FTF-WDIP-005
Revision 0

WASTE WILL BE DISPOSED OF IN ACCORDANCE WITH THE PERFORMANCE OBJECTIVES 10 CFR 61.41 & 10 CFR 61.42 INPUT PACKAGE

for the

Section 3116 Draft Basis Document for F-Tank Farm at the Savannah River Site

June 2010

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Prepared for U.S. Department of Energy Under Contract No. DE-AC09-09SR22505

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ACRONYMS / ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
CFR	Code of Federal Regulations
DCFs	Dose Conversion Factors
DOE	United States Department of Energy
FTF	F-Tank Farm
mrem	Millirem
mSv	milliSievert
NDAA	Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005
NRC	United States Nuclear Regulatory Commission
PA	Performance Assessment
TEDE	Total Effective Dose Equivalent
yr	Year

1.0 INPUT PACKAGE DESCRIPTION

Input package FTF-WDIP-005 provides information anticipated to be used in Section 7.0, *Waste Will Be Disposed of in Accordance With Performance Objectives in 10 CFR 61, Subpart C*, of the Draft F-Tank Farm (FTF) 3116 Basis Document. Specifically, this input package addresses Title 10 Code of Federal Regulations (CFR) 61.41, *Protection of the General Population from Releases of Radioactivity*, and 10 CFR 61.42, *Protection of Individuals from Inadvertent Intrusion*. Development of FTF-WDIP-005 allows for early review of this information before the Draft FTF 3116 Basis Document is submitted to the Nuclear Regulatory Commission (NRC) for further consultation, and issued for public comment. This input package provides both the anticipated approach for demonstrating compliance with 10 CFR 61.41 and 10 CFR 61.42 and wording representative of the information anticipated to be included in the Draft FTF 3116 Basis Document[1].

2.0 DRAFT FTF 3116 BASIS DOCUMENT APPROACH

The following describes the approach the Department of Energy (DOE) is considering for demonstrating compliance with performance objectives in 10 CFR 61.41 and 10 CFR 61.42 as it pertains to the closure of waste tanks and ancillary structures in FTF.

- The FTF Performance Assessment (PA) is the key risk assessment tool used to inform closure decisions and includes information needed to demonstrate compliance with the requirements of 10 CFR 61.41 and 10 CFR 61.42. [SRS-REG-2007-00002]
  - The FTF PA utilized the scoping meeting process to solicit initial input from an array of stakeholders. [SRS-REG-2007-00002]
  - The FTF PA incorporates lessons learned from the following documents:
    - DOE/NE-ID-11226, *Basis for Section 3116 Determination for the Idaho Nuclear Technology and Engineering Center Tank Farm Facility*;
    - ICP/EXT-06-01204, *Response to Request for Additional Information on the Draft Section 3116 Determination, Idaho Nuclear Technology and Engineering Center Tank Farm Facility*;
    - DOE-WD-2005-001, *Basis for Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*;
    - CBU-PIT-2005-00131, *Response to Request for Additional Information on the Draft Section 3116 Determination for Salt Waste Disposal at the Savannah River Site*;
    - SRS-REG-2007-00002 (Rev. 0), *Performance Assessment for the F-Tank Farm at the Savannah River Site*; and
    - ML071150165, *U.S. Nuclear Regulatory Commission Plan for the Monitoring of the U.S. Department of Energy Salt Waste Disposal at the Savannah River Site in Accordance with the National Defense Authorization Act for Fiscal Year 2005*.

[1] The purpose of developing this input package and utilizing the scoping process parallel to development of the Draft FTF 3116 Basis Document is to expedite the identification of issues and assess the reasonability of DOE's approach in addressing the NDAA Section 3116 criteria, thereby allowing for more informed and efficient consultation with the NRC and a more informed draft for public comment. Changes in the described approaches and information presented in this input package may occur based on discussions during the scoping process.

- The FTF PA is comprehensive, including a range of data and analyses required to make risk informed decisions regarding FTF closure. The FTF PA includes such items as:
  - Site-specific input data;
  - Deterministic and probabilistic FTF computer models;
  - Extensive uncertainty and sensitivity analyses investigating a variety of modeling parameters; and
  - Data beyond the 10,000 year performance period to aid in making risk informed decisions.
- Revision 0 of the FTF PA underwent review by all applicable regulatory agencies, and the Revision 0 comments have been dispositioned and incorporated into the Revision 1 of the FTF PA. Significant enhancements to the FTF PA were made in Revision 1 in response to NRC comments, including addition of a Barrier Analyses and additional Uncertainty and Sensitivity Analyses. [SRS-REG-2007-00002]

- The DOE is considering including in the Draft FTF 3116 Basis Document the following key points in demonstrating compliance with the requirements of 10 CFR 61.41 and 10 CFR 61.42.
  - The performance period for demonstrating compliance with the requirements of 10 CFR 61.41 and 10 CFR 61.42 is a post-institutional control period of 10,000 years.
  - For the purpose of calculating doses to a member of the public, the point of assessment is located at the point of maximum exposure at/or outside of 100 meters from the FTF. The 100 meter distance is consistent with the guidance in NUREG-1854.
  - The assumed institutional control period for FTF is the 100 year period following final closure activities. The 100 year institutional control period is consistent with the guidance in NUREG-1854.
  - Demonstration of compliance with 10 CFR 61.41 will be based on compliance with a 25 millirem (mrem)/year (yr) all-pathways total effective dose equivalent (TEDE) limit, and will not address individual thyroid or other organ doses. The NRC acknowledges in NUREG-1854 that the use of only the 25 mrem/yr all-pathways TEDE 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.
  - The all-pathways peak dose calculated in Revision 1 of the FTF PA (2.5 mrem/yr during the 10,000 year performance period) provides "reasonable assurance" that the 10 CFR 61.41 all-pathways dose limit of 25 mrem/yr is met. [SRS-REG-2007-00002]
  - Demonstration of compliance with 10 CFR 61.42 will be based on compliance with a 500 mrem/yr peak intruder dose, consistent with the guidance in NUREG-1854.

  - The peak intruder doses calculated in Revision 1 of the FTF PA (73 mrem/yr peak Intruder Chronic Dose and 1.6 mrem/yr peak Intruder Acute Dose) provide "reasonable assurance" that the 10 CFR 61.42 intruder dose performance objective of 500 mrem/yr is met. [SRS-REG-2007-00002]
  - The uncertainty and sensitivity analyses included in the FTF PA provide sufficient information on parameter sensitivities and modeling uncertainties, in conjunction with the base case analyses, to provide reasonable assurance of compliance with the 10 CFR 61.41 and 10 CFR 61.42 performance objectives. [SRS-REG-2007-00002]
- The ICRP-72 Dose Conversion Factors (DCFs) are used consistently for all FTF PA internal dose assessments. This approach utilizes recent data using the latest dosimetric models and is consistent with the guidance provide in Section 4.6.1.3 of NUREG-1854. [SRS-REG-2007-00002]
- The DOE is considering providing in the Draft FTF 3116 Basis Document an overview of the modeling approach used in the FTF PA to develop dose results. In addition, DOE is considering including a description of the barriers that are evaluated and documented in the FTF PA. [SRS-REG-2007-00002]
- The DOE is considering including specific dose values calculated in the FTF PA in the Draft FTF 3116 Basis Document, recognizing that those values may be updated in future FTF PA revisions. [SRS-REG-2007-00002]

Based on the above outlined approach, the following section provides wording similar to that anticipated to be contained in the Draft FTF 3116 Basis Document. Although the wording will be revised as DOE further develops and refines the Draft FTF 3116 Basis Document, the information provided represents the level of information and general compliance demonstrations anticipated to be provided in the Draft FTF 3116 Basis Document.

3.0 WASTE WILL BE DISPOSED OF IN ACCORDANCE WITH PERFORMANCE OBJECTIVES IN 10 CFR 61, SUBPART C

Section Purpose

This section demonstrates that the stabilized residuals in the FTF waste tanks and ancillary structures, the waste tanks, and the ancillary structures (including integral equipment) will be disposed of in compliance with the performance objectives for land disposal of low-level waste found in Title 10 of the CFR Part 61, Subpart C, Sections 61.41 and 61.42 for the purpose of the Draft FTF 3116 Basis Document.

Section Contents

This section outlines key parameters of the FTF PA that demonstrate compliance with the performance objectives in 10 CFR 61.41 and 10 CFR 61.42 for the purpose of the Draft FTF 3116 Basis Document.

Key Points

- The FTF PA demonstrates that the 10 CFR 61.41 and 10 CFR 61.42 performance objectives will be met.
- The institutional control period will be 100 years following the FTF closure.
- For the purpose of calculating doses to a member of the public, a 100 meter buffer zone around the FTF boundary is assumed.
- The FTF PA evaluates a performance period of 10,000 years, and provides additional data beyond this period of time, for the purpose of making risk informed decisions related to the closure of FTF.
- Demonstration of compliance with 10 CFR 61.41 will be based on compliance with a 25 mrem/yr peak all-pathways Total Effective Dose Equivalent.
- Demonstration of compliance with 10 CFR 61.42 will be based on compliance with a dose limit of 500 mrem/yr.

3.1 Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA) Criterion

NDAA Section 3116(a) provides in pertinent part:

> *[T]he term "high-level radioactive waste" does not include radioactive waste resulting from the reprocessing of spent nuclear fuel that the Secretary of Energy..., in consultation with the Nuclear Regulatory Commission…, determines –*
>
> *(3) (A)(i) [will be disposed of] in compliance with the performance objectives set out in subpart C of part 61 of title 10, Code of Federal Regulations.*

3.2 10 CFR Part 61 Subpart C Performance Objectives

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 during disposal facility operations, and the stability of the disposal site after closure. The following subsections discuss the 10 CFR 61.40 through 10 CFR 61.44 compliance requirements.

3.2.1 10 CFR 61.40

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 and are discussed below:

- The DOE will maintain an FTF PA to demonstrate compliance with 10 CFR 61.41, *Protection of the General Population from Releases of Radioactivity*, and 10 CFR 61.42, *Protection of Individuals from Inadvertent Intrusion*. The FTF PA demonstrates the annual dose to a member of the public is within dose limits established in 10 CFR 61.41, and dose to an inadvertent intruder is within dose limits established in 10 CFR 61.42. Compliance with these performance objectives are demonstrated in this section of the Draft FTF 3116 Basis Document.
- The DOE will implement programs to ensure facility operations are in compliance with standards for radiation protection specified in 10 CFR 61.43, *Protection of Individuals During Operation*. Compliance with this performance objective is described in input package FTF-WDIP-006.
- The DOE will demonstrate that FTF is sited, designed, used, operated, and closed to meet requirements of 10 CFR 61.44, *Stability of the Disposal Site After Closure*. Compliance with this performance objective is described in input package FTF-WDIP-007.

3.2.2 FTF Performance Assessment

The DOE has developed an FTF PA which provides the technical basis and results demonstrating that the 10 CFR 61.41 and 10 CFR 61.42 performance objectives will be met after FTF closure. As required by the DOE Order 435.1-1, maintenance of the FTF PA will include future revisions to incorporate new information, update model codes, etc., as appropriate[2]. [SRS-REG-2007-00002]

[2] Under the provisions of NDAA Section 3116 (b), the NRC will monitor DOE actions pursuant to the performance objectives in 10 CFR 61 Subpart C. Revisions to the FTF PA will be made available to the NRC in support of that role.

The FTF PA details the analysis performed to provide "reasonable assurance" that the stabilized residuals, tanks and ancillary structures will be disposed of in compliance with the performance objectives at 10 CFR 61.41 and 61.42 in conjunction with closure of the FTF. Individual FTF system behaviors are evaluated within the FTF PA for various waste tank and ancillary structure configurations, including a base case, which provides results reflecting the closure system behavior. The FTF PA provides the development and calculation of the following doses: [SRS-REG-2007-00002]

- Potential radiological doses to a hypothetical member of the public
- Potential radiological doses to 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 FTF.

The following general definitions and assumptions are used in the FTF PA and will serve as the basis for future FTF PA revisions. [SRS-REG-2007-00002]

<u>FTF Boundary</u>: The FTF boundary is the line of demarcation enclosing the FTF waste tanks (Figure 3.2-1).

<u>Buffer Zone</u>: The buffer zone is the radial area that encompasses the FTF 100 meters from its boundary (Figure 3.2-1).

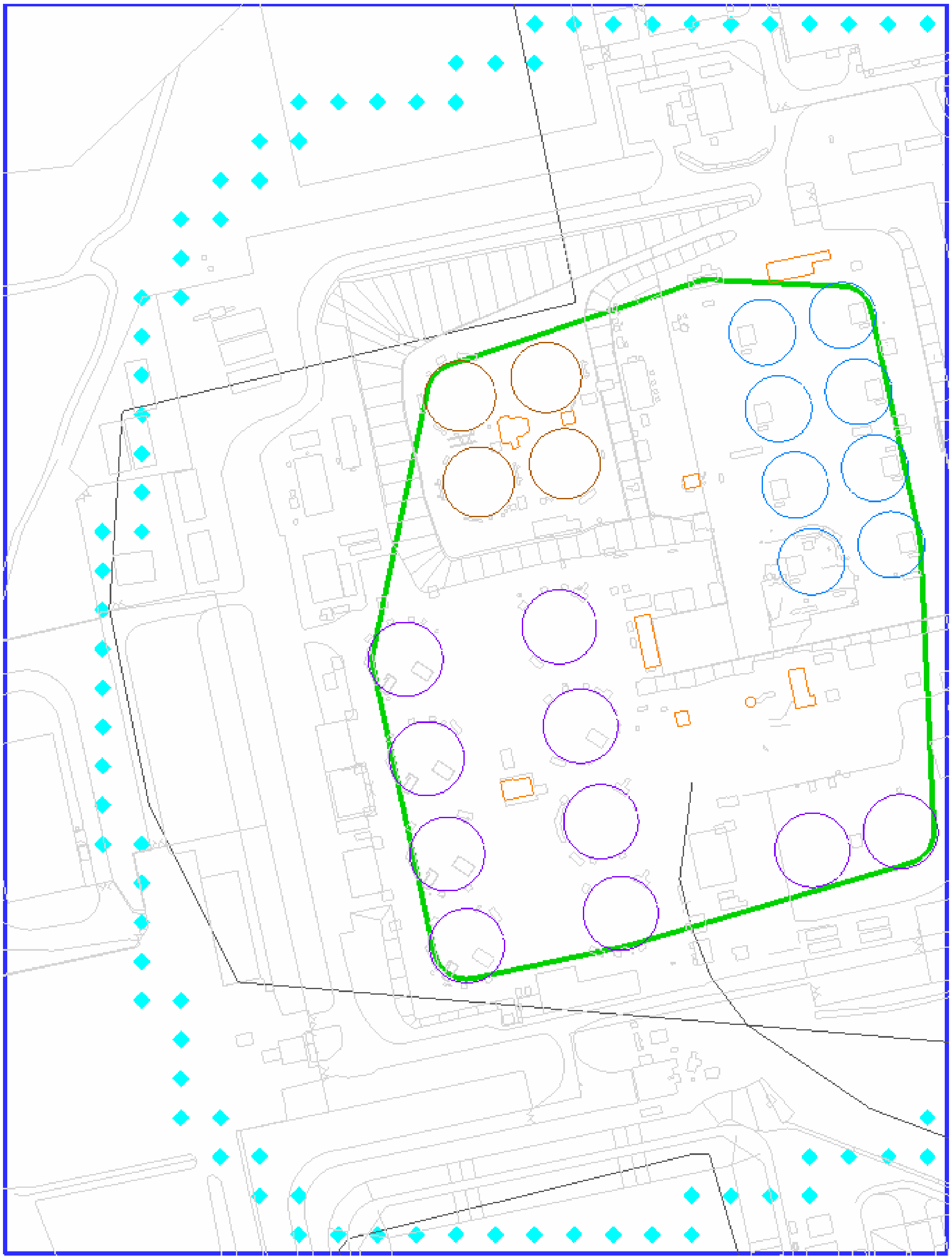
<u>Institutional Control</u>: Institutional control is a 100 year period in which DOE retains ownership and control of FTF such that FTF facility maintenance and controls will be performed to prevent inadvertent intrusion and protect public health and the environment.

<u>Performance Period</u>: The performance period is the 10,000 years following final closure activities. The FTF PA evaluates consequences of closure activities during the performance period (i.e., 10,000 years) after closure. The DOE has evaluated for periods beyond 10,000 years in the FTF PA to further inform closure decisions.

<u>Uncertainty and Sensitivity</u>: Uncertainty and sensitivity analyses are employed to consider the effects of uncertainties in the conceptual models and sensitivity of simulation results to the parameters in the mathematical models. The sensitivity analyses consider sensitivity of results to parameters both individually and collectively. The FTF PA and future revisions will include uncertainty and sensitivity analyses.

Specific information regarding 10 CFR 61.41 and 10 CFR 61.42 is contained in the following subsections.

Figure 3.2-1: FTF Boundary and Buffer Zone



= Boundary
= Buffer Zone (100 meters from FTF Boundary)

3.2.3 10 CFR 61.41

Protection of the public from radioactive material that may be released from the facility by any pathway is established in 10 CFR 61.41. The NRC requirement 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.*

3.2.3.1 General Approach

Demonstration of compliance with the 25 mrem/yr peak all-pathways dose versus considering individual organ doses will be used to demonstrate compliance with the 10 CFR 61.41 performance objectives. The NRC acknowledges in NUREG-1854 that use of the 25 mrem/yr all-pathways TEDE 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.

In addition NUREG-1854 states:

> *This guidance document advocates the use of dosimetry consistent with 10 CFR Part 20. This ensures that compliance calculations between 10 CFR 61.41 and 10 CFR 61.43 remain consistent, as discussed in NUREG-1573. The proposed rule for 10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in a Proposed Geological Repository at Yucca Mountain, Nevada; Proposed Rule," states*
>
> > *"As a matter of policy, NRC considers 0.25 mSv [25 mrem] TEDE as the appropriate dose limit within the range of potential doses represented by the current 10 CFR 72.104 limit of 0.25 mSv [25 mrem] (whole body), 0.75 mSv [75 mrem] (thyroid dose), and 0.25 mSv [25 mrem] (to any other critical organ) (NRC 1999)."*
>
> *As 10 CFR 61.41 has the same standard as 10 CFR 72.104, this policy is applicable, and therefore, incidental waste determinations may use total effective dose equivalent (TEDE) without specific consideration of individual organ doses. Intruder calculations should be based on 5 mSv [500 mrem] TEDE limit, without specific consideration of individual organ doses, to ensure consistency between 10 CFR 61.41 and 10 CFR 61.43. Because of the tissue weighting factors and the magnitude of the TEDE limit, specific organ dose limits are not necessary for protection from deterministic effects.*

The public receptor, protected by 10 CFR 61.41, is assumed to be located at the boundary of the DOE controlled area until the 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 FTF 100 meters buffer zone. For the purposes of demonstrating compliance with 10 CFR 61.41, the peak all-pathways dose at or outside of the 100 meter buffer zone will be used.

The pathways for release to a member of the public considered in the FTF PA analyses are discussed below[3]. The scenarios are not assumed to occur until after the 100 year institutional control period ends. [SRS-REG-2007-00002]

3.2.3.2 Public Release Pathways Dose Analysis

The primary water sources for the member of the public release pathways are either a well drilled into the groundwater aquifers or a General Separations Area stream. The bounding dose scenario and associated exposure pathways for the member of the public was determined to be an agricultural resident who uses water from a well for domestic purposes. The bounding public dose scenario and associated exposure pathways were discussed during the FTF PA scoping meetings and are documented in FTF PA. The following exposure pathways involving the use of contaminated well water were considered:

- Direct ingestion of well water
- Ingestion of milk and meat from livestock (e.g., dairy and beef cattle) that drink well water.
- Ingestion of vegetables grown in garden soil irrigated with well water
- Ingestion of milk and meat from livestock (e.g., dairy and beef cattle) that eat fodder from pasture irrigated with well water
- Ingestion and inhalation of well water while showering

The following exposure pathways involving the use of contaminated surface water (from the applicable stream) for recreational use are assumed to occur:

- Direct irradiation during recreational activities (e.g., swimming, fishing) from stream water
- Dermal contact with stream water during recreational activities (e.g., swimming, fishing)
- Incidental ingestion and inhalation of stream water during recreational activities
- Ingestion of fish from the stream water

Additional exposure pathways could involve releases of radionuclides into the air from the water taken from the well (i.e., volatile radionuclides such as C-14 and I-129). Exposures from the air pathway in the FTF PA are:

- Direct plume shine
- Inhalation

Secondary and indirect pathways that contribute relatively minor doses to a receptor when compared to direct pathways (e.g., ingestion of milk and meat) include:

- Inhalation of well water used for irrigation
- Inhalation of dust from the soil that was irrigated with well water
- Ingestion of soil that was irrigated with well water
- Direct radiation exposure from radionuclides deposited on the soil that was irrigated with well water

[3] The pathways described are based on best available information at the time the FTF PA was developed and are not necessarily the same as those that will be evaluated in future revisions to the FTF PA.

The point of assessment for the groundwater wells used in the member of the public scenario is located 100 meters from the FTF, as shown in Figure 3.2-1. The peak concentrations used to determine the peak doses for the member of the public exposure pathways are calculated and documented in the FTF PA. The groundwater concentrations used are peak concentrations for each radionuclide at the given point of assessment, from any of the aquifers. [SRS-REG-2007-00002]

The groundwater concentrations were calculated based on the FTF PA conceptual model. The conceptual model is used to simulate the performance of the FTF closure system during the 10,000 year period following FTF closure. The conceptual model is comprised of both near field and far field conceptual models that represent the FTF closure system and the environmental media through which radionuclides may migrate. Various computer codes are used to simulate the release of radiological contaminants from the 22 underground waste tanks and the associated ancillary structures in the FTF, and to simulate transport of the radiological contaminants through soil and groundwater to the 100 meter assessment point and nearby streams. [SRS-REG-2007-00002]

The conceptual models used numerous FTF specific input parameters to represent the FTF 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 FTF conceptual model, such as the waste tank steel liners and cementitious barriers. The models and model inputs used in the FTF conceptual model to calculate groundwater concentrations are described in detail in the FTF PA. [SRS-REG-2007-00002]

The groundwater peak dose for the member of the public is calculated in the FTF PA using site-specific input parameters and the bounding dose scenario exposure pathways and peak concentrations discussed previously. Numerous bioaccumulation factors (e.g., soil-to-plant transfer factors), human health exposure parameters (e.g., water ingestion rates, vegetable consumption data), and DCFs are used in the computer modeling to calculate doses for each of the exposure pathways, and these parameters are documented in the FTF PA. [SRS-REG-2007-00002]

An air-pathway analysis was also performed in addition to the groundwater analysis to determine the dose contribution from the air pathway. This analysis used the same analysis as used in the FTF PA, atmospheric screening methodology, to identify radionuclides for modeling based on waste tank radionuclide projected inventories and the limited number of radionuclides susceptible to volatilization. Computer modeling was performed to calculate the transport of radionuclides through the stabilized waste form and the closure cap to the surface of FTF. An air-pathway dose was then calculated based on the specific curies of each radionuclide assumed to be transported to the surface of FTF. The air pathway analysis and groundwater analysis are combined to determine an all-pathways peak dose for a member of the public. [SRS-REG-2007-00002]

In addition to the all-pathways peak dose analyses, additional analyses are provided in the FTF PA to characterize the context of uncertainty and sensitivity surrounding the FTF PA all-pathways peak dose results. These evaluations focused on the key uncertainties and sensitivities identified during calculation of the member of the public dose. The uncertainty analyses provide information regarding how collective uncertainty in model input parameters is propagated through the model to the various model results. The sensitivity analyses provide information as to how various individual input parameters affect dose results. Together the uncertainty and sensitivity analyses provide assurance that the impacts of variability and uncertainty in the member of the public dose analyses are understood and addressed. [SRS-REG-2007-00002]

3.2.3.3 Results of the Analysis

The FTF PA modeling was used to determine an all-pathways dose to a member of the public for comparison with the 10 CFR 61.41 performance objectives. The FTF PA projected the peak all-pathways dose to the FTF public receptor (i.e., individual greater than or equal to 100 meters from the FTF) to be less than the 25 mrem/yr performance objective during the 10,000 year performance period[4, 5]. The 25 mrem/yr peak all-pathways dose includes the groundwater pathways and air pathways associated with all 22 FTF waste tanks and ancillary structures with the groundwater pathway being the most significant contributor. [SRS-REG-2007-00002]

Compliance demonstration with the 25 mrem/yr peak all-pathways dose is provided by the fact that peak FTF all-pathways base case dose calculated in the FTF PA is less than 25 mrem/yr during the 10,000 year performance period. In addition, the uncertainty and sensitivity analyses included in the FTF PA provide sufficient information on parameter sensitivities and modeling uncertainties to provide reasonable assurance that the 25 mrem/yr all-pathways dose limit will be met during the 10,000 year performance period[6]. [SRS-REG-2007-00002]

3.2.3.4 Conclusion

Based on the preceding discussion, reasonable assurance is provided that the performance objective at 10 CFR 61.41 will not be exceeded. The FTF PA demonstrates compliance with the 25 mrem/yr peak all-pathways dose, which is sufficient to meet the 10 CFR 61.41 performance objective[7].

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[4] The DOE is considering including, in the Draft FTF 3116 Basis Document, the peak FTF all-pathways base case dose value from the latest FTF PA revision. Revision 1 of the FTF PA [SRS-REG-2007-00002] is currently undergoing review by the NRC, SCDHEC, EPA and the public. Final interpretation of the FTF PA results by DOE will occur after the review process is complete.

[5] If included in the Draft FTF 3116 Basis Document, the FTF PA dose value is not to be considered a limit. As required by DOE Order 435.1-1 maintenance of the FTF PA will include future updates to incorporate new information, update model codes, analyze actual residual inventories, etc., as appropriate. These updates may result in a peak FTF all-pathways base case dose value either higher or lower than that stated, should DOE decide to include the dose value, in the Draft FTF 3116 Basis Document.

[6] The DOE is considering including additional information in the Draft FTF 3116 Basis Document regarding results of the FTF PA uncertainty and sensitivity analysis.

[7] As inventory projections and modeling assumptions are confirmed, the FTF PA will be updated as necessary to confirm that the peak FTF all-pathways base case dose remains less than or equal to 25 mrem/yr during the 10,000 year performance period.

3.2.4 As Low As Reasonably Achievable (ALARA)

The NRC performance objective in 10 CFR 61.41 also require that reasonable effort be made to maintain releases of radioactivity in effluents to the environment as low as reasonable achievable. The FTF PA was developed in accordance with the comparable requirement in DOE M 435.1-1:

> *"Performance assessments shall include a demonstration that projected releases of radionuclides to the environment shall be maintained as low as reasonably achievable (ALARA)."*

As discussed previously, the FTF PA provides the information to demonstrate compliance with the 25 mrem all-pathways dose performance objective, including stabilization of the residual waste using grout to minimize releases to the environment. [SRS-REG-2007-00002] Section 5.2 of the Draft FTF 3116 Basis Document will provide the information to show that the residual waste inventory in the waste tanks will be removed to the maximum extent practical. These factors demonstrate reasonable effort to maintain releases of radioactivity as low as reasonably achievable.

3.2.5 10 CFR 61.42

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.*

3.2.5.1 General Approach

Demonstration of compliance with a 500 mrem/yr peak intruder dose will be 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 the waste. The performance objective does not place quantitative limits on exposure. However, the 10 CFR 61 environmental impact statement suggests a dose limit of 500 mrem/yr for the waste classification scheme in 10 CFR 61.55. Consequently, the NRC uses 500 mrem/yr dose limit for evaluating impacts to an inadvertent intruder for purposes of 10 CFR 61.42. [NUREG-0945, NUREG-1854]

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 active institutional controls are no longer enforced.

To calculate the dose to an inadvertent intruder, potential intruder scenarios were considered in the FTF PA and the bounding Acute Intruder and Chronic Intruder dose scenarios were determined to be the Acute Intruder-Drilling Scenario and Chronic Intruder-Agricultural (Post-Drilling) Scenario respectively[8].

[8] The scenarios evaluated and scenarios determined to be bounding may differ in future revisions to the FTF PA, since future revisions will be based on guidance documentation and best available site information at the time.

3.2.5.2 Acute Intruder-Drilling Scenario

The bounding Acute Intruder scenario analyzed in the FTF PA is an Acute Intruder-Drilling scenario. This scenario assumes that after the end of active institutional controls a well is drilled within the FTF buffer zone. The well is assumed to be used for domestic water use and irrigation. Because no other natural resources have been identified in the FTF, no additional drilling scenarios are considered. In a drilling scenario, an Acute Intruder is assumed to be the person or persons who install the well and are exposed to drill cuttings during well installation.

The exposure pathways for this acute drilling scenario include:

- Inhalation of resuspended drill cuttings
- External exposure to the drill cuttings
- Inadvertent drill cuttings ingestion

3.2.5.3 Chronic Intruder-Agricultural (Post-Drilling) Scenario

The bounding chronic intruder scenario analyzed in the FTF PA is Chronic Intruder-Agricultural (Post-Drilling) Scenario. This scenario assumes that after the end of active institutional controls, a farmer lives within the FTF buffer zone and consumes food crops grown, and meat and milk from animals raised there using water from a well drilled within the FTF buffer zone. The chronic intruder-agricultural scenario (i.e., post-drilling) is an extension of the acute intruder-drilling scenario. This scenario assumes that an intruder lives in a building near the well drilled as part of the intruder-drilling scenario and engages in agricultural activities within the FTF buffer zone. Excavation to the surface of the stabilized contaminants in the waste tanks was not considered credible because its depth is more than 40 feet below the closure cap. Therefore, the intruder-agricultural scenario was retained for the ancillary structures inventory and specifically a waste transfer line. This is because it is less protected than a diversion box, valve box, or pump pit, which are protected by thick shield covers, equaling several feet of concrete. The soil used for agricultural purposes is assumed to be contaminated by both drill cuttings and well water used for irrigation.

The intruder is exposed to:

- Direct ingestion of well water
- Ingestion and inhalation of well water while showering
- Ingestion of milk and meat from livestock (e.g., dairy and beef cattle) that drink well water
- Ingestion of vegetables grown in garden soil irrigated with well water and containing contaminated drill cuttings
- Ingestion of milk and meat from livestock (e.g., dairy and beef cattle) that eat fodder from pasture irrigated with well water
- Inhalation of well water used for irrigation
- Inhalation of dust from the soil that was irrigated with well water
- Ingestion of soil that was irrigated with well water
- Direct radiation exposure from radionuclides deposited on the soil that was irrigated with well water

The intruder may also be exposed to a release of volatile radionuclides (e.g., C-14, H-3, I-129) from the drill cuttings and contaminated well water. These pathways include direct plume shine and inhalation.

3.2.5.4 Intruder Release Pathways Dose Analysis

As discussed previously, the bounding Acute Intruder and Chronic Intruder dose scenarios are the Acute Intruder-Drilling Scenario and Chronic Intruder-Agricultural (Post-Drilling) Scenario respectively. These bounding intruder dose scenarios and associated exposure pathways were discussed during the FTF PA scoping meetings and are documented in FTF PA. The water source for the intruder release pathways is a well drilled into the groundwater aquifers. The contaminated drill cuttings in the intruder release pathways are from drilling into a waste transfer line.

The point of assessment for the groundwater wells used in the intruder scenario is located one meter from the FTF, as shown in Figure 3.2-1. The peak concentrations used to determine the peak doses for the intruder release exposure pathways are calculated and documented in the FTF PA. The groundwater concentrations used are peak concentrations for each radionuclide at the given point of assessment, from any of the aquifers.

The groundwater concentrations were calculated based on the FTF PA conceptual model. The conceptual model is used to simulate the performance of the FTF closure system during the 10,000 year period following FTF closure. The conceptual model is comprised of conceptual models that represent the FTF closure system and the environmental media through which radionuclides may migrate. Various computer codes are used to simulate the release of radiological contaminants from the 22 underground waste tanks and the associated ancillary structures in the FTF, and to simulate transport of the radiological contaminants thorough soil and groundwater to the assessment point. [SRS-REG-2007-00002]

The conceptual models used numerous FTF specific input parameters to represent the FTF 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 FTF conceptual model, such as the waste tank steel liners and cementitious barriers. The models and model inputs used in the FTF conceptual model to calculate groundwater concentrations and the waste transfer line drill cutting inventory are described in detail in the FTF PA. [SRS-REG-2007-00002]

The peak intruder dose is calculated in the FTF PA using site-specific input parameters and the bounding dose scenario exposure pathways and peak concentrations discussed previously. Numerous bioaccumulation factors (e.g., soil-to-plant transfer factors), human health exposure parameters (e.g., water ingestion rates, vegetable consumption data), and DCFs are used in the computer modeling to calculate doses for each of the exposure pathways, and these parameters are documented in the FTF PA. [SRS-REG-2007-00002]

In addition to the intruder peak dose analyses, additional analyses are provided in the FTF PA to characterize the context of uncertainty and sensitivity surrounding the FTF PA intruder peak dose results. These evaluations focused on the key uncertainties and sensitivities identified during calculation of the intruder dose. The uncertainty analyses provide information regarding how collective uncertainty in model input parameters is propagated through the model to the various model results. The sensitivity analyses provide information as to how various individual input parameters affect dose results. Together the uncertainty and sensitivity analyses provide assurance that the impacts of variability and uncertainty in the intruder dose analyses are understood and addressed. [SRS-REG-2007-00002]

3.2.5.5 Results of the Analysis

The FTF PA modeling was used to determine an inadvertent intruder dose for comparison with the 10 CFR 61.42 performance objectives. The FTF PA projected the peak inadvertent intruder (i.e., individual within the FTF boundary) dose to be less than the 500 mrem/yr performance objective during the 10,000 year performance period[9, 10]. The 500 mrem/yr inadvertent intruder dose considers releases associated with the closure of all 22 waste tanks and related ancillary structures within FTF.

Demonstration of compliance with the 500 mrem/yr peak inadvertent intruder dose is provided by the fact that peak FTF base case inadvertent intruder dose calculated in the FTF PA is less than 500 mrem/yr during the 10,000 year performance period. In addition, the uncertainty and sensitivity analyses included in the FTF PA provide sufficient information on parameter sensitivities and modeling uncertainties to provide reasonable assurance that the 500 mrem/yr peak inadvertent intruder dose limit will be met during the 10,000 year performance period[11]. [SRS-REG-2007-00002]

3.2.5.6 Conclusion

The preceding discussion concludes reasonable assurance is provided that the 10 CFR 61.42 performance objective will not be exceeded after FTF closure. The FTF PA demonstrates compliance with the 500 mrem/yr peak inadvertent intruder dose, which is sufficient to ensure protection of individuals who inadvertently intrude and occupy the closure site or come in contact with the waste after active institutional controls over the site are removed.[12]

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[9] The DOE is considering including, in the Draft FTF 3116 Basis Document, the peak FTF inadvertent intruder dose values, both chronic and acute, from the latest FTF PA revision. Revision 1 of the FTF PA [SRS-REG-2007-00002] is currently undergoing review by the NRC, SCDHEC, EPA and the public. Final interpretation of the FTF PA results by DOE will occur after the review process is complete.

[10] If included in the Draft FTF 3116 Basis Document, the FTF PA dose values are not to be considered limits. As required by DOE Order 435.1-1 maintenance of the FTF PA will include future updates to incorporate new information, update model codes, analyze actual residual inventories, etc., as appropriate. These updates may result in peak inadvertent intruder dose values either higher or lower than those stated, should DOE decide to include the dose values, in the Draft FTF 3116 Basis Document.

[11] The DOE is considering including additional information in the Draft FTF 3116 Basis Document regarding results of the FTF PA uncertainty and sensitivity analysis.

[12] As inventory projections and modeling assumption are confirmed, the FTF PA will be updated as necessary to confirm that the peak FTF inadvertent intruder base case dose remains less than or equal to 500 mrem/yr during the 10,000 year performance period.

4.0 REFERENCES

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