evaluated and optimized. In addition, the usefulness and practicality of additional technology deployment once the existing technology has reached the point of diminished effectiveness for highly radioactive radionuclide removal is evaluated. The DOE's approach to highly radioactive radionuclide removal consists of the following phases: initial technology selection, technology implementation, technology execution, technology effectiveness evaluation and additional technology evaluation.

The F-Tank Farm Type IV waste tanks, Tanks 17, 18, 19 and 20, have all undergone waste removal and tank cleaning activities resulting in a relatively small quantity of resultant tank residuals. Two of the eight Type I waste tanks in F-Tank Farm, Tank 5 and Tank 6, have also undergone extensive heel removal campaigns. A Type I waste tank represents the most challenging tank for waste removal activities due, in part, to a limited number of access points, horizontal coiling coil runs at the bottom of the waste tank and the presence of roof support columns. Experience in Tank 5 and Tank 6 demonstrates successful deployment of innovative technologies capable of removing highly radioactive radionuclides even under the most challenging conditions.

Effective radionuclide removal is expected to be achieved during cleaning of the remaining tanks, and the cleaning and/or flushing of ancillary structures, for a number of reasons. As

discussed above, DOE has successfully removed waste from Type IV waste tanks (including Tanks 18 and 19) as well as Type I waste tanks (Tanks 5 and 6), which present the most challenging conditions in the F-Tank Farm. The cleaning process employed is thorough, and the process is reviewed and documented during cleaning to maximize effectiveness. DOE will continue to use such measures as visual (remote) observation of remaining tank residuals against benchmarks in the tanks (or ancillary structures), transfer line radiation readings, sampling and analysis, radiation monitoring, and equipment operating parameters to evaluate efficiency and effectiveness of cleaning operations. Moreover, removal activities on a given tank or ancillary structure will not be considered complete until it is clearly demonstrated and documented, for each individual tank or ancillary structure, that further deployment of the existing technology is no longer useful or sensible, and that other proven technologies have been evaluated and would not be practical. These documented considerations will take into account a variety of factors including such things as the conditions in the specific waste tank or ancillary structure, the status of the F-Tank Farm and the overall Liquid Waste System (e.g., available waste tank volume), available proven technologies, the potential benefits from long-term risk reduction from continued highly radioactive radionuclide removal, increased radiation exposure to site workers or the public due to removal activities, increased risk associated with impacts to other DOE missions involving risk-reducing activities, direct monetary expenditures and effectiveness of available technologies.

Removal of highly radioactive radionuclides to the maximum extent practical in F-Tank Farm waste tanks and ancillary structures occurs through a systematic progression of waste removal and cleaning activities using proven technologies to a point where further removal of highly radioactive radionuclides is not sensible or useful in light of the overall benefit to human health, safety and the environment. As a result of this systematic progression, the F-Tank Farm waste tanks, ancillary structures and their associated stabilized residuals will have had highly radioactive radionuclides removed to the maximum extent practical at the time of closure.

Radionuclide Concentrations of Stabilized Residuals, Tanks and Ancillary Structures

For the purposes of making a determination under NDAA Section 3116(a)(3), regardless of whether the waste exceeds or does not exceed the concentration limits for Class C low-level waste as set out in 10 CFR 61.55, [11] the Secretary of Energy, in consultation with the NRC, must determine that the waste will be disposed of in compliance with the performance objectives of 10 CFR 61, Subpart C, and that the waste will be disposed of in accordance with State-approved closure plans. In situations where the waste exceeds the concentration limits for Class C low-level waste, NDAA Section 3116(a)(3)(B)(iii) provides for DOE consultation with NRC about the disposal plans for the waste.

Prior NRC guidance to determine concentrations for comparison with Class C concentration limits of 10 CFR 61.55 was based on excavation as the likely pathway to expose an inadvertent member of the public to waste in a commercial shallow land burial site [9]. Due to the disposal depth of the F-Tank Farm stabilized residuals in the waste tanks and the ancillary structures, the basement excavation scenario associated with development of 10 CFR 61.55 Table 1 and 2 is not applicable to the F-Tank Farm waste tanks and ancillary structures. A more appropriate scenario for the purposes of calculation and comparison with Class C concentration limits is one that

assumes the inadvertent intruder drills a groundwater well and drills through a waste tank or ancillary structure.

Consistent with more recent NRC staff guidance, the Draft F-Tank Farm 3116 Basis Document follows the Category 3—Site-Specific Averaging approach set forth in NUREG-1854, using the intruder-drilling scenario [9]. This approach utilizes a risk-informed approach that takes into consideration such things as the specific conditions of the F-Tank Farm site, the final form of the stabilized residuals, site-specific parameters and the final closure configuration. In order to account for the site-specific conditions relative to F-Tank Farm, DOE has developed, consistent with the Category 3—Site-Specific Averaging methodology, averaging expressions for F-Tank Farm based on the results of the inadvertent intruder analysis performed within the F-Tank Farm Performance Assessment. The F-Tank Farm Performance Assessment models used to simulate the performance of the F-Tank Farm closure system take into account the release of radiological contaminants from the waste tanks and the associated ancillary structures in the F-Tank Farm and simulates transport of the radiological contaminants through soil and groundwater to the assessment point. The models use numerous F-Tank Farm-specific input parameters to represent the F-Tank Farm closure system behavior over time. Many of the input parameters are based on site-specific data (e.g., soil and cementitious materials distribution coefficients) used in transport modeling. In addition, site-specific information is used to model the behavior of individual barriers within the F-Tank Farm, such as the waste tank carbon steel primary tanks and secondary liners (as applicable), and cementitious barriers. Numerous bioaccumulation factors (e.g., soil-to-plant transfer factors), human health exposure parameters (e.g., water ingestion rates, vegetable consumption data) and dose conversion factors are used in the computer modeling to calculate doses for each of the exposure pathways. All of these parameters factor into development of the F-Tank Farm averaging expressions.

The concentrations of the stabilized residuals have been compared, using the sum of fractions methodology and the F-Tank Farm averaging expressions, against the concentration limits for Class C low-level waste as set out in 10 CFR 61.55 Table 1 and Table 2. For Tank 18, this comparison was based on the actual residual inventory in the tank following cleaning. For the ancillary structures, this comparison was based on the projected inventories at closure in the F-Tank Farm Performance Assessment.

The stabilized F-Tank Farm waste at closure is expected to meet concentration limits for Class C low-level waste as set out in 10 CFR 61.55. Nevertheless, DOE is also consulting with the NRC pursuant to the consultation process in NDAA Section 3116(a)(3)(B)(iii) to take full advantage of the consultation process. In this regard, DOE is specifically requesting in the Draft F-Tank Farm 3116 Basis Document that NRC identify what changes, if any, NRC would recommend to DOE's disposal plans as described in the Draft F-Tank Farm 3116 Basis Document, and DOE intends to consider the NRC recommendations, as appropriate, in the development of DOE's plans.

The Waste Will be Disposed of in Accordance with the Performance Objectives Set Out in 10 CFR 61, Subpart C

The 10 CFR 61, Subpart C, Sections 61.40 through 61.44 detail performance objectives the NRC established for land disposal of radioactive waste. These performance objectives address

protection of the general population from radioactivity releases, individuals from inadvertent intrusion on the disposal site, protection of workers and the public during disposal facility operations and the stability of the disposal site after closure.

10 CFR 61.40 states:

> *Land disposal facilities must be sited, designed, operated, closed, and controlled after closure so that reasonable assurance exists that exposures to humans are within the limits established in the performance objectives in §§61.41 through 61.44.*

The 10 CFR 61.40 general provisions require "reasonable assurance" that exposures are within the limits of the subsequent performance objectives for 10 CFR 61.41 through 10 CFR 61.44. As discussed below, the F-Tank Farm Performance Assessment provides the technical basis and results demonstrating that the 10 CFR 61.41 and 10 CFR 61.42 performance objectives will be met after F-Tank Farm closure.

10 CFR 61.41 states:

> *Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants, or animals must not result in an annual dose exceeding an equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public. Reasonable effort should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable.*

To demonstrate compliance with this performance objective, a 250 microSv/year (25 mrem/year) peak all-pathways total effecetive dose equivalent is used, rather than individual organ doses. The NRC states in NUREG-1854 that use of the 250 microSv/year (25 mrem/year) all-pathways total effective dose equivalent is used by the NRC in making the assessment for compliance with the whole body, thyroid and any other organ limits in 10 CFR 61.41 and is protective of human health and the environment [9].

The hypothetical future member of the public is assumed to be located at the boundary of the DOE controlled area until the assumed active institutional control period ends (i.e., 100 years after closure), at which point the receptor is assumed to move to the point of maximum exposure at or outside of the F-Tank Farm 100-meter buffer zone. For the purposes of demonstrating compliance with 10 CFR 61.41, the peak all-pathways dose, calculated in the F-Tank Farm Performance Assessment, at or outside of the 100-meter buffer zone during the 10,000-year performance period is used.

The F-Tank Farm Performance Assessment projected the peak all-pathways dose to the F-Tank Farm public receptor to be less than the 250 microSv/year (25 mrem/year) performance objective during the 10,000-year performance period. The peak all-pathways dose includes the groundwater pathways and air pathways associated with all 22 F-Tank Farm waste tanks and associated ancillary structures with the groundwater pathway being the most significant contributor. In addition, the F-Tank Farm Performance Assessment modeling performed for the uncertainty and sensitivity analyses was used to determine the projected dose to the F-Tank Farm public receptor for the base case, as well as other tank configurations, over a wide range of

variability in input parameters. The uncertainty and sensitivity analyses included in the F-Tank Farm Performance Assessment provide sufficient information on parameter sensitivities and modeling uncertainties to provide reasonable assurance that the 250 microSv/year (25 mrem/year) all-pathways dose limit will be met during the 10,000-year performance period [7].

Provisions in 10 CFR 61.42 require:

> *Design, operation, and closure of the land disposal facility must ensure protection of any individual inadvertently intruding into the disposal site and occupying the site or contacting the waste at any time after active institutional controls over the disposal site are removed.*

Demonstration of compliance with a 5000 microSv/year (500 mrem/year) peak intruder dose is used to demonstrate compliance with the 10 CFR 61.42 performance objective. The requirement of 10 CFR 61.42 exhibits the NRC's intent to protect persons who inadvertently intrude on the waste. The performance objective does not place quantitative limits on exposure. However, the 10 CFR 61 Final Environmental Impact Statement suggests a dose limit of 5000 microSv/year (500 mrem/year) for the waste classification scheme in 10 CFR 61.55. Consequently, the NRC uses 5000 microSv/year (500 mrem/year) dose limit for evaluating impacts to an inadvertent intruder for purposes of 10 CFR 61.42 [9]. The 10 CFR 61.42 regulations do not specify use of a particular scenario to demonstrate compliance. In developing intruder scenarios, the DOE assumes that humans will continue land use activities, which are consistent with past (e.g., recent decades) and present regional practices, after the end of the assumed active institutional control period.

To calculate the dose to an inadvertent intruder, potential intruder scenarios were considered in the F-Tank Farm Performance Assessment and the bounding Acute Intruder and Chronic Intruder dose scenarios were determined. The F-Tank Farm Performance Assessment projected the peak inadvertent intruder (i.e., individual within the F-Tank Farm boundary) dose to be less than the 5000 microSv/year (500 mrem/year) performance objective during the 10,000-year performance period. The inadvertent intruder dose considers releases associated with the closure of all 22 waste tanks and related ancillary structures within F-Tank Farm. The uncertainty and sensitivity analyses included in the F-Tank Farm Performance Assessment provide sufficient information on parameter sensitivities and modeling uncertainties to provide reasonable assurance that the 10 CFR 61.42 performance objective will not be exceeded after F-Tank Farm closure [7].

Provisions in 10 CFR 61.43 state:

> *Operations at the land disposal facility must be conducted in compliance with the standards for radiation protection set out in part 20 of this chapter, except for releases of radioactivity in effluents from the land disposal facility, which shall be governed by §61.41 of this part. Every reasonable effort shall be made to maintain radiation exposures as low as is reasonably achievable.*

This requirement references 10 CFR 20 [12], which contains radiological protection standards for workers and the public. The DOE requirements for occupational radiological protection are provided in 10 CFR 835 [13] and those for radiological protection of the public and the environment are provided in DOE Order 5400.5 [14]. Consistent with NDAA Section 3116(a),

the cross-referenced "standards for radiation protection" in 10 CFR 20 that are considered in detail in the Draft F-Tank Farm 3116 Basis Document are the dose limits for the public and the workers set forth in the applicable 10 CFR 20 standards listed in Table I. Table I provides a crosswalk between the standards set forth in 10 CFR 20 and the applicable DOE requirements.

Table I: Crosswalk Between Applicable 10 CFR 20 Standards and DOE Requirements

10 CFR 20 Standard	**DOE Requirement**	**Dose Limit**
10 CFR 20.1101(d)	DOE Order 5400.5	Air Emissions Limit for Individual Member of the Public
10 CFR 20.1201(a)(1)(i)	10 CFR 835.202 (a)(1)	Total Effective Dose Equivalent Limit for Adult Workers
10 CFR 20.1201(a)(1)(ii)	10 CFR 835.202 (a)(2)	Any Individual Organ or Tissue Dose Limit for Adult Workers
10 CFR 20.1201(a)(2)(i)	10 CFR 835.202 (a)(3)	Annual Dose Limit to the Lens of the Eye for Adult Workers
10 CFR 20.1201(a)(2)(ii)	10 CFR 835.202 (a)(4)	Annual Dose Limit to the Skin of the Whole Body and to the Skin of the Extremities for Adult Workers
10 CFR 20.1201(e)	DOE Order 440.1A	Limit on Soluble Uranium Intake
10 CFR 20.1208(a)	10 CFR 835.206 (a)	Dose Equivalent to an Embryo/Fetus
10 CFR 20.1301(a)(1)	DOE Order 5400.5 (II.1.a)	Total Effective Dose Equivalent Limit for Individual Members of the Public
10 CFR 20.1301(a)(2)	10 CFR 835.602 10 CFR 835.603	Dose Limits for Individual Members of the Public in Unrestricted Areas
10 CFR 20.1301(b)	10 CFR 835.208	Dose Limits for Individual Members of the Public in Controlled Areas

Consistent with NUREG-1854, the Draft F-Tank Farm 3116 Basis Document demonstrates that these dose limits correspond to the dose limits in 10 CFR 835 and relevant DOE Orders which establish DOE regulatory and contractual requirements for DOE facilities and activities and therefore show the F-Tank Farm closure meets these dose limits and that doses will be maintained as low as reasonably achievable.

10 CFR 61.44 states:

> *The disposal facility must be sited, designed, used, operated, and closed to achieve long-term stability of the disposal site and to eliminate to the extent practicable the need for ongoing active maintenance of the disposal site following closure so that only surveillance, monitoring, or minor custodial care are required.*

A site characteristics review of demography, geography, meteorology, climatology, ecology, geology, seismology, and hydrogeology supporting the siting aspect of this performance objective is presented in the Draft F-Tank Farm 3116 Basis Document and F-Tank Farm Performance Assessment.

The use and operation of F-Tank Farm waste tanks and ancillary structures will support long-term stability consistent with the performance objective. During operations, corrosion control and structural integrity programs are implemented to maintain design features utilized for waste containment (e.g., waste tanks and ancillary structures). These programs ensure that waste tanks are monitored for structural integrity via mechanisms such as a tank inspection program and a tank leak detection system. Programs such as these will be maintained throughout F-Tank Farm use and operation. The F-Tank Farm waste tanks and ancillary structures monitoring continues after closure via the site Groundwater Protection Program.

Final F-Tank Farm closure design will support long-term stability consistent with this performance objective. In this context, long-term stability of the closed F-Tank Farm site means that the stabilized residuals in the waste tanks and ancillary structures, the waste tanks, and the ancillary structures (including integral equipment) maintains structural integrity under the closure conditions for hundreds to thousands of years following closure. A stable closure system prevents subsidence of, and minimizes water intrusion into, the closed site and mitigates migration of residual material into the environment. In addition, a carefully designed closure site minimizes the likelihood of inadvertent intrusion into the system and disturbance of the stabilized residuals. The waste tank systems (i.e., primary tank, secondary tank or annular pan, and concrete roofs and vaults, as applicable) and the ancillary structures themselves will provide the primary stability for the closed F-Tank Farm site. Grouting of the waste tanks and backfilling of ancillary structures with an appropriate fill material, as necessary, will prevent subsidence and will minimize the migration of radioactive material into the environment over time, and will support long-term stability of both the tank structures and the waste form. Grout used to fill the domed roof of the Type IV waste tanks will deter intrusion. Type I and Type III/IIIA tanks have sufficient thicknesses of reinforced concrete roofs to deter such intrusion.
A closure cap is expected to be designed and constructed over the the F-Tank Farm site following grouting of the F-Tank Farm waste tanks and backfilling of the ancillary structures, as necessary. The final closure cap design will minimize water infiltration into the waste tanks and ancillary structures, and the likelihood of intrusion into the waste. The SRS Land Use Plan requires Federal ownership and control of the site, including F-Tank Farm, well beyond 100 years after tank closure.

State-Approved Closure Plan

The F-Tank Farm waste storage and removal operations are governed by a South Carolina Department of Health and Environmental Control industrial wastewater construction permit [15]. The *Industrial Wastewater General Closure Plan for F-Area Waste Tank Systems* [16] (hereinafter referred to as the General Closure Plan) addresses the State's regulatory authority relevant to removing the F-Tank Farm waste tanks and ancillary structures from service. The General Closure Plan sets forth the general protocol by which DOE intends to remove from service the F-Tank Farm waste tanks and ancillary structures to protect human health and the environment. The General Closure Plan requires approval by the South Carolina Department of Health and Environmental Control.

Before final stabilization activities commence, individual waste tank and ancillary structure closure plans, referred to as Closure Modules, describing closure details will be developed and

submitted to South Carolina Department of Health and Environmental Control for approval. Prior to approval, the Closure Modules will be made available to the public for review and comment as deemed appropriate by South Carolina Department of Health and Environmental Control. The Closure Modules will describe the waste tank(s) or ancillary structure(s) being covered, waste removal activities performed and effectiveness, justification that additional waste removal is not technically practical from an engineering perspective, characteristics of remaining residuals and the stabilization process. The Closure Modules will provide analysis for each waste tank or ancillary structure demonstrating conformance with the performance objectives set forth in the General Closure Plan.

As explained above, the F-Tank Farm waste tanks and ancillary structures will be removed from service, stabilized and operationally closed pursuant to State-approved Closure Modules, consistent with the General Closure Plan. Thus, the F-Tank Farm waste tanks, ancillary structures and the stabilized residuals "[will be disposed of] pursuant to a State-approved closure plan or State-issued permit, authority for the approval or issuance of which is conferred on the State outside of this section."

CONCLUSION

DOE has prepared the Draft F-Tank Farm 3116 Basis Document and the document was provided to the NRC for review and comment under their consultative role within NDAA Section 3116. Although not required by NDAA Section 3116, DOE also issued the document for public review and comment. The Draft F-Tank Farm 3116 Basis Document will be finalized after DOE consults with the NRC and the Secretary of Energy has made a determination pursuant to Section 3116(a) of the NDAA.

REFERENCES

1. "Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005", Public Law 108-375, Section 3116 (2004).
2. "Draft Basis for Section 3116 Determination for Closure of F-Tank Farm at the Savannah River Site," DOE/SRS-WD-2010-001, U.S. Department of Energy (2010).
3. "Section 3116 Determination for Salt Waste Disposal at the Savannah River Site," DOE-WD-2005-001, U.S. Department of Energy (2006).
4. "Section 3116 Determination for the Idaho Nuclear Technology and Engineering Center Tank Farm Facility at the Idaho National Laboratory," DOE-WD-2006-001, U.S. Department of Energy (2006).
5. "Savannah River Site F-Tank Farm NDAA Section 3116 Basis Document Scoping Meeting Minutes," Savannah River Remediation (2010).
6. "Notice of Availability of Draft Basis for Determination Under Section 3116 of the Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA) for Closure of the F-Tank Farm at the Savannah River Site," Federal Register / Vol. 75, No. 194, FR Doc. 2010-25341 Filed 10-6-10, U.S. Department of Energy (2010).
7. "Performance Assessment for the F-Tank Farm at the Savannah River Site," SRS-REG-2007-00002, Revision 1, Savannah River Remediation (2010).
8. "Radioactive Waste Management," DOE O 435.1, Chg. 1, U.S. Department of Energy (2007).

9. “NRC Staff Guidance for Activities Related to U.S. Department of Energy Waste Determinations, Draft Final Report for Interim Use,” NUREG-1854, U.S. Nuclear Regulatory Commission (2007)
10. “Consolidated Decommissioning Guidance: Characterization, Survey, and determination of Radiological Criteria,” Volume 2, NUREG-1757, U.S. Nuclear Regulatory Commission (2006)
11. “Licensing Requirements for Land Disposal of Radioactive Waste,” 10 CFR 61, U.S. Nuclear Regulatory Commission (2010)
12. “Standards for Protection Against Radiation,” 10 CFR 20, U.S. Nuclear Regulatory Commission (2010)
13. “Occupational Radiation Protection,” 10 CFR 835, U.S. Department of Energy (2009)
14. “Radiation Protection of the Public and the Environment,” DOE O 5400.5, Change 2, U.S. Department of Energy (1993)
15. “Partial permit to Operate F and H Area High Level Radioactive Waste Tank Farms Construction Permit No.: 17,424-IW,” DHEC_03-03-1993, South Carolina Department of Health and Environmental Control (1993)
16. “Industrial Wastewater General Closure Plan for F-Area Waste Tank Systems,” LWO-RIP-2009-00009, Revision 1, Savannah River Site (2010)