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TPBAR
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ILV

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Permanent

SPECIAL ANALYSIS:
EVALUATION OF THE PROPOSED DISPOSAL OF THE INITIAL TEF-TPBAR WASTE CONTAINER WITHIN THE E-AREA LOW-LEVEL WASTE FACILITY INTERMEDIATE LEVEL VAULT

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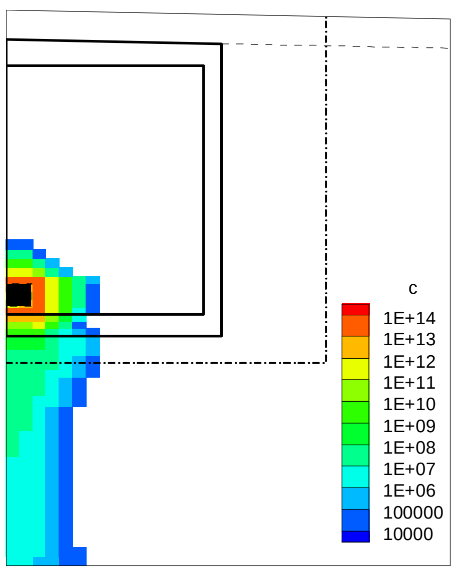

NOVEMBER 2004

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

Prepared for the U.S. Department of Energy Under Contract Number DE-AC09-96SR18500

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ANL-W	Argonne National Laboratory-West
Btu	British thermal unit
Ci	curie
CLSM	consolidated low-strength material
DOE	U.S. Department of Energy
ILV	Intermediate Level Vault
L	liters
LTA	Lead Test Assembly
m	meters
mrem	millirem
MCL	maximum contaminant level
PA	performance assessment
pCi	picocuries
PNNL	Pacific Northwest National Laboratory
SA	Special Analysis
SOF	sum-of-fractions
TEF	Tritium Extraction Facility
TPBAR	Tritium Producing Burnable Absorber Rod

EXECUTIVE SUMMARY

This Special Analysis (SA) evaluated a unique waste disposal item, the initial Tritium Extraction Facility (TEF) waste container, to determine its suitability for disposal within the Intermediate Level Vault (ILV). This waste container will be used to dispose 900 extracted Tritium Producing Burnable Absorber Rods (TPBARs) and the Lead Test Assembly (LTA) container, which will hold 32 unextracted TPBARs. Suitability was determined by evaluating the contribution of the expected radionuclide inventory of the initial TEF waste container versus the disposal limits derived for it.

Because of the durability of the TEF container, non-tritium radionuclides will not be released until well beyond the 1000-year Performance Assessment (PA) time of compliance. Consequently, it was unnecessary to evaluate the impact of the initial TEF container disposal through the air and groundwater pathways for non-tritium radionuclides; however an analysis was conducted for these radionuclides with respect to the inadvertent intruder pathway. Tritium has the ability to permeate the exterior walls of the TEF container and therefore evaluations were conducted to assess its potential to cause human exposure through the air, groundwater and resident (intruder) pathways. A detailed study of the groundwater pathway was conducted using the updated ILV vadose zone and groundwater models to evaluate transport of tritium through the groundwater pathway because of the relatively small size of the TEF disposal container in comparison to the size of the ILV. The results of these analyses determined a TEF disposal container Sum of Fractions (SOF) for the air, resident and groundwater (GW1 and GW2) pathways. These are 4.97E-06, 7.09E-05, 2.35E-05 and 3.05E-05, respectively.

The conclusion of this SA is that the TEF disposal container described in this investigation will not cause any exceedance of U.S. Department of Energy (DOE) Order 435.1 performance measures over the 1000-year PA compliance period and may therefore be disposed of within the ILV.

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1.0 INTRODUCTION

The purpose of this SA is to evaluate the suitability of disposing a unique waste item within the ILV. This item is the initial TEF waste container for extracted TPBARs. While a typical TEF disposal container has 4 positions to house extraction baskets for extracted TPBARs, the initial TEF disposal container will house the LTA in place of one of the extraction baskets. This SA addresses only the initial TEF disposal container because its waste content is different from a "production" TEF container (i.e., containers filled after TEF has begun routine operation) and because the impact of the heat load associated with multiple production TEF containers has not yet been addressed. The scope of this SA included an evaluation of the radionuclide content of the waste package and the characteristics of the initial TEF disposal container, identifying which, if any, exposure pathways need to be evaluated and generating container specific ILV limits for those pathways.

2.0 DISPOSAL CONTAINER CONCEPT

The TEF disposal container is a rectangular carbon steel box with approximate dimensions of 5-feet (60-inches) by 5-feet (60-inches) by ~19 feet (227-inches) long. The sides, top and bottom are all approximately 13 inches thick, as shown in Figure 1. The darkened area on the left-hand side of the drawing depicts the lid that is bolted on to provide shielding so that the 1-inch-thick outer closure can be welded on with a full-penetration weld.

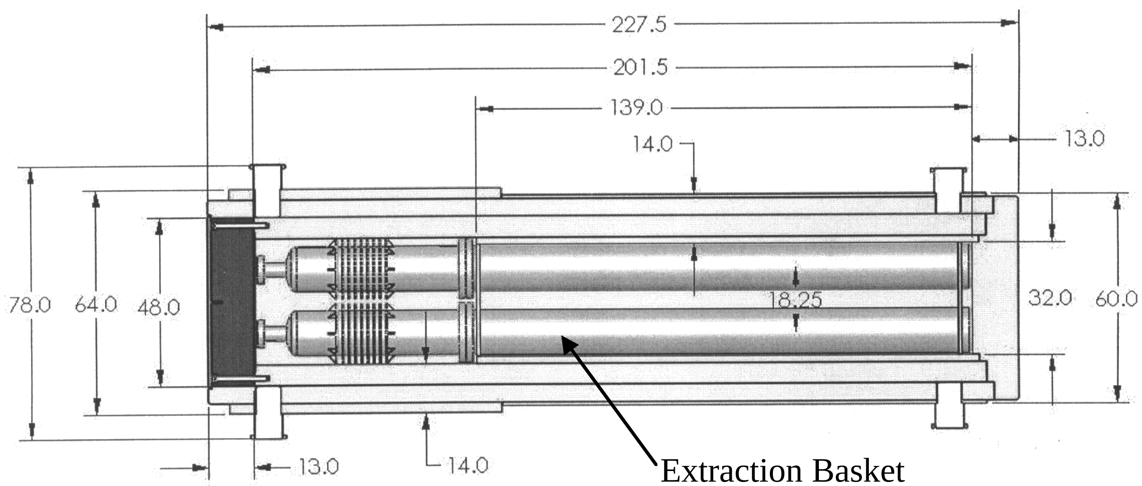

Figure 1. Sectional diagram of the TEF disposal container (dimensions are in inches)

Inside the carbon steel outer wall, there are slots to place 4 extraction baskets, each designed to hold up to 300 extracted TPBARs. In the initial TEF disposal container, evaluated in this SA, one of the 4 slots will be occupied by the similarly sized LTA container. The stainless steel LTA container, which will contain 32 unextracted TPBARs, will be welded shut prior to placement within the TEF disposal container. Once loaded with the 3 TPBAR baskets and LTA container, this disposal container will be welded shut. The container will be placed within the ILV for final disposal and encased in grout or CLSM as the waste cell is filled.

This SA considers only the initial TEF disposal container and not the later TEF containers that will contain 4 baskets. A separate SA is planned in FY05 to evaluate production-mode TEF disposal containers and the disposal options available for them.

3.0 TEF DISPOSAL CONTAINER RADIONUCLIDE INVENTORY

The inventory of radionuclides contained in the TEF waste disposal container was provided in several sources. Radionuclide inventory data for an irradiated production TPBAR is contained in Pagh 2004. The data listed in that report present the inventory of radionuclides for an unextracted TPBAR and therefore could not be used to determine the tritium inventory of an extracted TPBAR since most of the tritium is removed from the TPBARs in the extraction process. This data can, however, be used to estimate the non-tritium radionuclide inventory of either an extracted or unextracted TPBAR since only tritium is extracted in the extraction process.

For the purpose of calculating the non-tritium radionuclide content of the initial TEF container at the time of disposal all of the three TPBAR bundles are assumed to be decayed for 1 year from the time of irradiation. This assumption is quite conservative given that the first bundle of production TPBARs (300 TPBARs) will have decayed for more than 3 years, the second bundle (300 TPBARs) for ~2 years, and the last bundle (300 TPBARs) for at least 0.5 years at the time of disposal. The numbers provided in this report were also used to estimate the non-tritium inventory of the 32 unextracted TPBARs in the LTA container, which were actually irradiated between August 1997 and February 1999, and will have decayed for a significantly longer period of time than the assumed 1 year.

The tritium inventory was estimated separately from the other radionuclides and was based on several correspondences with the Defense Programs Project Startup team, primarily from Brizes. In the first correspondence (Brizes 2004a) the tritium inventory for the initial TEF disposal container is calculated to be 316,846 Ci. Of the 316,846 Ci, 119,700 Ci were attributed to the three bundles of extracted TPBARS (133 Ci per TPBAR following extraction) while 197,146 Ci were attributed to the 32 unextracted TPBARs in the LTA. In the second correspondence (Brizes 2004b), the tritium content of the LTA is corrected to be 171,283 curies. The tritium and non-tritium radionuclide inventories of the TEF disposal container are listed in Table 1.

In addition to the radionuclide content of the TPBARs, four of the 32 TPBARs in the LTA were stored in one of the Pacific Northwest National Laboratory (PNNL) hot cells and may have acquired surface contamination during that time-period. The other 28 TPBARs were stored in the ANL-W hot cells. Wall smears from the PNNL hot cells are available and are thought to provide bounding conditions on any contamination that may have inadvertently been deposited on the 14 shrouds used to hold the unextracted TPBARs and which are assumed to be included within the LTA. Wall smear data from the PNNL hot cells was provided in Brizes 2004c. The smear analyses from Argonne National Laboratory-West (ANL-W) (Brizes 2004d) were utilized to apply to the other 28 TPBARs in a comparable way that the PNNL hot cell data was applied. These activities were then combined and added to the TEF container inventory. The activities of all isotopes are listed in Table 1.

Table 1. Radionuclide Inventory for the Initial TEF Disposal Container

Nuclide	Activity, Ci	Nuclide	Activity, Ci	Nuclide	Activity, Ci
Am-241	8.36E-07	Hf-181	2.35E+00	Sb-124	2.81E-01
Am-243	3.16E-09	In-113m	1.41E+02	Sb-125	1.23E+03
Ar-37	2.94E-01	In-114	7.79E-01	Sb-126	1.05E-07
Ar-39	8.82E+00	In-114m	8.14E-01	Sc-46	3.95E-01
Ba-131	2.51E-08	K-42	7.62E-09	Sc-47	9.32E-25
Ba-133	6.33E-01	La-140	1.88E-12	Se-75	1.04E+02
C-14	1.32E+00	Lu-177	3.17E-04	Sn-113	1.41E+02
Ca-41	7.00E-02	Mn-54	1.76E+04	Sn-117m	1.53E-04
Ca-45	6.36E+01	Mo-93	9.69E-01	Sn-119m	2.85E+03
Ca-47	2.44E-25	Nb-92	6.91E-09	Sn-121m	5.09E-01
Cd-115m	6.52E-04	Nb-93m	8.14E-03	Sn-123	6.51E+01
Ce-144	1.27E-04	Nb-94	4.44E-01	Sn-125	1.33E-08
Cm-242	8.42E-08	Nb-95	2.74E+03	Sr-89	5.12E-01
Cm-243	2.92E-07	Nb-95m	9.41E+04	Sr-90	1.00E-04
Cm-244	3.76E-08	Ni-59	1.57E+02	Ta-182	1.16E+03
Co-58	7.51E+03	Ni-63	2.12E+04	Ta-183	1.70E-17
Co-60	2.95E+04	Np-237	2.03E-10	Tc-99	4.06E-02
Cr-51	1.16E+02	Np-239	6.17E-09	Te-123m	3.54E-01
Cs-131	1.40E-07	Os-191	4.53E-09	Te-125m	3.00E+02
Cs-137	1.17E-07	P-32	2.81E-05	W-181	7.06E-01
Eu-152	1.09E-08	Pu-238	4.07E-07	W-185	7.12E+00
Eu-154	1.27E-06	Pu-239	2.55E-06	W-188	4.31E-01
Eu-155	9.26E-06	Pu-240	2.58E-06	Y-90	1.37E-03
Fe-55	1.55E+05	Re-186	8.25E-28	Y-91	2.57E+00
Fe-59	7.42E+01	Re-188	4.35E-01	Zn-65	1.39E+00
H-3[a]	1.71E+05	Ru-103	5.37E-03	Zr-89	5.22E-34
H-3[b]	1.20E+05	Ru-106	8.83E-05	Zr-93	1.05E-01
Hf-175	8.73E-01	S-35	7.62E-01	Zr-95	1.27E+03

Note The following nuclides were present in the TPBAR immediately following irradiation but had decayed to zero after 1 year: As-76, Ba-133m, Ba-135m, Br-82, Cd-115, Cu-64, Cu-66, Mo-99, Na-24, Nb-96, Nb-97, Nb-97m, Ni-66, Sb-122, Sn-121, W-187, Y-89, Zr-97.

Note: H-3[a] is tritium inside the LTA, H-3[b] is tritium contained in the 3 bundles of extracted TPBARs.

4.0 TEF DISPOSAL CONTAINER DURABILITY WITHIN THE ILV

The durability of the TEF disposal container impacts the ability of its radionuclide contents to migrate out of the ILV and contribute to a potential human exposure through one of the defined pathways. Such mobility cannot occur until the outer wall of the TEF container fails, either mechanically or chemically, as by corrosion. The ability of hydrogen (i.e., tritium) and other elements to diffuse in metals at room temperatures has been extensively investigated. One source is cited herein, Nowick and Burton 1975, in which the relative rates of diffusion are established for hydrogen versus other interstitial elements (e.g., oxygen, nitrogen, carbon). The difference is noted to be 15-20 orders of magnitude higher for tritium than the other elements. Data from this resource confirms the inability of non-hydrogen elements to escape the TPBAR container by diffusion prior to penetration of the disposal container's exterior wall.

There is considerable mechanical strength to the TPBAR disposal container owing to its 13-inch thick, carbon-steel exterior walls, in addition to the strength afforded by the Consolidated Low Strength Material (CLSM) or grout matrix surrounding the container. Given the robust construction design of the TPBAR container, the chief mechanism of failure potentially leading to release of its radionuclide inventory is likely to be corrosion of the container walls and welds.

To address that concern several studies focusing on the ability of the TEF container to isolate its radionuclide waste contents and to evaluate the release rate of tritium were conducted prior to this SA. These studies investigated the potential for heat buildup about the initial TEF container when it is imbedded in grout or CLSM material and the potential for corrosion of the carbon and stainless steel components of the TEF disposal container in the ILV environment. These investigations are documented in Vinson, et al. 2004.

Initially, the heat buildup surrounding the initial TEF container imbedded in grout or CLSM was calculated. In that study, a total initial thermal load of 2,458.4 Btu/hr was assumed to bound the first TEF container. This input was used in a numerical simulation to determine the heat field surrounding the initial TEF container. The results indicate that the highest steady-state temperature will reach 200^{o}F in the center of the first TEF container while the highest temperature at the inner surface of the exterior wall will be 175^{o}F. This temperature is sufficiently low that there will be no effect on the curing of grout or CLSM material used to surround the first TEF container (Vinson, et al. 2004). The temperature projections from this analysis were then used in subsequent corrosion calculations and tritium permeation calculations.

The corrosion analysis considered both general corrosion and localized corrosion (i.e., pitting and stress corrosion cracking). These processes were evaluated on the exterior surface of the TEF container where it comes into contact with the grout or CLSM, and inside the TEF disposal container where the vapor comes into contact with both carbon and stainless steel. With respect to the exterior surface of the TEF disposal container, the penetration time for a 0.5-inch weld (i.e., one-half the weld thickness of the TEF disposal container) was calculated to be approximately 12,600 years (Vinson, et.al. 2004). With respect to corrosion of carbon steel and stainless steel inside the TEF container, the total metal loss from general corrosion was calculated to be insignificant. The potential for breaching of the thinnest section of the stainless-steel LTA container by pitting was also evaluated using conservative assumptions and the penetration time for the 0.25-inch wall was calculated to be 180 years.

This determination has an important implication for this investigation. All radionuclides, with the exception of tritium, will be bound within the TEF container for the full 1000-year PA compliance period. None of these will be able to contribute to a potential human exposure along any of the PA-defined exposure pathways that depend on radionuclide migration from the waste (i.e., air and groundwater). As a result, no disposal limits are needed for this waste package for air and groundwater pathways, except for tritium.

Tritium is able to escape the TEF container by diffusion through the carbon-steel exterior wall, hence it is discussed in further detail.

5.0 TRITIUM RELEASE FROM THE INITIAL TEF CONTAINER

Tritium will not be isolated within the TEF disposal container like the other radionuclides in the TEF container because of its propensity to diffuse through the exterior walls. Due to this characteristic, further consideration must be given to the rate of permeation through the TEF container walls and the potential release of tritium via the air and groundwater pathways.

Two investigations specifically address the rate of tritium permeation from the TEF disposal container. One investigation is summarized in Vinson, et al. 2004 and addresses tritium permeation from the LTA, while the other is documented in Clark 2004 and focuses on tritium permeation from the TEF container.

Tritium permeation from the LTA was found to be only 24 Ci/year at the temperatures predicted to occur when the TEF disposal container is disposed within grout. This release to the space inside the TEF container is very small compared to the initial tritium inventory of the three extraction baskets (119,700 Ci) which hold the extracted TPBARs and which forms the starting point for the calculation of the rate of tritium permeation through the walls of the TEF disposal container. This calculation (Clark, 2004), which ignores the very small contribution from the LTA, estimated tritium release on an annual basis until the tritium flux decreased to zero. Calculations were made for two temperatures, 175^{o}F and 200^{o}F, however the estimate made for 175^{o}F temperature is more relevant because that is the estimated average steady-state temperature of the TEF disposal container wall when it is initially placed in the ILV. The calculation makes the conservative (worst-case) assumption that all of the tritium is immediately released from the TPBAR getters as tritium gas and is available to permeate the TEF disposal container walls. The tritium permeation rate through the walls of the TEF container at 175^{o}F is listed in Table 2.

Table 2. Annual Tritium Permeation through Initial TEF Container Walls at 175^{o}F

Year	Curies Permeated	Year	Curies Permeated	Year	Curies Permeated
1	6465	9	3906	17	1843
2	6113	10	3623	18	1614
3	5771	11	3349	19	1389
4	5438	12	3081	20	1168
5	5115	13	2821	21	951
6	4800	14	2567	22	735
7	4494	15	2320	23	518
8	4196	16	2079	24	288

6.0 ANALYSIS

Tritium is the only radionuclide that can escape the TEF disposal container within the 1000-year PA compliance period. Tritium is also relatively mobile within the subsurface environment and hence could cause human exposure through either the air or groundwater pathways. As a result, both of these pathways must be evaluated for tritium.

In addition to these analyses, the resident intruder pathway is evaluated since, theoretically, radiation can emanate from all radionuclides within the TEF disposal container and could cause an exposure to the resident intruder.

6.1 AIR PATHWAY ANALYSIS

The air pathway is of limited significance for the TEF disposal container since the thick steel walls prevent the release of all radionuclides, with the exception of tritium, over the 1000-year PA compliance period. For this reason, C-14 is not considered in the air pathway analysis despite an initial activity level that suggests it could contribute a significant fraction. Tritium can permeate the TEF disposal container and potentially escape the vault and result in an exposure, hence an air pathway evaluation is provided for that radionuclide.

The air release is calculated at two exposure points, at the SRS boundary during the period of institutional control and at 100 m from the ILV after the loss of institutional control. An analysis was performed for both locations.

6.1.1 SRS Boundary Analysis

The calculations for the SRS boundary used the following constants, obtained from Flach and Hiergesell 2004:

Exposure limit = 10 mrem/yr
Dose factor = 2.4E-06 mrem/yr
Release fraction = 3.2E-04 Ci/yr per Ci inventory

The maximum annual permeation from the initial TEF container was previously calculated to be 6465 Ci/year, hence this is the inventory that should be used to determine the exposure that could result from disposing the initial TEF container in the ILV. From this information:

Air release = Disposed Inventory x Air Release Fraction = (6465 Ci/yr.) x 3.2E-04 = 2.07 Ci/yr

This is converted to a human exposure as follows:

2.07 Ci/year released x 2.4E-06 mrem/Ci = 4.97E-06 mrem/yr.

This exposure represents only a small fraction of the human exposure limit of 10 mrem/year, which is calculated as follows:

Fraction of exposure limit = (4.97E-06 mrem/yr.) / (10 mrem/yr.) = 4.97E-07

This fraction is used to back calculate the maximum number of Ci of tritium that might be disposed within the initial TEF container as follows:

Initial TEF container tritium limit = 119,700 Ci x (10 mrem/yr.) / (4.97E-06 mrem/yr.) = 2.41E+11 Ci

The fraction of this limit that the initial TEF container inventory consumes is equivalent to the exposure fraction and is calculated as follows:

Fraction of disposal limit = 119,700 Ci / 2.41E+11 Ci = 4.97E-07

6.1.2 100 m Analysis

Calculation of the TEF container limit at the 100-m compliance point can be evaluated using the different ILV tritium air pathway limits determined for each exposure location, in Flach and Hiergesell 2004. These limits were determined to be 1.3E+10 Ci and 1.3 E+09 Ci for the SRS boundary and 100 m exposure points, respectively.

Since the disposal limit is 1 order of magnitude lower when the analysis is performed 100 m from the ILV, the TEF container limit at the 100 m compliance point is therefore an order of magnitude lower than is calculated for the SRS boundary. This limit is 2.41E+10 Ci. Accordingly, the fraction that the initial TEF container inventory represents is calculated to be 119,700 Ci / 2.41E+10 Ci = 4.97E-06.

6.2 RESIDENT (INTRUDER) PATHWAY ANALYSIS

An automated resident pathway analysis was conducted in Flach and Hiergesell 2004 to establish new ILV disposal limits. Examining the TEF disposal container inventory, summarized in Table 1, with respect to these limits, indicates the fractions for each radionuclide. The greatest fractions are for Co-60 and Nb-94 and are calculated to be 3.68E-05 and 3.41E-05, respectively. The other radionuclides' fractions are all much, much less (i.e., the next largest fraction is 1.32E-10 for Ba-133). As a result, there are no radionuclides associated with the TEF disposal container that pose a threat to the resident intruder.

6.3 GROUNDWATER PATHWAY ANALYSIS

The groundwater pathway analysis was based on the analysis described in Flach and Hiergesell 2004. That report computed new disposal limits for the ILV disposal unit based upon several changes to the original E-Area Performance Assessment (PA). The most important change evaluated in that study was the implementation of a 1,000-year time of compliance compared to a 10,000- year period for the PA. Other revisions to the original PA included: refinement of the groundwater model mesh to allow a more precise incorporation of the IL vault footprints, a new Pu chemistry model accounting for incorporation of different transport properties of oxidation states III/IV and V/VI, and the implementation of a timed sum-of-fractions approach to setting disposal limits. In this SA, the groundwater model developed in Flach and Hiergesell 2004 was modified to evaluate the tritium flux introduced into the ILV by the initial TEF disposal container.

The tritium source term was handled differently than it was in Flach and Hiergesell 2004 because the TEF container has much smaller volumetric dimensions than the ILV, for which tritium limits were originally calculated. The highly compact placement of the tritium source term within the ILV could produce higher concentrations at the 100-meter compliance well than what would be produced from a uniformly distributed placement throughout the ILV. Consequently, an evaluation was performed to evaluate the groundwater pathway under this condition.

The analysis utilized the tritium release calculated to occur by permeation through the TEF container outer wall and the vadose zone groundwater models developed in Flach and Hiergesell 2004, which were adapted to incorporate the specific geometry of the TEF disposal container. As in Flach and Hiergesell 2004, separate simulations were conducted for the vadose zone and the saturated (groundwater) zone. Within the vadose zone, a position close to the base of the ILV was selected for placement of the TEF container because such positioning is likely to produce the higher tritium concentrations at the 100-meter compliance well.

The vadose zone model construction reflects the geometry of the current E-Area closure plan and separate flow fields were established for the different configurations and infiltration rates associated with operation, institutional control and final closure of the ILV facility. Individual flowfields corresponded to the time-periods 0-25 years, 25-125 years, 125-325 years and 325 to 575 years. Time zero is the start of disposal unit operation.

Tritium was the only contaminant simulated in the transport simulations because it is the only radionuclide that can escape the TEF container within the 1000-year PA compliance period. The half-life of tritium is sufficiently short that the fluxes passing from the vadose zone to the groundwater zone and concentrations in the 100-meter compliance well are both well past their respective peaks by 575 years. Consequently, it was not necessary to continue the simulation for time periods beyond that time frame as was done in the simulations described in Flach and Hiergesell 2004.

The vadose zone model takes advantage of symmetry by only simulating ½ of the ILV disposal unit. Consistent with this approach only ½ of the TEF container was introduced into the model domain. The TEF container was configured within the existing model elements so as to be situated at the base of an individual ILV cell and centrally positioned. Material properties were altered so as to make the TEF container virtually impermeable and new steady-state flow fields were simulated for each of the relevant time periods. Next, the tritium source term was introduced within a "halo" zone surrounding the TEF container to mimic the release of tritium by permeation through the container exterior wall and transport of tritium was simulated with respect to time.

The results of this simulation are shown in Figure 2 and Figure 3. In Figure 2 the tritium concentration distribution is illustrated for 100 years following placement of the TEF container within the ILV. The small black rectangle represents the end-view of the TEF container imbedded within the ILV while the surrounding colors represent tritium concentrations in pCi/L. The simulation utilized symmetry of the ILV and TEF container to simplify the simulation, hence only half of the ILV and TEF are illustrated here.

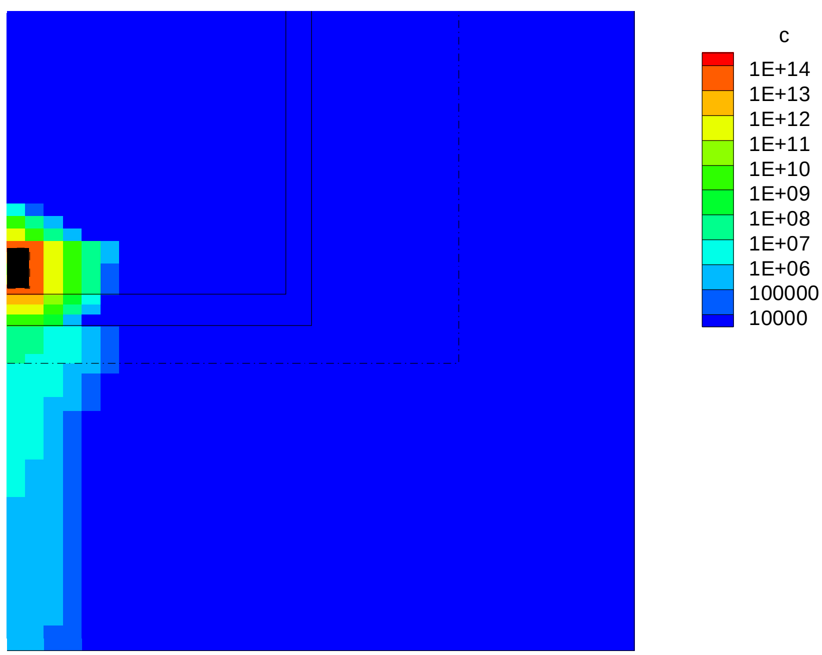

Figure 2. Tritium concentration in vadose zone at 100 years

The total flux leaving the vadose zone with respect to time is presented in Figure 3. In this graph tritium flux rapidly increases, reaching a peak of 3.52E-06 Ci /year at about 119 years after which it begins a steady decline to 1.01E-14 Ci/year at the end of the simulation (575 years). A slight decrease in the flux curve is noted between 125 and 325 years, which is attributable to the placement of the final closure cap over the ILV and surrounding soil and the accompanying decrease in infiltration into the soil immediately surrounding the ILV. The closure cap is assumed to degrade significantly after 325 years, resulting in increased infiltration to the soil, thus there is a small increase in the flux curve after 325 years. After 575 years the closure cap over the ILV is assumed to fail and infiltration at the land surface will revert to 40 cm/yr. This may cause a flushing of any remaining tritium in the ILV and eventually result in a small peak in the groundwater concentration. The residual tritium at that time is calculated to be 6.18E-10 Ci, which is very small compared to the maximum tritium flux from the vadose zone to the aquifer (3.52E-06 Ci/yr). Any resulting peak at the 100 m well after 575 years will therefore be less than the peak observed at the 100-meter well shortly after the maximum flux to the aquifer is realized.

The flux output from the vadose zone model was utilized as input to the groundwater (saturated zone) model. This flux was applied to one model element immediately below the ILV in rates that varied in 0.1-year increments.

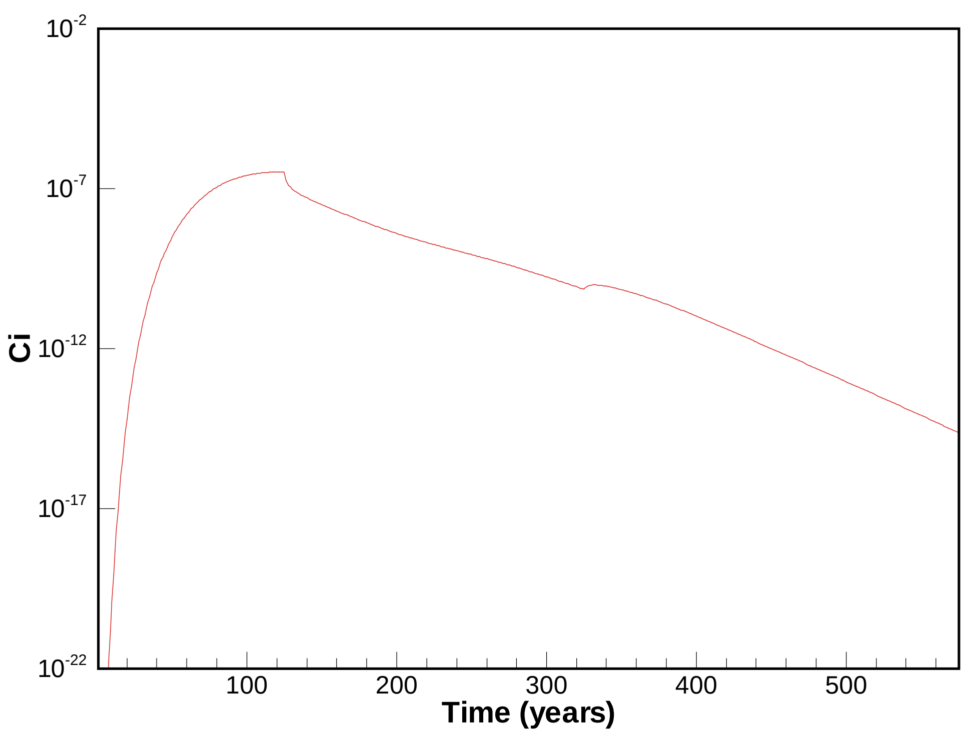

Figure 3. Tritium flux at lower boundary of Vadose Zone model

The groundwater (or saturated zone) model utilized in this SA is essentially the same one developed and described in Flach and Hiergesell 2004. A few minor adaptations of the previous model were implemented to accommodate specific needs for this investigation, including limiting the simulation period to 575 years and restricting the element(s) within which tritium flux from the vadose zone was introduced.

The tritium groundwater concentrations at a position 100 meters down gradient from the ILV were tracked and are presented in Figure 4. To identify the location where the peak groundwater concentration occurs with respect to time, a "wall" of elements was identified to record concentration histories. The concentration history for the element at which the peak concentration occurs is what appears in Figure 4. The tritium concentration at the location of this element begins to increase significantly after 50 years and continues this trend until a peak of 0.61 pCi/L is reached at 123 years. After this, the tritium groundwater concentration decreases at a similar rate until it approaches zero after 200 years. While the peak concentration occurs within the time period used to calculate the GW2 disposal limit (100-1325 years), the maximum groundwater concentration to occur in the time period used to calculate the GW1 disposal limit (0 to 100 years) is 0.47 pCi/L. This maximum groundwater concentration occurs at 100 years since the concentration is still increasing prior to reaching the peak at 123 years.

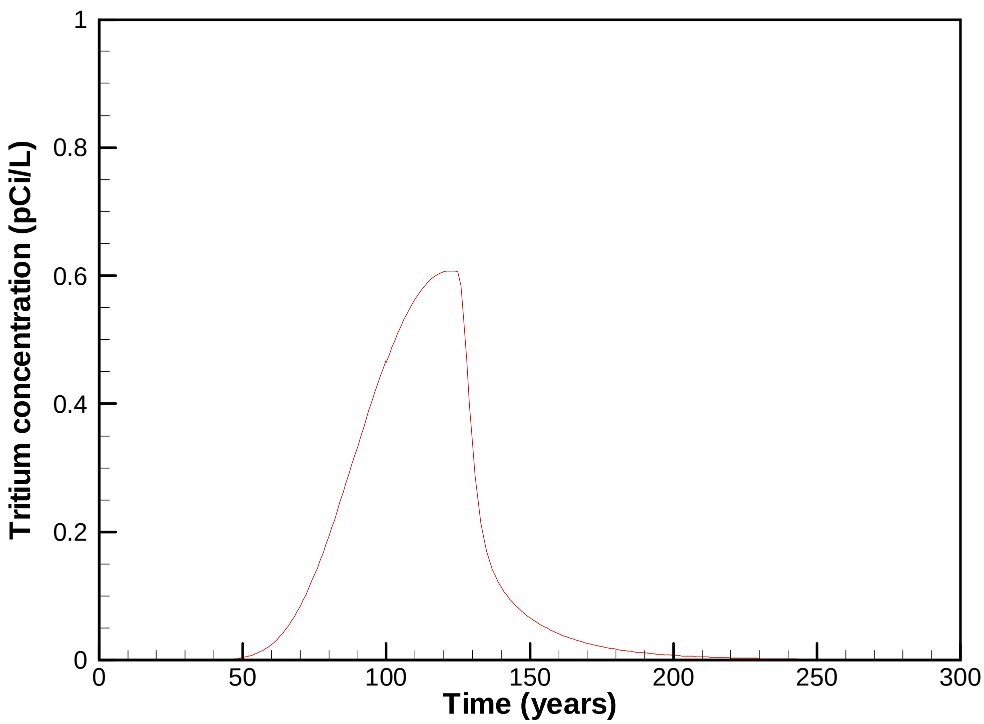

Figure 4. Tritium concentration at the 100 meter compliance point

The peak groundwater tritium concentration realized at the 100-meter compliance well as a result of disposing the TEF container in the ILV represents only a small fraction of the MCL of 20,000 pCi/L. That fraction of the MCL is calculated to be (0.61/20,000) or 3.05E-5.

Using the peak tritium groundwater concentration at the compliance point, the maximum tritium activity that could be introduced into the TEF container without exceeding the MCL (i.e., the inventory limit) is calculated using the following relationship.

$$\frac{(0.61)}{(20{,}000)} = \frac{(119{,}700)}{(X)} \qquad \text{or} \qquad X = 3.92E+09\,Ci$$

The fraction that the TEF container's actual tritium inventory (non-LTA) represents of this calculated container limit is therefore:

$$\frac{1.20E+05\,Ci}{3.92E+09\,Ci} = 3.05E-05$$

This fraction is applicable to the GW2 time period since the peak tritium groundwater concentration occurs within the 100-1350 year time period.

Similarly, for the GW1 time period (0-100 years) the maximum groundwater tritium concentration is a very small fraction of the MCL. This fraction of the MCL is calculated to be (0.47/20,000) or 2.35E-05.

For the GW1 time period, using the maximum tritium groundwater concentration at the compliance point, the maximum tritium activity that could be introduced into the TEF container without exceeding the MCL (i.e., the inventory limit) is calculated using the following relationship.

$$\frac{(0.47)}{(20{,}000)} = \frac{(119{,}700)}{(X)} \qquad \text{or} \qquad X = 5.09E+09\,Ci$$

The fraction that the TEF container's actual tritium inventory (non-LTA) represents of this calculated container limit is therefore:

$$\frac{1.20E+05\,Ci}{5.09E+09\,Ci} = 2.35E-05$$

This is the TEF container's tritium fraction applicable to the GW1 time period.

7.0 RADIONUCLIDE DISPOSAL LIMITS

The limits for tritium for the air, radon, and groundwater pathways are shown in Table 3. The limit for every other radionuclide for these pathways is >1E+20 Ci. For the resident intruder pathway, the limits determined in the ILV SA should be used.

Table 3. Radionuclide Limits for the First TEF-TPBAR Disposal Container

Radionuclide	Air	GW1	GW2	Radon	Resident
H-3[a]	2.4E+10[b]	5.1E+09[b]	3.9E+09[b]	> 1.E+20[b]	> 1.E+20[c]
All other radionuclides	> 1.E+20[b]	> 1.E+20[b]	> 1.E+20[b]	> 1.E+20[b]	Individual limits[c]

a No tritium limits for the air and groundwater pathways are needed for the LTA (i.e., the LTA ^{3}H limits for the air and groundwater pathways are >1E20 Ci)
b TEF-TPBAR disposal container specific limit.
c Limits established for the ILV in Flach and Hiergesell 2004.

A summary of the TEF container inventory for the most significant radionuclides, along with the associated exposure pathway limits for the ILV and the fraction represented by the TEF inventory for each is presented in Table 4. At the bottom of this table the Sum of Fractions is indicated for each pathway.

Table 4. Summary of Inventory, Pathway Limits, and Fraction

		Pathway Limits				Fraction of Limit			
	TEF	Resident	Air	GW1	GW2	Resident	Air	GW1	GW2
Nuclide	Inventory	Limit[a]	Limit[b]	Limit[b]	Limit[b]	Fraction	Fraction	Fraction	Fraction
	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)				
H-3[c]	1.20E+05		2.4E+10	5.1E+09	3.9E+09		4.97E-06	2.35E-05	3.05E-05
Co-60	2.95E+04	8.0E+08				3.68E-05			
Nb-94	4.44E-01	1.3E+04				3.41E-05			
				Sum of Fractions		7.09E-05	4.97E-06	2.35E-05	3.05E-05

a for generic waste from Flach and Hiergesell 2004
b for the TEF disposal container determined in this investigation.
c the initial tritium inventory in the TEF container, excluding the LTA

8.0 CONCLUSIONS AND RECOMMENDATIONS

A unique waste disposal item, the initial TEF waste container, was evaluated to determine its suitability for disposal within the Intermediate Level Vault (ILV). This waste container will be used to dispose 900 extracted TPBARs and the Lead Test Assembly container, which will hold 32 unextracted TPBARs.

A heat generation analysis previously indicated that the initial heat load of the fully loaded initial TEF container is low enough that it can be imbedded in the grout or CLSM matrix of the ILV. Additionally, another investigation (Vinson et al. 2004) indicated that the expected corrosion rate of the TEF disposal container's exterior carbon steel wall is slow enough that the wall will not be breached until a point in time that is well beyond the 1000-year PA compliance period. This same study indicated that localized corrosion of the thinnest part of the LTA container will not breach the container for 180 years, thus minimizing concern about release of tritium from the unextracted TPBARs.

The durability of the TEF disposal container will prevent the release of all non-tritium radionuclides within the 1000-year PA compliance period. Therefore, no further action is required to evaluate the air, radon, and groundwater pathways for those radionuclides (i.e., the limits for all radionuclides other than tritium for air, radon, and groundwater pathways are > 1.E+20). However, due to its ability to permeate the exterior wall of the TEF container, tritium was evaluated with respect to the air and groundwater pathways. The tritium permeation rate was obtained from a previous investigation for use in these evaluations.

The air pathway analysis indicates the tritium that permeates the TEF container contributes a very small fraction, 4.97E-06, to the annual exposure limit through the air pathway. With respect to the resident intruder pathway, the largest fraction contributed by any radionuclide in the entire inventory is 3.68E-05, for Co-60. The Sum of Fractions for the air and resident intruder pathways are calculated to be 4.97E-06 and 7.09E-05, respectively. These pathways are therefore of no further concern for the TEF disposal container.

With regard to the groundwater pathway, the groundwater models developed in the recent SA to update ILV disposal limits were utilized to evaluate this pathway for the TEF container. Since the planned disposal represents the introduction of a significant tritium source term into a compact zone, it was thought that such a disposal method could produce higher concentrations at the 100-meter compliance well than if considering a source term distributed uniformly throughout the ILV. Hence, the model was set up to depict the geometry of an actual TEF container and the tritium source term was introduced accordingly.

Since groundwater pathways are evaluated with respect to time, fractions are determined for the GW1 and GW2 time periods. The GW1 fraction applies to the 0-100 year time period while the GW2 fraction applies to the 100-1350 year time period.

The groundwater model results reflect groundwater tritium activity at the 100-meter compliance well. For the 0-100 year period the maximum groundwater tritium activity level was determined to be 0.47 pCi/L while the overall peak groundwater tritium activity, 0.6 pCi/L, was observed to occur at 123 years. These tritium groundwater activities are very small relative to the MCL of 20,000 pCi/L and result in the calculation of very small fractions for the GW1 and GW2 pathways, these being 2.35E-05 and 3.05E-05, respectively.

To implement the results of this SA in the Waste Information Tracking System (WITS), radionuclide disposal limits for the TEF disposal container must be entered by using a unique designator for each radionuclide (e.g., H-3T, C-14T). The limits for tritium for the air, radon, and groundwater pathways are shown in Table 3. The limit for every other radionuclide for these pathways is >1E+20 Ci. For the intruder pathway, the limits determined in the ILV SA should be used.

The conclusion of this SA is that the TEF disposal container described in this investigation will not cause any exceedance of DOE Order 435.1 performance measures over the 1000-year PA compliance period and may be disposed of within the ILV. To be consistent with how the groundwater analysis was conducted, it is recommended that the TEF disposal container be placed centrally within an interior ILV cell (non-end cell) with its long axis oriented perpendicular to the long axis of the cell and parallel to the long-axis of the ILV. If placement is required in an end cell, it is recommended that the TEF container be placed centrally with its long axis oriented parallel to the long-axis of the cell and perpendicular to the long-axis of the ILV.

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9.0 REFERENCES

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Brizes, W.F. 2004d. Email correspondence of 10/24/2004 to R.A. Hiergesell.

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APPENDIX A.
EMAIL TRANSMITTALS DOCUMENTING TPBAR RADIONUCLIDE INVENTORY

William Brizes/WSRC/Srs
02/27/2004 04:41 PM

To Elmer Wilhite/WSRC/Srs@Srs

cc Benjamin Snider/WSRC/Srs@Srs, Catherine Flavin/BSRI/Srs@Srs, Dennis Grove/BSRI/Srs@Srs, Kevin Tempel/WSRC/Srs@Srs, Rex Lutz/WSRC/Srs@Srs, Tom Butcher/WSRC/Srs@Srs, Welford03 Goldston/WSRC/Srs@Srs, William Brizes/WSRC/Srs@Srs, bobby-d.smith@srs.gov, Dale Parrott/BSRI/Srs@Srs, Les Barrett/WSRC/Srs@Srs, Bob Snyder/WSRC/Srs@Srs, Scott Booth/WSRC/Srs@srs

bcc

Subject Re: TPBAR Radionuclide content

Elmer, the radionuclide content of a TPBAR is given PNNL document TTQP-1-111, Rev.2, 6/16/03, "Unclassified Bounding Source Term, Radionuclide Concentrations, Decay Heat and Dose Rates for the Production TPBAR". The document was sent to you in the mail.

After extraction the tritium content of a TPBAR is reduced from 1.2 grams to 133 Ci per rod. That is 39,900 Ci per 300 TPBARs, 119,700 Ci's for a group of 3 extraction baskets, and 159,600 Ci's for a group of 4 extraction baskets.

If one of the baskets contained the unextracted LTA TPBARs (32 TPBARs at 1.2 grams per rod decayed 8 years to 20.4 grams) the basket would contain 197,146 Ci's. The total curies in a waste container (three extraction baskets plus the LTA rods) would be 316,846 Ci's (119,700 Ci's + 197,146 Ci's).

I hope this information is useful.

William F. Brizes
TEF/CLWR/Defense Programs
Westinghouse Savannah River Co.
Bldg. 233-34-H, Room 14
Aiken, SC 29808

803-208-8174 office
803-208-8198 fax
1-6446 pager
william.brizes@srs.gov
Elmer Wilhite/WSRC/Srs

Cynthia Hammond/BSRI/Srs
10/25/2004 01:11 PM

To Robert Hiergesell/WSRC/Srs@Srs
cc Elmer Wilhite/WSRC/Srs@Srs, Tom Butcher/WSRC/Srs@Srs, Catherine Flavin/BSRI/Srs@Srs, Dennis Grove/BSRI/Srs@Srs, Bobby-D Smith/WSRC/Srs@Srs, William Brizes/WSRC/Srs@Srs
bcc
Subject LTA TPBAR Inventory

This message is being sent for Bill Brizes:

The following information relates to the inventory of tritium that will be present when the TPBARs are sent to E-Area:

* Cycle 2 irradiation at Watts Bar, 471 EFPD, 10/8/97 to 2/27/99
* The amount of tritium produced per rod was slightly less than 1 gram. (Reactor physics, He-4, He-3, Li-6 input.) Power variation around center of core was minimal for the 32 rods.
* Thirty two rods were irradiated. Four, four foot lengths were extracted (1.33 rods.) Relative to tritium, total rod inventory should be 30.66 rods.
* The shipment date for the LTA rods to E- Area is November 2008. (November date could be pushed out two to three months due to planned heat exchanger change out at the Watts Bar Plant.)
* Tritium decay time is at least 9 years 8 months for 30.66 rods.
* Fraction of tritium remaining = exp(-1.5402E-4 x 3,528 days) = 0.58078
* Grams of tritium remaining = 30.66 grams x 0.58078 = 17.801 grams
* Curies of tritium remaining = 17.801 grams x 9,619 curies/gram = 171,283 curies

February 27, 2004

TO: ELMER WILHITE

FROM: BILL BRIZES

CONTAMINATION FROM PNNL HOT CELL B (U)

Information provided below is to support the burial of irradiated LTA TPBARs.

Four irradiated LTA TPBARS were stored in PNNL's hot cell for several years. The sectioned TPBARS were stored in 14 shroud tubes that were stored in an open rack in their B cell. An analysis of the hot cell walls and equipment at the time of shipment are provided below.

Alpha

Isotype	**Activity mCi/300 cm2**
Pu-239	3.75E-2
Pu-240	
Pu-238	3.68 E-1
Am-241	
Cm-243	4.02 E+0
Cm-244	
Cm-242	1.24 E-2
Am-243	7.25E-3
Total	4.44E+0

1.48μ Ci/100cm^2 = 32.86 x10^{6}dpm

Beta

Isotype	**Activity mCi/300 cm2**
SR-90	6 E+0
Y-90	6 E+0
Other	3 E+0
Total	15E +1

Please note that tritium was not measured.

Gamma

Isotype	**Activity mCi/300 cm2**
Mn-54	2.13 E-2
Co-60	8.56 E-1
CS-137	1.61 E+0
Eu-152	1.47 E-2
Eu-154	3.04 E-2
Am-241	3.37 E-1
Np-239	5.64 E-2
Am 243	7.61 E-3
Total	2.93 E+0

The shroud/TPBARs were subsequently sent to ANL-W where a swipe was taken. A swipe on an undetermined area, probably less than 100 cm2, gave approximately 10,000 dpm alpha. This is about 0.3% of the count taken from the hot cell at PNNL and appears reasonable. (see bottom of alpha table)

ANL-W has kept the other 28 TPBARs (84 4-foot sections) in their hot cells. They are planning on providing similar data. That is, will provide isotope and activity levels. These cells are significantly cleaner, but do have alpha contamination.

In order to obtain the total activity, the outside area for 14 shrouds can be assumed to be 7,250 cm^2.

Mr. Wilhite, is this the type of information you need to characterize the waste for LTA TPBAR burial? In addition to the contamination data provided above, we will provide the radionuclide content of the extracted TPBARs. Ref (1)

Ref (1): Unclassified Bounding Source Term, Radionuclide Concentrations, Decay Heat, and Dose Rates for the Production TPBAR, TTQP-1-111, Rev. 2, 6/16/03.

William Brizes/WSRC/Srs
10/24/2004 01:41 PM

To Robert Hiergesell/WSRC/Srs@Srs
cc Elmer Wilhite/WSRC/Srs@Srs, Tom Butcher/WSRC/Srs@Srs, William Brizes/WSRC/Srs@Srs, Catherine Flavin/BSRI/Srs@Srs, Dennis Grove/BSRI/Srs@Srs, bobby-d.smith@srs.gov
bcc
Subject Fw: ANL-W Quarterly Presentation

Bob, see if slide 4 below is enough information to characterize the ANL-W HFEF hot cell for actinides. If you need any other information to support the Design Check for the Special Analysis please let me know.

William F. Brizes
TEF/CLWR/Defense Programs
Westinghouse Savannah River Co.
Bldg. 233-34-H, Room 14
Aiken, SC 29808

803-208-8174 office
803-208-8198 fax
1-6446 pager
william.brizes@srs.gov
----- Forwarded by William Brizes/WSRC/Srs on 10/24/2004 01:34 PM -----

"Duncan, David" <david.duncan@anl.gov>
03/23/2004 03:41 PM

To "Richard J. Denton (Richard.Denton@nnsa.doe.gov)" <Richard.Denton@nnsa.doe.gov>, "Ramsey, Clay (SRS)" <Clay.Ramsey@srs.gov>, dennis.grove@srs.gov, "William F. Brizes (william.brizes@srs.gov)" <william.brizes@srs.gov>, "Mike Hickman (NNSA-SRSO) (mike.hickman@srs.gov)" <mike.hickman@srs.gov>, "John Patterson (JPatterson@NACINTL.COM)" <JPatterson@NACINTL.COM>, "Richardson, Wayne (SRS)" <Wayne.Richardson@srs.gov>, "Adkins, Keith" <keith.adkins@ch.doe.gov>, "Cheryl Thornhill (ck_thornhill@pnl.gov)" <ck_thornhill@pnl.gov>, "Chardos, Jim (TVA-WattsBar) (Chardos, Jim (TVA-WattsBar))" <jschardos@tva.gov>, "'travisml@westinghouse.com'" <travisml@westinghouse.com>, "'glenn.hollenberg@pnl.gov'" <glenn.hollenberg@pnl.gov>, "'jengel@kcp.com'" <jengel@kcp.com>, "'jschicker@kcp.gov'" <jschicker@kcp.gov>, "Nanette Founds (nfounds@doeal.gov)" <nfounds@doeal.gov>
cc
Subject ANL-W Quarterly Presentation

All,

Sorry this took so long- I was delinquent in getting an attendance sheet....

Dave Duncan

David S. Duncan, **P.E., P.M.P.**
Project Manager
Argonne National Laboratory
P.O.Box 2528
Idaho Falls, Idaho 83403-2528
email: david.duncan@anl.gov
Ph: (208) 533-7847
Fax:(208) 533-7857
cell: (208) 521-9338

<<clwrqtrly0304.ppt>> [attachment "clwrqtrly0304.ppt" deleted by Elmer Wilhite/WSRC/Srs]

The following table describes the smear analysis data for the 28 TPBARs that were temporarily stored in the ANL-W Hot Cells. This table was part of a Power Point presentation provided by Mr. David Duncan at ANL-W and was forwarded by Brizes on 10/24/04 (Brizes 2004d).

Activities of Selected Fission and Activation Products and Actinides on HFEF Smear
Assumptions: 3 year decay, 16atom % burnup, 19% Plutonium, 52% enriched U-235.

Half-life	Isotope	Origen Estimation of Ci/ 4.5 Kg Heavy Metal	Origen calculated Isotope ratio to calculated Cs-137	Cs-137 activity on hottest measured 1998 HFEF smear • Ci/100cm2	Calculated Activity • Ci/100cm^2 smear	Calculated Activity • Ci/300cm^2 smear	PNNL reported Activity • Ci/300cm^2 smear	Ratio of ANL activity to PNNL activity
87.7	**Pu-238**	5.34	0.002656716	0.94	0.002497	0.007492	0.368	0.020358533
24100	**Pu-239**	35.8	0.017810945	0.94	0.016742	0.050227	0.0375	**1.339383085**
6560	**Pu-240**	36.3	0.018059701	0.94	0.016976	0.050928	0	
432.7	**Am-241**	11.4	0.005671642	0.94	0.005331	0.015994	0.337	0.047460029
7370	**Am-243**	0.0294	1.46E-05	0.94	0.000014	0.000041	0.00761	0.005420205
162.8d	Cm-242	1.17	0.00058209	0.94	0.000547	0.001641	0.0124	**0.13237843**
29.1	**Cm-243**	0.00948	4.72E-06	0.94	0.000004	0.000013	0.00725	0.001834524
18.1	**Cm-244**	0.528	0.000262687	0.94	0.000247	0.000741	0	
2.14E+06	**Np-237**	0.00269	1.34E-06	0.94	0.000001	0.000004	0	
2.355d	Np-239	2.94E-02	1.46E-05	0.94	0.000014	0.000041	0.00564	*0.007313433*
29.1	**Sr-90**	1400	0.696517413	0.94	0.654726	1.964179	6	0.327363184
3.19h	Y-90	1400	0.696517413	0.94	0.654726	1.964179	6	0.327363184
13.48	Eu-152	1.38E-01	6.87E-05	0.94	0.000065	0.000194		
8.59	**Eu-154**	17.8	0.008855721	0.94	0.008324	0.024973	0.0304	0.821484682
4.7	Eu-155	130	0.064676617	0.94	0.060796	0.182388		
284.6d	Ce-144	1780	0.885572139	0.94	0.832438	2.497313		
1.02	Ru-106	1240	0.616915423	0.94	0.579900	1.739701		
30.17	Cs-137	**1920**		0.94				
						ANL Ci	**PNNL Ci**	**ANL/PNNL**
	Total Fission and Activation Products	**1.62E+04**	**8.059701493**		**7.6**	**22.7**	**18**	**1.3**
	Total Actinides	**1.39E+03**	**0.691542289**		**0.7**	**2**	**4.44**	**0.4**

APPENDIX B
DESIGN CHECK

DESIGN CHECK INSTRUCTIONS

Perform a design check for the report *Special Analysis: Evaluation of the proposed disposal of the initial TEF-TPBAR waste container within the E-Area Low-Level Waste Facility Intermediate Level Vault), WSRC-TR-2004-00498, Rev. 0*, following the general guidance provided in WSRC-IM-2002-00011, Rev.1.

Specific instructions for this design check are as follows:

Verify that the inventory provided in TTQP-1-111 Rev. 4 for 1 TPBAR decayed for 1 year (Table 3 in that report) has been correctly transcribed into Inventory.xls on the TPBARs spreadsheet tab. Verify that the multiplication to 932 TPBARs was correctly done. (Note, please ignore the tritium number in this table since this data reflects unextracted TPBARs and the tritium inventory used in the analysis comes from another source). Then verify that the non-tritium radionuclide inventory for 932 TPBARs has been correctly transcribed into Table 1 of WSRC-TR-2004-00498.

Verify that the radionuclide inventory for the potential contamination that may have been acquired when the unextracted TPBARs were stored in the PNL hot cells (see Brizes memo to Wilhite of 2/27/04) was correctly transcribed into the excel spreadsheet Inventory.xls, under the PNL Smear spreadsheet tab. Check the calculation of the activity that might possibly have been deposited on the 14 shrouds to verify it was done correctly and verify that these activity levels have been correctly transcribed into the appropriate table of WSRC-TR-2004-00498I. Note that for Am-243 the total in this table is the sum of the alpha and gamma activities. Now included iw the smear data received from ANL-W for the 28 TPBARs that were stored in their Hot Cells. Check the calculations to verify that the contamination that might have been deposited on the surface of the TPBARs was computed correctly.

Check the tritium flux listed in Table II of the report contained in the Word file WSRC-TR-2004-00424 (Flux at 175 deg. F) to be sure it has been transcribed correctly into the appropriate table in WSRC-TR-2004-00428 and also into Hydrogen Permeation.xls in the spreadsheet tab Annual Rate.

Check calculations performed in the following sections of the report.

Air Analysis

Check the calculations performed in the Air Analysis part of the report. Verify that the correct release factor and dose conversion factor were utilized.

<u>Intruder Analysis</u>

Using the excel file Radionuclides3.xls verify that the correct fractions have been calculated for the radioisotopes in the inventory. Verify that the isotopes with the most significant fractions have been selected for display in the Results table, where the SOF is calculated.

Groundwater Analysis

1. Groundwater Pathway Models

Provide a general inspection of the groundwater model approach to evaluating tritium transport in support of this pathway analysis. The models developed in the WSRC-TR-2004-00346 (Special Analysis: Revision of ILV limits) were utilized to evaluate the TEF container within the ILV. The following items should be addressed:

Check how the TEF was incorporated into the original vadose zone geometry.

Verify that the tritium source term was appropriately introduced into the vadose zone model

Verify that the vadose zone tritium flux was appropriately introduced into the groundwater model

Verify that the tritium activity curve generated for the 100 meter compliance well is correct.

Verify that the maximum tritium activity at this well was correctly determined at the times needed to evaluate the GW1 (0-100 years) and GW2 (100-1350 years) fractions and that the appropriate values were utilized in subsequent groundwater calculations.

2. Check the groundwater calculations in the text and verify that the correct numbers appear in the Results table.

This analysis is different than all previous Special Analyses because it actually examines the specific location and volume for a special waste form. As stated in the comments, the specific location is not the most restrictive, hence Solid Waste must dispose the waste in the location analyzed or the Special Analysis must be revised to consider the location selected. It is important to note that this SA only considers the heat from the LTA TEF and that if future heat sources are placed in the ILV, then this SA needs to be revised to include the effects of the additional heat sources.

This type of analysis will help for closure modeling, because it more accurately represents field conditions than does using uniform distribution for a decidedly discrete and unique waste form.

Specific comments are included in the table below. A separate spreadsheet table follows this table to help describe the actual H-3 annual flux that is being introduced in the vadose zone model and how that compares to the annual flux presented in the report referenced.

Document Review Comments						
Document No.	Rev.	Title: Special Analysis: Evaluation of the proposed disposal of the initial TEF-TPBAR waste container within the E-Area Low-Level Waste Facility Intermediate Level Vault			Comments Due:	
WSRC-TR-2004-00498	0					
#	**Section/Page/ Paragraph/Line**	**Comment**	Reviewer Initial	**Response/Resolution**		Reviewer Concur
1		General: the design check procedure number is obsolete Add DOE, PNNL and SA to the acronyms		The Design Check Procedure number has been changed to 2.60. DOE, PNNL, and SA have been added to the acronym list		
2		Attach all referenced emails		The referenced emails have been attached		
3	Brizes' eMail 6/16/04	The inventory for the LTA should be 24.5 g or 236,098 Ci, not 197,146 Ci. This value appears in multiple locations in the report and feeds many calculations, probably including the thermal and permeation analyses.		The LTA inventory was initially provided by Bill Brizes. Brizes recalculated the LTA inventory, taking into account the irradiation data, cooling time, and the fact that some of the TPBAR segments were extracted. The inventory was revised to 171,283 Ci. Thus, the LTA permeation calculation is conservative.		
4	Vinson report WSRC-TR-2004-00374	p. 25 used "197,146-curies" for H-3 permeation out of LTA container rather that 2.36E+05 Ci. See comment 1 above.		See response to item #3		
5	Vinson report WSRC-TR-2004-00374	p.25. Free volume calculation did not include presence of shrouds around unextracted TPBAR.		The volume of the shrouds is expected to be insignificant in light of the conservatism in the LTA inventory.		

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6	Vinson report WSRC-TR-2004-00374	Page 8 "ignores the presence of other heat generating materials" Please include a note in WSRC-TR-2004-00498 that states for the SA examining future TPBARs that if placement in the ILV is considered, then WSRC-TR-2004-00498 needs to be revised to include other heat sources.		When the second SA, which will assess the production schedule for disposals, is done it will address emplacement of multiple TEF containers and, if the decision is to put those in the ILV, the current analysis will be revisited. No change is needed in the current SA.		
7	Vinson report WSRC-TR-2004-00374	p. 9 "thermal performance characteristics of materials used in E-Area should be compared against those used from the current literature in the current report." Include a note in WSRC-TR-2004-00498 that this is a restriction and the results should be documented before disposal.		The statement in the Vinson report is not a restriction, it is a suggestion. Considering the conservatism inherent in this SA due to the assumption that all tritium is available for permeation, and the overstatement of the heat content, small changes in thermal properties will not change the outcome of the SA.		
8		Need to show calculation that 300 extracted TPBARs is more restrictive for thermal analysis than are 32 unextracted, aged TPBARs.		The attached spreadsheet "LTA Heat" shows that the decay heat load from the three bundles of TPBARs, decayed for 44, 25, and 6 months, respectively and the LTA, which contains 32 unextracted TPBARs, is 2067 BTU/hour. The thermal analysis used a heat load of 2458 BTU/hour. This SA does not need to show the calculation.		
9		Vinson reported (page 15) "the peak steady-state temperatures within the TEF container will reach approximately 200 degrees F" and "the temperature on the surface of the TEF container is calculated to be approximately 175 degrees F and 167 degrees F for the maximum and average temperatures, respectively." The force driving H-3 permeation is the temperature inside the TEF container, not the temperature outside the container. Therefore the H-3 permeation outside the TEF container should be greater than the values from the 175 degrees F calculations.		The surface temperatures reported in the Vinson report (175 F and 167 F) represent the temperatures of both the interior and exterior surfaces of the wall of the container. The thermal gradient is very small.		
10		Previous studies have examined the extent of the long-term reducing environment required for a high Kd for Tc-99. Those studies did not consider the presence of high-heat sources. Please address this issue.		Due to the relatively short half-lives of the radionuclides contributing to the heat load in the TEF container, long-term temperature effects will not be significant.		

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11		The Vinson report (page 23) discussed that chlorides could affect the corrosion results. It appears that Solid Waste should not dispose wastes high in chlorides near this waste, so this should be documented.		The influence of chlorides on pitting and stress corrosion cracking was discussed on page 22 of the Vinson report. They are potential issues for the LTA container but not for the TEF container. Since the LTA container is inside the TEF container, chlorides in the ILV will not be an issue for this SA.		
12		I find no evidence of a structural analysis. This dense waste form might cause the vault floor to fail earlier than previously calculated. It may also affect seismic results. Please address this issue.		Solid Waste and TEF are working placement of the TEF containers in the ILV so as to not impact the design loading assumptions. No impacts are expected.		
13	Fig. 1	Delete all dimensions that are not mentioned in the text or extend the discussion to include the extra dimensions. State why the left side is black while no other side is. State that the dimensions are in inches –(probably in the caption).		Text has been added to indicate that the black portion represents the bolt-on lid. Text has been added to indicate that dimensions are in inches. This is a drawing provided by the project. It's not worth having the drawing revised to delete the measurements; nor is it worthwhile to add text discussing every dimension.		
14	p. 2, 1st para.	State where the welds are located and their sizes		Text has been added to indicate that the weld on the lid is a 1-inch full-penetration weld.		
15		General: the text references are not consistent. In most documents if the author is listed, then the year is mentioned. In this document often the author is listed, but no year. In other cases the author and the full title are listed.		The references and citations have been made consistent with other Special Analyses.		
16	p. 2, 2nd para.	Add that for a separate SA, that this SA (WSRC-TR-2004-00498) needs to be reexamined because this SA considers only 1 heat source.		See response to item #6. No change needed.		
17	p. 2, 3rd para, 3rd s.	"presents" should be "present"		The change has been made		
18	p. 2, 3rd para, 3rd s.	State that only tritium is extracted (although other gases likely would be driven off as well). A few sentences on extraction would be beneficial.		This sentence and the following have been revised to indicate that only tritium is extracted in the extraction process.		
19	p. 2, last para	"is quite conservative" is not correct. No account was taken for daughter ingrowth.		No change is necessary. Only tritium can escape the TEF disposal container during the 1000-year time of compliance, thus daughters are insignificant. The intruder calculations take all daughters into account.		
20		The analysis needs to be modified to account for daughter ingrowth.		See response to item #19.		
21	p. 5, 1st s.	Change "human" to "potential human"		This change has been made.		
22	p. 5, 2nd s.	Modify sentence to exclude diffusion. Need sentence on diffusion.		The sentence was modified to exclude diffusion. Additional text discussing diffusion was added.		

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23	p. 5, 3rd para.	Doublecheck that CLSM is allowed. CLSM is a special material that likely does NOT satisfy Solid Waste specifications. The use of both grout and CLSM adds confusion to the report. Engineered backfill is much cleaner wording. CLSM appears elsewhere in the report.		CLSM was added per one of Don Sink's comments.		
24	p. 5, 1st para., last s.	What about weld failure?		The sentence was modified by adding "and welds" at the end.		
25	p. 5, para 3, s. 1	Change "in this study, total" to "in that study, a total initial"		The change has been made		
26	p. 5, para 2, s. 1	Change "release" to "near-field release"		The referenced studies examined the release of tritium from the container. "near-field" is implicit.		
27	p. 5, para3	Specify that this thermal study is for the initial TEF container, but that it applies to all. Need a calculation and sentence to indicate that the actual heat load from the initial TEF will be lower, even though it will contain more H-3 than subsequent TEF containers. This is the same as comment 8.		The second sentence in this paragraph was changed to indicate that the 2,458.4 BTU/hr heat load was assumed to bound the first TEF container. This thermal study does not apply to all TEF containers. Subsequent production containers will only be cooled for about 151 days and will, therefore, likely have a higher heat load. Additionally, because of the production schedule, more than one TEF container will be emplaced. Therefore a new thermal study will have to be done for the subsequent containers. See response to item #8.		
28	p. 5, next to last para.	Explain why other gases from the LTA will not diffuse like H-3 or show that no other gases will be present.		Text has been added to the first paragraph in Section 4 establishing that only tritium will be released from the container.		
29	p. 6, s. last	Explain whether this is for LTA TEF container only or all containers and why it is conservative.		The document as a whole is addressing only the first TEF disposal container, which will include the LTA. As stated, the assumption is conservative because all of the tritium is assumed to be present as free tritium gas.		
30	p. 6, para 3	This is very confusing. Explain that the "release" from the LTA is to the space inside the TEF container. An initial paragraph describing the standard consolidation containers, the LTA welded SS container and the surrounding TEF container is needed. A cross-section figure would help. State clearly that the 24 Ci/yr "internal release" from the LTA is ignored.		Text has been added to explain that the release from the LTA is to the interior space of the TEF container and that the release from the LTA is ignored in the calculation of release from the TEF container. Earlier sections of the SA clearly explain that the LTA is contained within the TEF disposal container.		

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31	p. 8, para 3	The welds on the LTA SS container fail at 180 years. How much H-3 is still available for instant release to inside the TEF container at 180 years and why can this be neglected?			After 180 years, the 171,283 Ci inventory of the LTA will have decayed to less than 8 Ci, which would result in less than 0.4 Ci being released from the TEF disposal container.		
32	p. 6, para. last	Change “the both” to “both.” Start the “In addition” sentence as a new paragraph. Change last sentence “from” to “from all nuclides”			These changes have been made.		
33	p. 7, s. 1	“worst-case container placement is assumed” This is incorrect, because the resident analysis uses the ILV results that are based on a uniform distribution throughout the ILV.			The “worst-case container placement is assumed” text has been deleted.		
34	p. 7, s. 1	Why do you have a mixture of uniform distribution for the resident intruder, but a specific “hot spot” analysis for the groundwater pathway? The analyses should use a consistent set of assumptions.			Since, at this time, our intruder program cannot represent shielding of more than 1-meter of earth-like material, we could neither take credit for the 13-inches of steel in the TEF container nor placement of it in specific locations within the ILV. Thus, the assumptions for the groundwater and intruder pathways are necessarily not consistent.		
35	p. 7, air pathway	There are two air pathway receptor locations, at 100 m and at the site boundary. This analysis only examines one.			Comment accepted. An analysis of the 100-m receptor after institutional control has been added.		
36	p. 7, air pathway	For the slit trench analysis plume interaction among multiple sets of slit trenches was considered to account for the wind blowing across multiple units. Plume interaction should be considered for the present analysis.			The present analysis is based on the ILV SA for which the air analysis used a single point source. It was judged that this was appropriate. Perhaps consideration of “plume interaction” in the air analysis should be added to the PA Maintenance Bin list.		
37	p. 7, air pathway	The dose conversion factor is for the boundary receptor where the limit is higher. This is unconservative.			See response to item # 35.		
38	p. 7, air pathway	In one line a value of 5.00E-6 is calculated, but a value of 4.97 is used in a subsequent calculation.			The calculation has been revised to use 4.97 instead of 5.00		
39	p. 7, air pathway	This whole analysis could be highly simplified. The ILV limits apply for what is near-field released. The highest 1 year release is 6465 Ci, thus the highest fraction is 6465/1.3E9. The limit for H-3 inside the TEF container is the original ILV limit times the TEF container inventory divided by its highest 1 year near-field release or limit = 1.3E9 * 376,000 / 6465. This limit is only for the LTA TEF.			We felt it appropriate to go through the calculation for the air pathway, using the amount of tritium released from the TEF disposal container, to generate an air limit specific to the initial TEF container.		

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40		An inventory table is needed showing Ci inside LTA and Ci inside 3 extraction baskets.		Based on comments from Don Sink, we have presented a combined inventory in Table 1, this inventory has two entries for tritium, that in the LTA and that in the 3 bundles of TPBARs		
41	p. 7, air pathway	There is no reason to calculate the fraction twice 5.00E-7.		We thought it best to work through the logic, which results in calculating the 4.97E-07 fraction twice. First as a fraction of the 10 mrem/year performance objective and secondly as a fraction of the disposal limit.		
42	p. 7, resident	Need a table showing all limits and fractions		Table 4 is a summary of the limits and fractions. We do not think it necessary to list all the intruder limits from the ILV SA and the respective inventory fractions.		
43	p. 8, GW, p. 1	From “that report” to “disposal limits” adds nothing of value to the report and should be deleted.		We felt it helpful to have a brief discussion of the ILV SA.		
44	p. 8, GW, s. last	Change “the TEF” to “a TEF” or “the LTA TEF”		“the TEF” has been changed to “the initial TEF”		
45	p. 8, GW, para 2	The essence of this paragraph needs to be captured in the Executive Summary. At first glance it appears that the existing ILV limits should suffice, so the reason for performing this work needs to be spelled out.		The Executive Summary has been revised to explain the reason for modeling the TEF container.		
46	p. 8, GW, para 3	End the first sentence at “outer wall.”		Simply ending the first sentence at “outer wall” will not suffice. It seems to us best to leave the sentence as it is.		
47	p. 8, GW, para 3	The vadose zone analysis suffers because an insufficient number of cells were allocated to the TEF container. Porflow averages some properties at the faces between adjacent cells. The minimum number of cells in any direction should be 3 so that the averaged properties at the faces of at least the center cell will be the same as the center cell. The model selected has 2 columns of nodes for the TEF container. The outer column of nodes are boundary nodes and do not represent cells. Hence the model only has a single column of cells for the TEF container.		A vadose zone simulation was conducted in which the dimensions of the TEF container were increased by one cell width in the X-direction.		

<table>
<tr><td colspan="6">Document Review Comments</td><td></td></tr>
<tr><td colspan="2">Document No.</td><td>Rev.</td><td colspan="3">Title: Special Analysis: Evaluation of the proposed disposal of the initial TEF-TPBAR waste container within the E-Area Low-Level Waste Facility Intermediate Level Vault</td><td>Comments Due:</td></tr>
<tr><td colspan="2">WSRC-TR-2004-00498</td><td>0</td><td colspan="3"></td><td></td></tr>
<tr><td>#</td><td>Section/Page/ Paragraph/Line</td><td>Comment</td><td>Reviewer Initial</td><td colspan="2">Response/Resolution</td><td>Reviewer Concur</td></tr>
<tr><td>48</td><td>p. 8, GW, para 3</td><td>The TEF placement at the bottom tends to be conservative, but the placement in the center of the ILV clearly is not. Essentially no flow occurs beneath the center of the ILV, while all the water that is shed by the ILV tends to flow outside and adjacent to the ILV. Placement of the TEF container near the edge could result in substantially higher H-3 fluxes to the water table and well concentrations. Unless another analysis is performed Solid Waste should be constrained to place the TEF container in the center of the ILV and away from all outer ILV cell boundaries. The long axis of the TEF container should be aligned with the long axis of the ILV cell in which it is disposed.</td><td></td><td colspan="2">Agreed, a recommendation will be made that the TEF container be placed in the center of the ILV with its long axis parallel to the ILV long axis.</td><td></td></tr>
<tr><td>49</td><td></td><td>This comment intentionally left blank</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>50</td><td>p. 8, next to last para.</td><td>Flow velocities likely jump at 575 years. Discuss the amount of H-3 still available at 575 years and why that will not produce higher well concentrations.</td><td></td><td colspan="2">Total tritium reported in vadose zone at end of 575 years is 6.18E-10 Ci. This is small compared to the peak flux from the vadose zone, which was calculated to be 1.18E-06 Ci/year. Thus, if all the tritium still in the vadose zone were released in a single year, it could not produce a peak as high as that observed.</td><td></td></tr>
<tr><td>51</td><td>p. 9, s. 2</td><td>Explain “situated at the base of an individual cell.” Change “positioned” to “positioned within the ILV.”</td><td></td><td colspan="2">Wording changed to reflect orientation described in response to Comment No. 48. Grammatical error corrected.</td><td></td></tr>
<tr><td>52</td><td>p. 9, para 2, s. last</td><td>Delete – this is included in previous para.</td><td></td><td colspan="2">Sentence deleted.</td><td></td></tr>
<tr><td>53</td><td>p. 9, next to last para.</td><td>Change “125” to “123”</td><td></td><td colspan="2">Peak flux and time of peak have now changed as a result of the new simulations. New values have been entered here.</td><td></td></tr>
<tr><td>54</td><td>p. 9, next to last para.</td><td>“a slight decrease in the flux curve is noted between t=123 and t=325 years, which is attributable to the decrease in infiltration through the ILV as a result of placement of the closure cap” is incorrect. The rate of infiltration jumps at 125 years and increases thereafter.</td><td></td><td colspan="2">The permanent closure cap is constructed at t=125. While there is a slight increase in infiltration directly over the ILV at this time (from near 0 to 4.39 cm/yr) there is a very large decrease in infiltration over the soil immediately outside the ILV. This decrease, from 40 to 4.39 cm/yr, is the main reason for the downward inflection in the flux curve. Additionally, the added infiltration into the closure cap directly above the ILV is largely deflected around the ILV itself, thus the darcy velocities within the ILV (and around the TEF container) are not substantially increased. Clarification has been added to the text.</td><td></td></tr>
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55	p. 9, next to last para.	There is a gap in the flux curve at 125 years. Because of the jump in the infiltration, the flux needs to be recorded more often that every year. The flux may actually spike up before falling, but the recording frequency missed any potential flux spike and subsequent concentration spike.		At 125 years the flow field changes instantaneously to reflect the closure cap placement. The flow fields were established in flow field simulations prior to the transport simulation. The new vadose zone model saves output every 0.1 yrs and flux output indicates a sharp downward turn at t=125 without a spike, at least on time increments of 0.1 years.		
56	p. 9, next to last para, s. last	Change “fail” to “degrade more rapidly” Infiltration does not peak until after 1000 years.		The change has been made.		
57	p. 9, last s.	Delete – this is a repeat of part of the previous para.		The sentence has been deleted.		
58	Fig. 3 and 4	Label the vertical axes and include the units inside parentheses		The change has been made.		
59	p. 10, last para.	Explain that the concentrations were monitored at multiple locations, but that only the maximum was reported.		Change has been incorporated.		
60	p. 10, last para.	Explain why the locations selected captured the peak, if they did. Use of the STATISTICS command in Porflow would indicate the location with the highest peak. If that was not recorded with the HISTORY command, then Porflow could be rerun.		A “wall” of elements was identified 100 m down gradient from the ILV such that the concentration histories could be recorded and the peak concentration identified. In the updated groundwater model the STAT command was also used and the node where the peak concentration was identified (>100m from ILV) was in the list of nodes monitored to capture the peak.		
61	p. 10, last para., s. 2	Change “begins to increase” to “increase.” Because the concentration started at zero, the concentration certainly increased earlier.		This change has been made.		
62	p. 11, para. 1	“0.06” should include more digits, else the result when dividing by 20,000 is 3.00E-6, not 3.05E-6		The numbers have been revised.		
63	p. 11, para. 2	Change “activity” to “activity, i.e., the inventory limit”		The change has been made.		
64	p. 11. para. 3	Delete – this is the same as 2 para. Earlier		Although the number is the same, the fractions are different. The first is the fraction of the MCL; the second is the fraction of the inventory limit. The sentence should not be deleted.		
65	p. 11 and 12	119,700 is wrong, see earlier comments The total inventory should include the LTA inventory.		No. Since the tritium in the LTA does not contribute significantly to the tritium released from the TEF disposal container, it should not be included here. Text has been added in Section 5 and in the limits tables explaining that no limit is needed for the LTA ^{3}H for the air and groundwater pathways.		
66	p. 12, para. 2	After “Ci” add “, i.e. limit”		A change similar to that in response to comment #63 has been made.		

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67	p. 12, para 3	Delete from "The fraction" to "time period" because this repeats information from 2 paragraphs earlier		No. The earlier information was the fraction of the MCL; this paragraph states the inventory fraction of the limit.		
68	p. 12, Table 4	Change "sum of fractions" to "partial sum of fractions"		No. The term Sum of Fractions is correct even though all the radionuclides with intruder limits are not shown. The table has been revised to show fractions for only Co-60 and Nb-94 because the Cs-137 inventory has been greatly reduced. The next largest inventory fraction of an intruder limit after Nb-94 is Ba-133 with a fraction of 1.32E-10.		
69	p. 12, Table 4	The tritium limits need to be for the full H-3 inventory including the LTA.		No. See response to item # 65.		
70	p. 12	Need to add a table with limits only (and only if less than 1E20 Ci). The table should include all nuclides with their limits, because Solid Waste needs to have all limits in one document for this waste form.		No. There is no need to repeat the intruder limits from the ILV SA. Only the nuclides with the larger inventory fractions of the intruder limits are shown. The table has been revised to show fractions for only Co-60 and Nb-94 because the Cs-137 inventory has been greatly reduced. The next largest inventory fraction of an intruder limit after Nb-94 is Ba-133 with a fraction of 1.32E-10.		
71	p. 12, para. Next to last	Change "container" to "container with LTA"		"the TEF waste container" was changed to "the initial TEF waste container".		
72	p. 12, para last	Provide references. The "another investigation" is actually in the same report		Accepted. A reference was added.		
73	p. 13, para 4, s. 1	Change "was" to "were"		The change has been made.		
74	p. 14	Would help to include month of each report		Document dates have been added.		
75	appendix	This is a partial set of files. The value of including the aquifer model input file is questionable because it uses multiple include statements for external files that are not provided.		Agreed. The input files presented will be eliminated.		

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76		Examining the Tecplot output file for the first flow stage, the coordinates for the TEF cask range in the X direction from 0 to 1.5 ft and in the Y direction from 29.3 ft to 31.9 ft. Even though the node width in the X-direction was 2, the outer node is a boundary node and does not define a cell, thus only one column of nodes was selected. Therefore the ½ cross-section of the cask is 1.5 ft wide by 2.6 ft tall and the full cross-section of the modeled cask is 3.0 ft wide by 2.6 ft tall. This is much smaller than the 5 ft by 5 ft (~60 in by ~60 in) cross-section described in the report (area of 7.8 ft^2 vs. 25 ft^2 or about 31%)..		In the new vadose zone simulation the width of the TEF container was widened by 1 element. This is closer to the actual width of half of the TEF container, which is now 91 cm (~35”) wide. The height was not adjusted and the simulated container is shorter than the actual container. The impact of this departure from actual dimensions is not expected to impact the groundwater peak concentration significantly since this part of the flow domain has a very low velocity.		
77		The near-field source release (vadose zone) on an annual basis does not match the reference document (Clark). The attached spreadsheet shows that this analysis always releases more than Clark stated, with a maximum error of about 7.5%.		The values used to enter the tritium source term closely track the values referenced in the reference document (Clark) but do not match exactly because of the time increments chosen to enter the annual flux values. The level of accuracy, indicated by the %error table provided in this design check, is judged to be acceptable.		
78		The vadose zone property command is not consistent : it changed from GEOM for the ILV analysis to HARM for the TEF analysis.		The updated simulations were switched to the GEOM property command to remain consistent with the ILV SA model.		
79		Fluxes and concentrations should be saved every 0.1 year because H-3 moves so rapidly and some behavior may be missed otherwise. Continuation of comment 55.		This change was incorporated in the updated simulations to allow for more detailed assessment of concentration behavior.		
80		The aquifer property command is not consistent : it changed from GEOM for the ILV analysis to HARM for the TEF analysis. This SA is an extension of the ILV SA. Explain why you are changing this value, but that the ILV SA results are acceptable.		The property command was changed to GEOM in the updated simulation to be consistent with the ILV SA model.		
81		You changed recording the well concentrations from every 10 years to every year. However, the data still exhibit a gap at about 125 years. It is recommended to record the information every 0.1 years, at least for a few years after a major change in the model occurs. Continuation of comment 79.		Data was recorded every 0.1 years in the updated simulations.		

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82		The aquifer effective porosity is 0.25 for the flow runs, but 0.42 for the transport runs. Please explain. Given full saturation, the extra porosity provides extra dilution water and slows travel times, thus allowing additional decay – both factors that decrease well concentrations and increase limits.		The aquifer effective porosity was changed to 0.25 for the transport run when the new simulations were conducted.		
83		Only analyzing one ILV in the aquifer overlooks plume interaction. This is a departure from the ILV SA and will lead to lower well concentrations and higher limits, which is unconservative. Please explain.		This SA is only for the first TEF disposal container. Therefore, only one ILV was simulated. Thus, groundwater plume interaction with a potential second ILV was not considered.		
84		The thermal analysis used decay heat of 0.6 W per TPBAR - that matches the decay for 5 years. However, Section 3 states that the maximum decay is only 3 years. Please address this issue in the report.		See response to item #8		
85		In INVENTORY.XLS the H-3 limit for the resident should use 900*the inventory for 1 TPBAR (from Table 4) + 32 * the decayed inventory for 1 LTA TPBAR (from Brizes).		This tritium activity is irrelevant because it represents 900 x an unextracted TPBAR.		
86		Inventory.xls corrected inventory Ci Nb-95m 7.48e-2 Ba-133 6.97e-4		These changes are now reflected in Inventory2.xls		
87		H-3 inventory should be 3.49E5 Ci in Table 1 2.37E+05 from LTA 1.13E+05 from 1 yr aged non-LTA rods (900) This is different than the spreadsheet value.		Table 1 and Table 2 are now combined into a single Table 1. Tritium inventories for the LTA and the 900 extracted TPBARs are entered separately. The tritium inventory cited in Brizes 2004a was utilized for the extracted TPBARs.		
88		Smear inventory – Brizes stated that H-3 was not measured. This needs to be captured in the report and slightly discussed.		Even if a small amount of tritium was introduced via the smears it would be dwarfed by the tritium of the unextracted TPBARs.		
89		Smear inventory – it would help to have geometry of shrouds. Brizes stated "the outside area for 14 shrouds can be assumed to be 7250 cm2" but there is not information to check this claim		We have no reason to question Brizes estimate of 7250 sq. cm. for the area of the 14 shrouds.		

Document Review Comments						
Document No.	Rev.	Title: Special Analysis: Evaluation of the proposed disposal of the initial TEF-TPBAR waste container within the E-Area Low-Level Waste Facility Intermediate Level Vault				Comments Due:
WSRC-TR-2004-00498	0					
#	**Section/Page/ Paragraph/Line**	**Comment**	Reviewer Initial	**Response/Resolution**	Reviewer Concur	
90		Smear inventory – rather than using the wall concentration, the smear concentration would be more representative, also including the smear area. Also, the surface area is already for 14 shrouds, while the spreadsheet multiplies again by 14. No further checking for transcription will be performed now.		A re-calculation of the inventory added via hot cell surface contamination from the PNNL Hot Cell and the ANL Hot cell has been incorporated into Inventory2.xls. This inventory was then transcribed into the text.		
91		This comment intentionally left blank.				
92		In radionuclides2.xls H-3 inventory should be 3.49E5		The inventory for tritium has been revised per Brizes. The LTA H-3 inventory has now been established to be 171,283 Ci, which is now the entry in radionuclides3.xls.		
93		Include smear information from ANL-W, because it may include other nuclides and different concentrations. Proportion based on number of TPBARS at each location.		The ANL-W smear data has now been received and was incorporated into Inventory2.xls. This file contains the calculation to convert the data provided into actual inventory.		
94		Radionuclides3.xls: Am-243 resident limit should be 4.4E-7 and frac. of 2.45E-17		The resident limit for Am-243 is 4.39E+07 which, with the revised inventory, gives a fraction of 2.47E-17. Incorporated.		
95		Table 4 will need to be checked later.???		Table 4 has been revised.		
96		The aquifer monitoring locations are the same as those used for the ILV analysis. However, the ILV analysis used 2 vaults, thus the 100-m buffer would be different than for the current analysis. A closer set of aquifer monitoring locations needs to be selected.		While the aquifer monitoring locations were the same, the source node was selected for a location below the "down gradient" ILV such that the distance was the appropriate 100m to the monitoring points. That was changed in the revised groundwater model whereby the source node was placed beneath ILV #1 and the monitoring locations moved closer to the appropriate distance. Use of the STAT command in the updated simulations verifies that the model element where the peak groundwater concentration occurred is in the list of model elements monitored to capture the peak.		
97		The last 3 bullets of the design check instructions will need to be checked later because of other expected changes. Comments on the formulas were provided earlier if there were any.		Reviewer has indicated that this comment will be withdrawn.		

Year	Report time	flux at start of this yr	Flux at report time	flux at end of this yr	outflow first 1/2 yr	outflow 2nd 1/2 yr	outflow full yr	SA-clark error	% error	Clark time	flux	1/2 flux
	0		3325.0	3325.0						0	0	0.0
1	0.5	3325.0	3232.5	3144.5	1639.4	1594.3	3233.6	1.125	0.03	1	6465	3232.5
2	1.5	3144.5	3056.5	2971.0	1550.3	1506.9	3057.1	0.625	0.02	2	6113	3056.5
3	2.5	2971.0	2885.5	2802.3	1464.1	1421.9	2886.1	0.563	0.02	3	5771	2885.5
4	3.5	2802.3	2719.0	2638.3	1380.3	1339.3	2719.6	0.625	0.02	4	5438	2719.0
5	4.5	2638.3	2557.5	2478.8	1298.9	1259.1	2558.0	0.500	0.02	5	5115	2557.5
6	5.5	2478.8	2400.0	2323.5	1219.7	1180.9	2400.6	0.563	0.02	6	4800	2400.0
7	6.5	2323.5	2247.0	2172.5	1142.6	1104.9	2247.5	0.500	0.02	7	4494	2247.0
8	7.5	2172.5	2098.0	2025.5	1067.6	1030.9	2098.5	0.500	0.02	8	4196	2098.0
9	8.5	2025.5	1953.0	1882.3	994.6	958.8	1953.4	0.438	0.02	9	3906	1953.0
10	9.5	1882.3	1811.5	1743.0	923.4	888.6	1812.1	0.563	0.03	10	3623	1811.5
11	10.5	1743.0	1674.5	1607.5	854.4	820.5	1674.9	0.375	0.02	11	3349	1674.5
12	11.5	1607.5	1540.5	1475.5	787.0	754.0	1541.0	0.500	0.03	12	3081	1540.5
13	12.5	1475.5	1410.5	1347.0	721.5	689.4	1410.9	0.375	0.03	13	2821	1410.5
14	13.5	1347.0	1283.5	1221.8	657.6	626.3	1283.9	0.438	0.03	14	2567	1283.5
15	14.5	1221.8	1160.0	1099.8	595.4	564.9	1160.4	0.375	0.03	15	2320	1160.0
16	15.5	1099.8	1039.5	980.5	534.8	505.0	1039.8	0.313	0.03	16	2079	1039.5
17	16.5	980.5	921.5	864.3	475.5	446.4	921.9	0.438	0.05	17	1843	921.5
18	17.5	864.3	807.0	750.8	417.8	389.4	807.3	0.250	0.03	18	1614	807.0
19	18.5	750.8	694.5	639.3	361.3	333.4	694.8	0.250	0.04	19	1389	694.5
20	19.5	639.3	584.0	529.8	305.8	278.4	584.3	0.250	0.04	20	1168	584.0
21	20.5	529.8	475.5	421.5	251.3	224.3	475.6	0.063	0.01	21	951	475.5
22	21.5	421.5	367.5	313.3	197.3	170.2	367.4	-0.063	-0.02	22	735	367.5
23	22.5	313.3	259.0	201.5	143.1	115.1	258.2	-0.813	-0.31	23	518	259.0
24	23.5	201.5	144.0	72.0	86.4	54.0	140.4	-3.625	-2.52	24	288	144.0
25	24.5	72.0	0.0	0.0	18.0	0.0	18.0	18.000		25	0	0.0

Nuclide	Half-life	Half-life Units	Half-life, years	Half-life, days	Watts/TPBAR 7 days	Extracted Watts/TPBAR 0 days	Extracted Watts/TPBAR 44 months	Extracted Watts/TPBAR 25 months	Extracted Watts/TPBAR 180 Days		Partially Extracted LTA Watts/TPBAR 9.75 Years
						44 Months =	3.67E+00	years			
						25 Months =	2.08E+00	years			
H-3	12.33	years	1.23E+01	4500.45	3.90E-01	4.48E-03	3.64E-03	3.98E-03	4.36E-03		1.80E-01
P-32	14.262	days	3.91E-02	14.262	1.04E-02	1.46E-02	8.25E-31	1.30E-18	2.38E-06		1.12E-77
Cr-51	27.7025	days	7.59E-02	27.7025	2.07E-01	2.47E-01	7.06E-16	1.35E-09	2.74E-03		5.26E-40
Mn-54	312.11	days	8.55E-01	312.11	2.09E-01	2.12E-01	1.09E-02	3.92E-02	1.42E-01		7.84E-05
Fe-55	2.73	years	2.73E+00	996.45	7.28E-03	7.32E-03	2.88E-03	4.31E-03	6.41E-03		6.15E-04
Fe-59	44.472	days	1.22E-01	44.472	1.54E-01	1.72E-01	1.50E-10	1.22E-06	1.07E-02		1.40E-25
Co-58	70.86	days	1.94E-01	70.86	1.61E+00	1.72E+00	3.56E-06	1.01E-03	2.96E-01		1.31E-15
Co-60	1925.1	days	5.27E+00	1925.1	5.55E-01	5.56E-01	3.44E-01	4.23E-01	5.21E-01		1.54E-01
Ni-63	100.1	years	1.00E+02	36536.5	2.30E-03	2.30E-03	2.24E-03	2.27E-03	2.30E-03		2.15E-03
As-76	1.0778	days	2.95E-03	1.0778	7.74E-03	6.98E-01	0.00E+00	2.88E-213	0.00E+00		0.00E+00
Zr-95	64.02	days	1.75E-01	64.02	3.33E-01	3.59E-01	1.83E-07	9.55E-05	5.11E-02		6.63E-18
Nb-95	34.997	days	9.59E-02	34.997	3.32E-01	3.81E-01	1.17E-12	1.10E-07	9.53E-02		9.34E-32
Mo-99	65.94	hours	7.53E-03	2.7475	5.40E-02	3.16E-01	7.32E-148	1.53E-84	6.24E-21		0.00E+00
Sn-117m	13.6	days	3.73E-02	13.6	1.52E-02	2.17E-02	5.17E-32	3.20E-19	2.91E-06		3.68E-81
Sn-119m	293.1	days	8.03E-01	293.1	4.35E-03	4.42E-03	1.87E-04	7.32E-04	2.67E-03		9.79E-07
Sn-125	9.64	days	2.64E-02	9.64	1.46E-02	2.42E-02	3.90E-44	4.34E-26	5.77E-08		1.79E-113
Sb-125	2.75856	years	2.76E+00	1006.8744	5.23E-03	5.26E-03	2.09E-03	3.11E-03	4.70E-03		4.54E-04
Ta-182	114.43	days	3.14E-01	114.43	9.55E-02	9.96E-02	3.00E-05	9.95E-04	3.36E-02		4.33E-11
Ta-183	5.1	days	1.40E-02	5.1	1.61E-01	4.17E-01	4.21E-80	5.45E-46	9.91E-12		3.66E-211
						Total	3.66E-01	4.79E-01	1.17E+00		3.38E-01
						watts per 300 TPBARs	1.10E+02	1.44E+02	3.52E+02	watts per 32 TPBARs	1.08E+01
						Total Watts	6.05E+02				
						Total BTU/hr	2066.87				