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SPECIAL ANALYSIS:
DISPOSAL OF ETF ACTIVATED CARBON VESSELS IN SLIT TRENCHES AT THE E-AREA LOW-LEVEL WASTE FACILITY

Prepared by:

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June 13, 2003

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Aiken, SC 29808

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

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 EXECUTIVE SUMMARY

This Special Analysis (SA) addresses two contaminants of concern, H-3 and I-129, in three Effluent Treatment Facility (ETF) Activated Carbon Vessels awaiting disposal as solid waste. The Unreviewed Disposal Question (UDQ) evaluation (Collard, 2002) listed two options for disposal of this waste, disposal as Components-in-Grout (CIG) or disposal in Slit Trenches with sealed openings to restrict release of H-3 from the vessels.

The first option was analyzed in the CIG SA (Collard and Cook, 2003). The second option is analyzed in this SA. Consumption of the CIG inventory limit and consumption of CIG facility volume are shown in Table 6 for the ETF vessels to allow easy comparison with the consumption of Slit Trench inventory limit and consumption of the Slit Trench facility volume shown in Table 7. The inventory projections are based on doubling the inventory of the three ETF vessels in the E-Area to account for the unknown inventory of three ETF vessels in the ETF (Sink 2003).

The facility volume consumption is about 0.6% for both facilities. H-3 in the vessels (called H-3_C) consumes insignificant amounts of its inventory limits in both facilities. The I-129 in the vessels (called I-129_C) consumes about 139% of its inventory limit for CIG trenches and about 6% for Slit Trenches.

The inventory consumption for I-129_C is much higher in the CIG trenches because the grout causes the waste zone to be transformed from an acidic environment to a cementitious environment where the I-129 is not as strongly adsorbed in the waste zone. In CIG trenches rainwater is transformed when it contacts the overlying grout, then the transformed rainwater infiltrates and transforms the waste zone. For an acidic environment Kaplan et al. (1999) measured the adsorption property of I-129 on the ETF activated carbon as a Kd of 7400 ml/g. For a cementitious environment the Kd is only 600 ml/g. Thus, while the grout impedes water movement, which tends to reduce well concentrations, it also creates an environment where the sorption is reduced for I-129 on ETF activated carbon that tends to increase well concentrations.

When the grout ultimately is assumed to degrade hydraulically, the water movement is not impeded as much as the release is accelerated by the presence of the grout. Under these conditions for the CIG trenches relative to the Slit Trenches, the well concentrations are higher, the inventory limit is lower and for a given inventory the inventory limit consumption is higher.

2.0 INTRODUCTION

This Special Analysis (SA) addresses two contaminants of concern, H-3 and I-129, in three Effluent Treatment Facility (ETF) Activated Carbon Vessels awaiting disposal as solid waste. The Unreviewed Disposal Question (UDQ) evaluation (Collard, 2002) listed two options for disposal of this waste, disposal as Components-in-Grout (CIG) or disposal in Slit Trenches with sealed openings to restrict release of H-3 from the vessels.

The first option was analyzed in the CIG SA (Collard and Cook, 2003). The second option is analyzed in this SA.

To restrict release of H-3 from the vessels, the openings must be sealed and the vessel must withstand structural loads. After burial and during the operational phase of the Slit Trenches the structural loads are assumed to consist of earth loads. During closure of the Slit Trenches structural loads could include dynamic compaction. The vessels are assumed to be unable to withstand dynamic compaction, thus credit for sealed openings is only considered during the first 25-year operational phase.

To ensure that the vessels themselves will not fail structurally and release H-3, a separate structural analysis (Estochen, 2002) was conducted. That report examined loading cases for upright vessels and vessels placed on their sides. That report recommended that the vessels be disposed in an upright orientation, but stated that disposal in either orientation would not cause the vessels to breach before the end of the assumed operational period of 25 years.

Preventing release of H-3 and I-129 during the operational period is a major change from the conceptual model used by previous models to analyze their release and movement (Collard, 2001 and McDowell-Boyer et al., 2002). In effect, there should be zero release during the operational stage of the Slit Trenches. Generic wastes release substantial quantities of H-3 and I-129 during the operational stage. That release will not happen for sealed vessels, thus those substantial quantities of H-3 and I-129 would still be available for release from sealed vessels when dynamic compaction occurs. A new model for this SA accounts for 25 years of decay with zero release followed by the typical second stage of an intact cap during 100 years of institutional control and by the typical third stage of a failed cap for the remaining 9875 years.

3.0 GROUNDWATER PATHWAY ANALYSIS

The I-129 in the vessels is designated as I-129_C because that is the nomenclature that Solid Waste has applied to that specific waste. A waste-specific Kd of 7400 ml/g was measured (Kaplan et al., 1999) that is much higher than the Kd of 0.6 ml/g for generic I-129. The Kd for the I-129_C is for acidic conditions that are expected to exist in the trenches due to the slightly acidic rainwater that will infiltrate the trench. The H-3 in the vessels is referred to as H-3_C in this report for consistency with the nomenclature for the I-129.

Peak values for the fractional contaminant flux at the water table generated by the vadose zone model and peak values for the concentration at the hypothetical 100-m well are shown in Table 1. The inventory limit for the groundwater pathway is also shown in Table 1. The fractional flux plot and the well concentration plots for each radionuclide are provided in Figures 1-4. The results shown assume that the waste is uniformly distributed throughout one set of five Slit Trenches.

Table 1. Peak contaminant flux, well concentration, and inventory limit

Radionuclide	Peak Fractional Flux (Ci per Ci inventory)	Time (years)	Peak Well Concentration (pCi/L per Ci inventory)	Time (years)	Groundwater Pathway Inventory Limit (Ci)
Generic H-3	1.56E-01	6.91	1.59E+03	9.00	6.3E+00
H-3_C	1.61E-04	130	1.41E+00	132	7.1E+03
Generic I-129	7.27E-02	22.3	4.77E+02	29.0	1.0E-03
I-129_C	5.57E-05	8180	1.15E+00	8720	4.3E-01

Results for the generic radionuclides in Table 1 were compared to those in the SA (Cook, 2002) that corrected the Performance Assessment (PA, McDowell-Boyer et al., 2002) and with results in the PA. The only differences for the generic radionuclides was that the PA indicated that the time of the peak flux was at 22.4 years rather than at 22.3 years shown in the current report.

4.0 INTRUDER ANALYSIS

The intruder analyses for H-3_C and I-129_C are different from the generic radionuclides because sealed openings delay the release of contaminants and cause more contaminant to remain in the waste zone at any point in time. Results for the residential, post-drilling and agricultural scenarios are shown in Tables 2-4 below.

Table 2. Residential scenario at 100 years

Radionuclide	Fraction Remaining	Concentration Limit ($\mu Ci/m^3$)	Inventory Limit (Ci)
Generic H-3	0.00E+00	No limit	No limit
H-3_C	2.19E-03	No limit	No limit
Generic I-129	7.28E-06	8.1E+09	2.3E+08
I-129_C	1.00E+00	5.9E+04	1.7E+03

Table 3. Post-Drilling scenario at 100 years

Radionuclide	Fraction Remaining	Concentration Limit ($\mu Ci/m^3$)	Inventory Limit (Ci)
Generic H-3	0.00E+00	No limit	No limit
H-3_C	2.19E-03	5.9E+08	3.1E+06
Generic I-129	7.28E-06	8.5E+09	4.4E+07
I-129_C	1.00E+00	6.2E+04	3.2E+02

Table 4. Agricultural scenario at 700 years

Radionuclide	Fraction Remaining	Concentration Limit (µCi/m^3)	Inventory Limit (Ci)
Generic H-3	0.00E+00	No limit	No limit
H-3_C	0.00E+00	No limit	No limit
Generic I-129	0.00E+00	No limit	No limit
I-129_C	9.71E-01	2.1E+03	5.9E+01

The air and radon pathways can also provide inventory limits. The air pathway has an inventory limit of 3.2E5 Ci for H-3 (Cook, 2002), which also applies to H-3_C. The air pathway has no limits for I-129 or I-129_C. Radon limits are not applicable for H-3 or I-129.

5.0 CONCLUSIONS

The most restrictive pathway or scenario controls the inventory limit for each contaminant. The inventory limit and the most restrictive pathway are shown in Table 5.

The inventory limit for I-129_C is based on acidic conditions. To ensure acidic conditions, ETF activated carbon vessels must be disposed separately from cementitious waste, e.g., concrete rubble. The separation distance should be a minimum of 16 feet in all directions.

In order to readily compare the two disposal options for ETF activated carbon vessels that were listed in the UDQ evaluation (Collard, 2002), the consumption of the inventory limits and facility volumes for each disposal option are provided in tables. Results for the first disposal option as CIG are presented in Table 6. Similar results for disposal in Slit Trenches are provided in Table 7. I-129_C consumes the most inventory, about 138% for CIG trenches and about 6% for Slit Trenches.

Table 5. Overall inventory limits and limiting pathway

Radionuclide	Inventory Limit (Ci)	Limiting Pathway
Generic H-3	6.3E+00	Gw
H-3_C	7.1E+03	Gw
Generic I-129	1.0E-03	Gw
I-129_C	4.3E-01	Gw

Table 6. Consumption of inventory limit and facility volume for disposal of ETF carbon vessels as CIG

Radionuclide	Inventory (Ci)	Inventory Limit (Ci)	Consumption of Inventory Limit (%)	Consumption of Facility Volume (%)
H-3_C	2.68E-1	1.8E+06	1.49E-05	0.60
I-129_C	2.36E-2	1.7E-02	1.39E+02	0.60

Table 7. Consumption of inventory limit and facility volume for disposal of ETF carbon vessels in Slit Trenches

Radionuclide	Inventory (Ci)	Inventory Limit (Ci)	Consumption of Inventory Limit (%)	Consumption of Facility Volume (%)
Generic H-3		6.3E+00		
H-3_C	2.68E-1	7.1E+03	3.77E-03	0.60
Generic I-129		1.0E-03		
I-129_C	2.36E-2	4.3E-01	5.49E+00	0.60

6.0 REFERENCES

Collard, L.B. 2001. *Special Analysis for Disposal of High-Concentration I-129 Waste in Slit Trenches at the E-Area Low-Level Waste Facility*, WSRC-TR-2001-00021, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina, 29808, August 15.

Collard, L.B. 2002. *Evaluation of Proposed New LLW Disposal Activity: Disposal of ETF Activated Carbon Vessels in Trenches*, WSRC-TR-2002-00339, Revision 0, Westinghouse Savannah River Company, Aiken, South Carolina, 29808, September 3.

Collard, L.B. and J.R. Cook 2003. *Special Analysis for Disposal of Cement-Stabilized Encapsulated Waste at the E-Area Low-Level Waste Facility*, WSRC-RP-99-00596, Revision 1, Westinghouse Savannah River Company, Aiken, South Carolina, 29808, May 21.

Cook, J.R. 2002. *Special Analysis: Correction and Update of E-Area Disposal Limits*, WSRC-TR-2002-00047, Revision 2, Westinghouse Savannah River Company, Aiken, South Carolina, 29808, May 2.

Estochen, E.G. 2002. *ETF Vessel External Pressure Capacity*, Calculation M-CLC-A-00189, Westinghouse Savannah River Company, Aiken, South Carolina, 29808, October 15.

Kaplan, D.I., S.M. Serkiz, and N.C. Bell, 1999. *I-129 Desorption from SRS Water Treatment Media From the Effluent Treatment Facility and the F-Area Groundwater Treatment Facility.* WSRC-TR-99-00270, Rev. 0. Savannah River Laboratory, Westinghouse Savannah River Company, Aiken, SC., August 24.

McDowell-Boyer, L., A.D. Yu, J.R. Cook, D.C. Kocher, E.L. Wilhite, H. Holmes-Burns, and K.E. Young. 2000. *Radiological Performance Assessment for the E-Area Low Level Waste Facility*, WSRC-RP-94-218, Revision 1, Westinghouse Savannah River Company, Aiken, South Carolina, 29808, January 31.

Sink, D.F., Jr. 2003. Personal Communication, June 17.

Appendix A. Flux and Concentration Plots

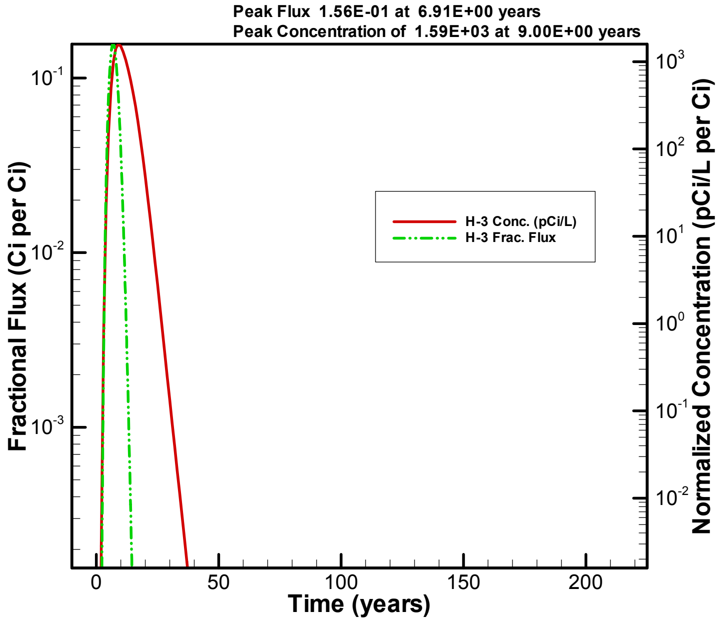

Figure 1. Fluxes and Well Concentrations for H-3

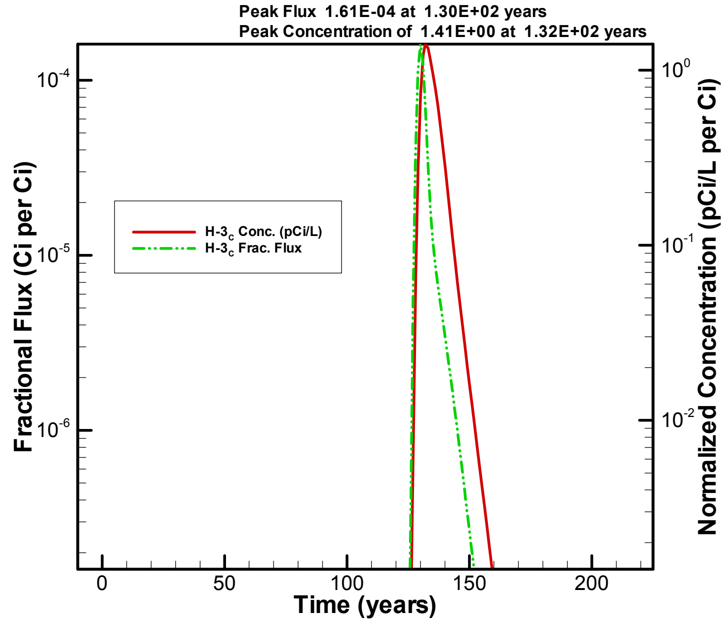

Figure 2. Fluxes and Well Concentrations for H-3_C

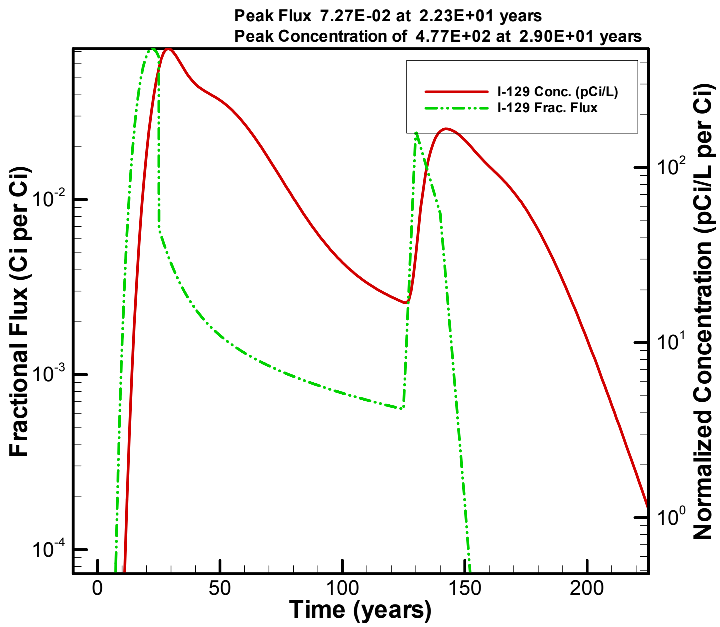

Figure 3. Fluxes and Well Concentrations for I-129

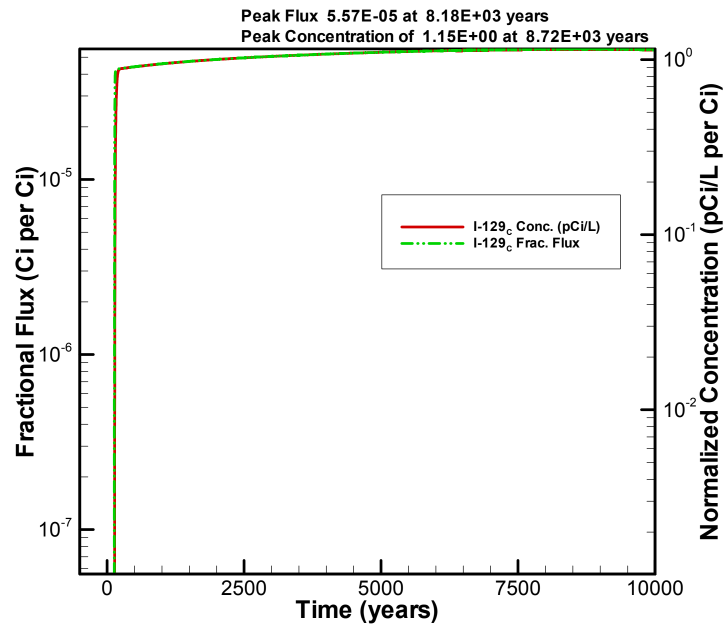

Figure 4. Fluxes and Well Concentrations for I-129_C

Appendix B. Design Check

Design check instructions

DESIGN CHECK INSTRUCTIONS FOR SPECIAL ANALYSIS OF ETF CARBON VESSELS IN SLIT TRENCHES

Perform a design check for *SPECIAL ANALYSIS: DISPOSAL OF THREE ETF ACTIVATED CARBON VESSELS IN SLIT TRENCHES AT THE E-AREA LOW-LEVEL WASTE FACILITY*, WSRC-TR-2003-XXXXX, Rev 0, June 13, 2003 following the general guidance provided in WSRC-IM-2002-00011.

Specific instructions for the groundwater pathway analysis are as follow:

1. Check the APPROACH to ensure that the conceptual model for sealed vessels is appropriate

2. Check the MATHEMATICS by
   - Checking the intruder spreadsheets

3. Check to ensure that the INPUTS are correct for
   - Check that the modeling changes stated in the report were properly implemented, i.e., that the initial inventory was properly decayed until after the Slit Trench operational phase
   - The proper Kd for I-129 in the vessels was applied
   - The PA models were effectively replicated except for the changes noted above

4. Check to ensure that the OUTPUTS are reasonable by
   - For each nuclide, check that the general pattern well concentrations "matches" the general pattern of the fluxes
   - Check the plots for generic waste versus PA results

5. TRANSCRIPTION:
   - Ensure that the peak concentrations, peak fluxes and times in the figures match the values in the tables. If the numbers are presented at two different locations throughout the report, they should be identical, except for rounding.
   - Check the inventory limit table and the tables comparing inventory with limits

Design check from B.T. Butcher

DESIGN CHECK INSTRUCTIONS AND REVIEWER COMMENTS FOR SPECIAL ANALYSIS OF ETF CARBON VESSELS IN SLIT TRENCHES

Perform a design check for *SPECIAL ANALYSIS: DISPOSAL OF THREE ETF ACTIVATED CARBON VESSELS IN SLIT TRENCHES AT THE E-AREA LOW-LEVEL WASTE FACILITY*, WSRC-TR-2003-00255, Rev 0, June 13, 2003 following the general guidance provided in WSRC-IM-2002-00011.

Specific instructions for the groundwater and intruder pathway analysis are provided below. Technical reviewer comments by Tom Butcher are shown in red beneath items checked. Items 3 and 4 were checked by Thong Hang in a separate review.

1. Check the APPROACH to ensure that the conceptual model for sealed vessels is appropriate

   The approach taken in this SA was to use the existing PA Slit Trench model and modify it to analyze disposal of ETF Activated Carbon Vessels. The release of contaminants was changed in the model to simulate the vessels being sealed during the first 25-year operational phase. This delay results in the need to reanalyze both groundwater and intruder pathways. The approach taken to simulate this proposed action is appropriate.

2. Check the MATHEMATICS by
   - Checking the intruder spreadsheets

   The intruder spreadsheet from the PA Revision 1 was used in the reanalysis of the intruder pathway. Spreadsheet values were cross-checked with values in E-Area PA Revision 1 or the Special Analysis correcting and updating E-Area disposal limits as appropriate. The values and formulas used in this SA are implemented consistently with the PA. The one exception was that the summary section of the spreadsheet where limits from the different pathways are listed side-by-side reference back to the incorrect cell where the limit was first calculated. However, the correct limit value was transcribed to the report. Correct references in cells AL145, AL146, AM145, AM146, AN145 and AN146.

3. Check to ensure that the INPUTS are correct for
   - Check that the modeling changes stated in the report were properly implemented, i.e., that the initial inventory was properly decayed until after the Slit Trench operational phase
   - The proper Kd for I-129 in the vessels was applied
   - The PA models were effectively replicated except for the changes noted above

4. Check to ensure that the OUTPUTS are reasonable by

- For each nuclide, check that the general pattern well concentrations “matches” the general pattern of the fluxes
- Check the plots for generic waste versus PA results

5. TRANSCRIPTION:
   - Ensure that the peak concentrations, peak fluxes and times in the figures match the values in the tables. If the numbers are presented at two different locations throughout the report, they should be identical, except for rounding.

   Peak concentrations, fluxes and times from the figures in Appendix A were compared with Table 1 values and were correctly transcribed. Values from modeling output showing fraction remaining with time when starting with one curie of each nuclide were compared with tables 2, 3 and 4 in the report. All were correct.

   - Check the inventory limit table and the tables comparing inventory with limits

   Correct limits were applied. Small errors found in tables. Marked up page set in your chair.

Design check from T.Hang

Design Check for Special Analysis of ETF Carbon Vessels in Slit Trenches

Item 3

- In the vadose zone, H-3_C and I-129_C were modeled in 2 stages: OKCap (i.e., intact cap from 25 years to 125 years), and BadCap (i.e., failed cap from 125 years to 10,000 years). At the start of the OKCap stage, concentration inventory was set to an initial value that was calculated from the initial inventory at time 0 and decay.
- New waste-specific Kd (7400 ml/g) for I-129_C was used in the new model. In the aquifer zone, however, old Kd for generic I-129 was correctly applied.
- Overall, the modeling changes stated in the report were properly implemented. The PA models were effectively replicated excepted for the new changes.

Item 4

- For each nuclide, the general pattern well concentrations were found to match the general pattern of the fluxes.
- For H-3, the plots for H-3_C are similar to those of H-3 except that the H-3_C curves are delayed (righ-shifted) by ~125 years.
- For I-129, the plots for I-129_C do not exhibit any peak due to the high new Kd. The plots for I-129 display double peaks for both concentration and flux.
- Check the plots for generic waste vs. PA results:

- The current special analysis and PA show identical results of peak fluxes and concentrations:
  - Fractional fluxes:
    1.53E-1 @ 6.91 years (H-3)
    7.27E-2 @ 22.3 years (I-129)
  - Normalized concentrations:
    1.59E+3 @ 9 years (H-3)
    4.77E+2 @ 29 years (I-129)

- In general, the plot trends for generic waste tend to agree with those shown in the PA report. An accurate comparison cannot be established since plots are displayed in different scales (i.e., larger time scale in Special Analysis; log scale for fluxes and concentrations in Special Analysis vs. linear scale for those variables in PA).