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DOE/RL-99-34
Supplement-Approval

Notice of Construction for Tank Waste Remediation System Vadose Zone Characterization

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Richland, Washington

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UC-630

Notice of Construction for Tank Waste Remediation System Vadose Zone Characterization

Date Issued
August 23, 1999

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for Public Release

Hanford Facility NOC Revision Form

Emissions Unit:	NOC Title and Approval Reference:
Tank Waste Remediation System Vadose Zone Characterization (Listed in Table 1)	No.DOE/RL-99-34, Rev. 0 Notice of Construction for Tank Waste Remediation System Vadose Zone Characterization

NOC Revision 0: Add discussion related to perched and purge water to the NOC.
The addition of purge and perched water falls within the bounding source term presented, therefore, no increase in the emissions estimate will be realized due to the addition of this topic. Actual emissions should decrease since wet soil is less mobile than dry soil.

DESCRIPTION

1. Revised Section 6.0 to provide process description describing operations associated with perched water, purgewater, and sampling groundwater.
2. Revised Section 7.0 to provide description on APQ associated with perched water, purgewater, and sampling groundwater.
3. Revised Section 8.0 to provide description on why there should be no controls associated with perched water, purgewater, and sampling groundwater operations.
4. Revised Section 9.0 to include perched water, purgewater, and sampling groundwater as additional fugitive emission sources.
5. Revised Section 10.0 to provide description on release rates associated with perched water, purgewater, and sampling groundwater.
6. Revised Section 11.0 to include offsite impacts associated with perched water, purgewater, and sampling groundwater. Also include correct Attachment designations and delete the word respectively since it no longer applies.
7. Revised Section 13.0 to provide description on why technology standards associated with perched water, purgewater, and sampling groundwater do not apply.
8. Revised Section 14.0 to include an additional reference to support discussion in Section 7.0.
9. Added Figure 2 – Flow Diagram for handling perched water and purgewater.
10. Revised Attachment E to include APQ, PTE, and TEDE to the MEI based on perched water, purge water and obtaining groundwater samples
11. Revised Attachment F to also sum the results for perched water, purge water and obtaining groundwater samples.

Pages with the added text changes are attached to this form.

Reviewed by Contractor:	Reviewed by RL/ORP:	Approved by WDOH: **
Eric M. Gregg 8/16/99	Dennis Bowser 8/18/99	for AWC 8/23/99
DJR Don Carrell per telecon 4:40 8/16/99		
E Bornemann 8/17/99		
Date	Date	Date

AW 8/16/99
JKP for JAB 8-17-99
DJR 8/16/99

** SEE ATTACHED additional Conditions & Limitations

No. DOE/RL-99-34
Rev. 0

The following are additional conditions and limitations that shall be applied to the Notice of Construction for Tank Waste Remediation System Vadose Zone Characterization.

1. No more than an average of 2,000 gallons of water (includes perched water, purge water and groundwater sampling) will be removed from each equivalent bore hole.* Perched water and purge water will be collected in passively ventilated open top containers. When a sufficient volume of water has been collected or at the end of groundwater sampling activities, the water shall be transferred from the passively ventilated containers into a tanker truck for treatment at the 200 Area ETF or other permitted storage/treatment facility. *Not to exceed 20,000 gal/year of water

2. The APQ associated with perched water, purge water and groundwater sampling shall not exceed 1.36E-03 curies.

3. The following controls shall be mandatory when handling perched water, ground water and ground water sampling: All contaminated liquids shall be contained; all exterior surfaces of liquid holding devices shall be maintained at the current radiological free release limit; vented drums shall be maintained non-smearable; storage and handling of the vented drums shall be as described in the Site wide Vented Drum Notice of Construction.

4. Fugitive emissions will be monitored using periodic confirmatory monitoring accomplished by operating three fixed head samplers around the location of the work activities. The fixed head samplers will also be located with 100 feet of where the casing removal activities are occurring and will be operated when the work activities have the potential to emit radionuclides.

8-23-99
for AWC

CONTENTS

1.0 INTRODUCTION 1

2.0 FACILITY LOCATION (REQUIREMENT 1) 2

3.0 RESPONSIBLE MANAGER (REQUIREMENT 2) 2

4.0 TYPE OF PROPOSED ACTION (REQUIREMENT 3) 2

5.0 STATE ENVIRONMENTAL POLICY ACT (REQUIREMENT 4) 3

6.0 PROCESS DESCRIPTION (REQUIREMENT 5) 3

7.0 ANNUAL POSSESSION QUANTITY AND PHYSICAL FORM (REQUIREMENTS 8, 10, and 11) 5

8.0 ABATEMENT TECHNOLOGY AND CONCEPTUAL DRAWING(S) (REQUIREMENTS 6 AND 7) 6

9.0 MONITORING SYSTEM (REQUIREMENT 9) 7

10.0 RELEASE RATES (REQUIREMENTS 12 AND 13) 8

11.0 OFFSITE IMPACT (REQUIREMENTS 14 AND 15) 10

12.0 COST FACTORS AND FACILITY LIFETIME (REQUIREMENTS 16 AND 17) 10

13.0 TECHNOLOGY STANDARDS (REQUIREMENT 18) 11

14.0 REFERENCES 11

ATTACHMENTS

A INSTRUCTIONS FOR BOREHOLE SAMPLING (WHC-SD-EN-AP-181, REV. 0) ..... ATT A-i

B TANK INVENTORY DATA ..... ATT B-i

C TANK ISOTOPE TO CESIUM-137 RATIOS ..... ATT C-i

D ANNUAL POSSESSION QUANTITY ..... ATT D-i

E POTENTIAL-TO-EMIT ASSUMPTIONS AND CALCULATIONS DRILLING BOREHOLES ..... ATT E-i

F POTENTIAL-TO-EMIT ASSUMPTIONS AND CALCULATIONS CLOSING BOREHOLES AND REMOVING CASING ..... ATT F-i

ATTACHMENTS (cont)

G SUMMARY OF POTENTIAL-TO-EMIT ASSUMPTIONS DRILLING BOREHOLES/CLOSING BOREHOLES AND REMOVING CASING ..... ATT G-i

H POTENTIAL-TO-EMIT EXAMPLE CALCULATION ..... ATT H-i

I TWRS ALARACT DEMONSTRATION FOR PACKAGING AND TRANSPORTATION OF EQUIPMENT AND VEHICLES ..... ATT I-i

J DISCUSSION OF BEST AVAILABLE RADIONUCLIDE CONTROL TECHNOLOGY ..... ATT J-i

FIGURE

Figure 1. Process Flow Diagram 13
Figure 2. Flow Diagram for Handling Perched Water and Purgewater. 14
~~Figure 1. Process Flow Diagram ..... 13~~12

TABLES

Table 1. Facility Locations. 2
Table 2. Average Allowable Concentrations of Cs-137. 109

tremie is an apparatus that consists of a hopper or funnel at the top (ground level) end and a long metal tube for placing fill materials directly on the bottom of the borehole. Using a tremie reduces void spaces while backfilling the hole and reduces the potential to resuspend contaminated particulates. Casing removal activities will be performed outside of the containment structure. The closure of the equivalent boreholes may also be performed by backfilling the borehole using a tremie without pulling the casing.

During drilling activities, there is the possibility of hitting perched water. Perched water is groundwater separated from an underlying body of groundwater by unsaturated rock. Any perched water would be collected in the drum at the bottom of the cyclone. The perched water is not expected to consist of undiluted tank waste since gamma logging activities have noted that the gamma sources from tank waste decrease with depth that is above any perched water table (BNWL 1966).

Approximately 1,000 gallons of purgewater will be removed from each equivalent borehole prior to inserting the screen into the water table. After installation of the screen, groundwater samples will be taken. An average of 2,000 gallons of water (includes perched water, purgewater and groundwater sampling) is expected to be removed from each equivalent borehole. As shown in Figure 2, perched water and purgewater will be collected in passively ventilated open top containers. When a sufficient volume of water has been collected or at the end of groundwater sampling activities, the water will be transferred from the passively ventilated containers into a tanker truck for treatment at the 200 Area ETF or other permitted storage/treatment facility.

7.0 ANNUAL POSSESSION QUANTITY AND PHYSICAL FORM
(REQUIREMENTS 8, 10, AND 11)

The annual possession quantity (APQ) was estimated based on drilling and closing ten equivalent boreholes per year with the soil containing an average of 330 microcuries of Cs-137 per gram of soil. The 330 microcuries of Cs-137 per gram of soil is based on a 100 percent saturation of the soil pore space (30 percent total porosity) by a waste solution (BNWL 1966). [Based on previous soil characterization activities, the highest actual measured Cs-137 concentration in the soil was 100 microcuries (100,000 nanocuries) per gram of soil (BNWL 1966).]

Other isotopes may have higher off-site dose consequences and they have been accounted for; however, Cs-137 was selected as the base isotope since it is readily detected in the soil. Attachment B provides a listing of known or assumed leaking tanks (HNF 1998) and the corresponding tank inventory from the database in the Tank Waste Information Network System 2 which is available on the internet (http://twins.pnl.gov:8001). A ratio of each isotope to Cs-137, based on curies, was calculated for each tank as shown in Attachment C. A comparison of the curie ratio for each isotope in each tank was performed with the average value being considered representative of the extent of soil contamination for other isotopes.

As shown in Attachment D, a maximum of 10 equivalent boreholes may be drilled per year. Each equivalent borehole will have a nominal top diameter of 10 inches for the first 50 feet and a nominal bottom diameter of 8 inches for the remaining 200 feet of boring (average depth is 250 feet). As a result of drilling, the soil has been observed to expand approximately 15% over what would be calculated based strictly on the volume of the equivalent borehole since the soil is no longer compacted. Based on previous drilling experience, the average vertical range of soil contamination is assumed to span an average of 20 feet per equivalent borehole (HNF 1999a). For conservatism, all contamination is assumed to occur in the 10-inch diameter section of the equivalent borehole.

Based on the previous assumptions, approximately 112 cubic feet of soil is removed per equivalent borehole. An estimated 13 cubic feet of the soil per equivalent borehole is assumed contaminated. Using the average isotope ratios multiplied by 330 microcuries of Cs-137 (average) per gram of soil and the total weight of soil [based on an average density of 97.5 pounds per cubic foot for loose dry sand and gravel, (Avallone and Baumeister)] the APQ of each isotope for drilling has been provided in Attachment D.

The APQ associated with the closure of 10 equivalent boreholes has also been provided in Attachment D. Under field conditions, the soil column abrasively scrubs the outside of the casing free of a soil layer leaving a few patches (up to 15% of the exposed surface area) of soil on the casing material (DSI 99b). The thin soil patches were assumed to consist of a thickness of 1/64-inch with the worst case composition of 330 microcuries of Cs-137 per gram of soil. For conservatism an additional 10% was added to the exterior contamination on the casing to account for any potential contamination on the interior of the casing. For boreholes that do not require casing removal, the APQ is assumed to be zero since the APQ was included in constructing the borehole.

A summary of the total APQ associated with the installation and closure of 10 equivalent boreholes per year has been provided in Attachment D (4.38E+04 curies per year). All isotopes are assumed to be in the form of particulate solids or liquids.

The APQ associated with perched water, purgewater and groundwater sampling is based on drilling 10 equivalent boreholes per year, with an average of 2,000 gallons per borehole contaminated with Tc-99 at a concentration of 18,000 picocuries per liter. The 18,000 picocuries per liter of Tc-99 corresponds to groundwater sampling near 241-T Tank Farm and it represents the highest concentration that has been found in groundwater (PNNL-12086). As shown in Attachment E, the APQ associated with perched water, purgewater and groundwater sampling is estimated at 1.36E-03 curies.

8.0 ABATEMENT TECHNOLOGY AND CONCEPTUAL DRAWING(S)
(REQUIREMENTS 6 AND 7)

Emissions from air rotary drilling activities will be contained using an active ventilation system attached to the process equipment and a passive vent system attached to the process equipment containment structure. The active ventilation system will have radioactive air emissions abated by one stage of high efficiency particulate air (HEPA) filter. The HEPA filter located downstream of the will be tested to provide a minimum collection efficiency of 99.95 percent for particulates with a median diameter of 0.3 microns. The containment structure will have a passive HEPA type filter that will provide high efficiency collection.

The average volumetric flowrate from the compressor to the equivalent borehole is estimated to be 1.2 cubic meters per second (2,400 cubic feet per minute) with approximately 0.6 cubic meters per second (1,200 cubic feet per minute) returning out the borehole into the cyclone. The difference in the flowrate is attributed to the soil column absorbing a fraction of the air volume which is gradually released into the process and abatement control equipment after the compressor is turned off.

The exhaust fan will have a maximum average velocity of 0.85 cubic meters per second (1,800 cubic feet per minute) with a range of 0.6 to 1.2 cubic meters per second (1,200 to 2,400 cubic feet per minute) to maintain the ducting between the cyclone and the HEPA filter at atmospheric or less than atmospheric pressure. The drill rig will be sealed to the casing so that particulates will be contained and routed to the process equipment (e.g., cyclone and torit) located inside the plastic containment structure. The flange on the well discharge head and on the inlet of the cyclone will be double flanged to reduce the potential for

an unabated release to the atmosphere. Additionally, the flexible line connecting the well discharge head and the cyclone will be encased by another flexible line. The flexible encasement line and flanges will also be vented to the cyclone. The plastic containment structure surrounding the process control equipment will be fitted with one stage of HEPA type filtration. Figure 1 is a conceptual drawing of the proposed system.

When the borehole has been completed and the process equipment is ready to be removed, equipment will be broken down at the disconnect points and contaminated equipment openings will be sealed or plugged to minimize the spread of contamination. All work related to disconnecting and moving the equipment will be performed in accordance with TWRS as low as reasonably achievable control technology (ALARACT) demonstration number 12 (HNF-1999b), "TWRS ALARACT Demonstration for Packaging and Transportation of Equipment & Vehicles" (Attachment I).

Emission controls to be used during sonic drilling, cable tool drilling, cone penetrometer, use of the closed end probe, and casing removal will be decontamination by non-aggressive manual methods such as wiping, sleeving into plastic or having fixatives applied to prevent the spread of contamination if the smearable contamination levels are greater than 100,000 disintegrations per minute per 100 square centimeters for beta/gamma or 2,000 disintegrations per minute per 100 square centimeters for alpha.

During cable tool drilling, when the barrel is removed from the ground, the barrel will be sleeved into plastic and the bottom will be tied off. During sample removal, the exterior of the barrel is hit with a hammer or other hard object, the moist soil will dislodge into the plastic sleeving with minimal potential for emissions. The soil samples from this activity will remain in the plastic sleeving after the sleeving is removed from the barrel. In the event that the soil does not dislodge from the barrel, the entire barrel will remain in the sleeving and the barrel will be placed in a suitable closed container for shipment to the laboratory or placed in a closed burial box.

Additionally, all other sample containers will be wrapped in plastic after retrieval and the casing will be sleeved into plastic during the removal process to prevent the spread of contamination.

Emissions associated with perched water, purgewater and groundwater samples are expected to be close to nondetectable. In the event that perched water is encountered, actual emissions from drilling will decrease since any contaminated soil will become wet and less mobile. Purgewater will result in wetting the interior of the casing and potentially entraining radionuclides adhered to the interior of the casing. As a result, potential emissions associated with radionuclides inside the casing will actually decrease since the radionuclides will be wetted or in solution. As shown in Figure 2, no controls are proposed for perched water, purgewater and groundwater sampling activities since water retards the resuspension of particulate radionuclides.

A wind speed restriction of 20 miles per hour will be applied to drilling, sampling and casing removal work. This criterion applies to sustained wind speeds as determined by the Hanford Meteorological Station. The radiological conditions associated with the work activities will be controlled by following a radiation work package (RWP). Continuous Health Physics Technician coverage will be provided while drilling, sampling and removing casing.

9.0 MONITORING SYSTEM (REQUIREMENT 9)

Periodic confirmatory monitoring of emissions from borehole drilling using the air rotary drilling technique will be accomplished by a destructive or non-destructive analysis of the record filter combined with radiological field surveys during the work. The record filter, located downstream of the active

ventilation HEPA filter, will receive all flow from the first filter and will have a minimum efficiency of 90 percent for particulates with a median diameter of 0.3 microns as specified by the manufacturer. The radiological analyses from the soil samples will be averaged to determine the isotopic distribution of Strontium-90 (Sr-90), Cs-137, Plutonium-239 (Pu-239) and Americium (Am-241). Sr-90, Pu-239 and Am-241 are the isotopes estimated to potentially contribute greater than 10% of the unabated offsite dose; whereas, Pu-239 and Sr-90 are the isotopes estimated to contribute greater than 25% of the offsite dose due to abated emissions. The record filter will be counted using a gamma spectrometer calibrated to Cs-137. Counting will be done annually using either a destructive or non-destructive technique.

The soil sample isotope ratios discussed above will be applied to Cs-137 on the record filter to confirm low emissions instead of the ratios used in Attachment C. The actual soil sample isotopic ratios are expected to be less than the overly conservative ratios contained within Attachment C since Pu-239 and Am-241 are not as soluble and will not transport through the entire leak plume as readily as Cs-137. The proposed periodic confirmatory method is capable of providing the required detection levels to verify low emissions. In addition, the HEPA filter housing will be field surveyed after the completion of each borehole to verify low emissions.

Periodic confirmatory monitoring of the passive HEPA type filter will be accomplished by performing a field survey of the filter housing to confirm low emissions. The field survey of the passive HEPA type filter will be performed after the completion of each borehole.

Fugitive emissions may result from cable tool and sonic drilling, use of the closed end probe and the cone penetrometer, the plastic containment structure during air rotary drilling, and during dismantlement/assembly or relocating the ventilation equipment, plastic containment structure, or process equipment. To confirm low emissions, periodic confirmatory monitoring will be accomplished by operating three fixed head samplers around the location of where the drilling and sampling operations are occurring. The fixed head samplers will be located within 100 feet of where the drilling and sampling work activities are occurring and will be operated whenever the work activities have the potential to emit radionuclides. After packaging the equipment and samples for shipment, Health Physics Technicians will perform surveys (swipes for removable contamination) in accordance with TWRS as low as reasonably achievable control technology (ALARACT) demonstration number 12 (HNF-1999b), "TWRS ALARACT Demonstration for Packaging and Transportation of Equipment & Vehicles" (Attachment I).

Fugitive emissions may also result from removing casing from the ground and from transferring the perched water and purgewater. To confirm low emissions, periodic confirmatory monitoring will be accomplished by operating three fixed head samplers around the location of the work activities. The fixed head samplers will also be located with 100 feet of where the casing removal activities are occurring and will be operated when the work activities have the potential to emit radionuclides.

10.0 RELEASE RATES (REQUIREMENTS 12 AND 13)

Up to ten equivalent boreholes may be drilled by the methods previously described in the NOC. Each of the proposed methods has the potential to emit radionuclides into the air. Individual methods are to be selected based on the highest concentration of contaminants likely to be encountered. The highest levels of contamination occur closest to the tanks. As the depth below the tank increases, the levels of contamination decrease substantially. Of the methods considered for use, the most conservative drilling approach (lowest potential to emit) will be applied first. Borehole logging will be used to determine when it is appropriate to apply drilling techniques that may have a higher potential to emit. Zones not sampled during advancement of the borehole due to having a high potential to exceed occupational exposure

more boreholes may be drilled until the 12 consecutive month period falls below the handling limit. Conversely, if the limit would not be reached after drilling 10 boreholes, additional boreholes may be drilled until the annual handling limit is reached. Table 2 has been included below to demonstrate how the average limit would be adjusted based on drilling one, five, and ten equivalent boreholes per year.

Table 2. Average Allowable Concentrations of Cs-137.

	Estimated Volume of Contaminated Soil Per Equivalent Borehole (Appendix D)	One Borehole Per Year	Two Boreholes Per Year	Ten Boreholes Per Year
Air Rotary Drilling	12.54 cubic feet	5.0E-08 curies per gram of soil	1.0E-08 curies per gram of soil	5.0E-09 curies per gram of soil
Cable Tool or Sonic Drilling	12.54 cubic feet	5.0E-06 curies per gram of soil	5.0E-06 curies per gram of soil	5.0E-06 curies per gram of soil
Closed End Probe or Cone Penetrometer	0.44 cubic feet	3.3E-03 curies per gram of soil	6.6E-04 curies per gram of soil	3.3E-04 curies per gram of soil

Perched Water, Purgewater, and Groundwater Sampling – Emissions associated with perched water, purgewater and groundwater sampling are based on applying a 2.0 E-03 (two times the 40 CFR 61 Appendix D release fraction of 1.0 E-03 for liquids and particulates) release fraction to the annual possession quantity. The 2.0 E-03 release fraction was used to conservatively account for transferring the water into the temporary containment structure and the subsequent transfer to the tanker truck. The total volume of the groundwater samples is insignificant compared to the potential volume associated with perched water or purgewater; therefore, applying the 2.0 E-03 release fraction to the groundwater samples will not have a significant impact on the estimated emissions. A summary of emissions associated with perched water, purgewater and groundwater sampling is provided in Attachment E. Emissions associated with perched water, purgewater and groundwater sampling are insignificant when compared to emissions associated with drilling and casing removal activities.

11.0 OFFSITE IMPACT (REQUIREMENTS 14 AND 15)

A detailed summary of the estimated potential-to-emit TEDE to the hypothetical MEI for each radionuclide for the various drilling techniques, casing removal activities, perched water, purgewater, groundwater sampling, and overall total summary has been provided in Attachments ~~E~~D, ~~F~~E, and ~~G~~F, ~~respectively~~. The MEI is 20,200 meters east southeast of the 200-East Area of the Hanford Site.

12.0 COST FACTORS AND FACILITY LIFETIME (REQUIREMENTS 16 AND 17)

Requirement 16 is not applicable because a best available radionuclide control technology (BARCT) demonstration is provided (Attachment J).

The maximum design life of the project is twenty years (July 15, 2019).

13.0 TECHNOLOGY STANDARDS (REQUIREMENT 18)

For air rotary drilling, the HEPA filter performance standards of ASME/ANSI N510, Section 10.5 will be met. The powered HEPA filter will have a minimum efficiency of 99.95 per cent for particles with a median diameter of 0.3 microns. ASME/ANSI AG-1 for the HEPA filter will be met as documented in a letter from the U.S. Department of Energy, Richland Operations Office, to the Washington State Department of Health (99-EAP-213). Other sections of ASME/ANSI 509 and 510 do not apply to this system due to its temporary configuration. The passive HEPA filter will be factory tested to a minimum efficiency of 99.95 per cent for particles with a median diameter of 0.3 microns and will provide a high efficiency of collection during passive ventilation. The systems will be visually inspected daily during operation and after any relocations to ensure the systems continues to operate as designed. Additionally, line pressure tests will be performed on the line between the well head and the cyclone and line between the torit and the fan prior to starting a new borehole. The line pressure test will be performed in accordance with ASME/ANSI N510.

In accordance with WAC 246-247-075(3), for emission units with a potential-to-emit of less than 0.1 millirem per year TEDE to the MEI, the option exists to estimate radionuclide emissions in accordance with 40 CFR 61 Appendix D, or other approved methods. Additionally, WDOH may require periodic confirmatory measurements during routine operations to verify low emissions. For the air rotary drilling, a destructive or nondestructive analysis of the record filters are proposed to be used for providing periodic confirmatory measurement to verify low emissions. Since the exhaust flow rate will not be needed to determine emissions, 40 CFR 60 Appendix A, Methods 1, 1A, 2, 2A, 2C, 2D, 4, 5, and 17 do not apply. In addition, ANSI N13.1 does not address the record filter system design because a sampling probe will not be used to measure emissions.

The air rotary drilling monitoring method will be compatible with NQA-1 as imposed by NESHAP Quality Assurance Project Plan for Radioactive Airborne Emissions, all of Sections 2.0, 3.0 and 5.0. ANSI/ASME NQA-2 is no longer an active National Standard and has been incorporated into NQA-1.

For cable tool drilling, sonic drilling, closed end probe, cone penetrometer, ~~and~~ casing removal activities, purgewater, and groundwater sampling, the technology standards do not apply since these will be fugitive emission sources. Emissions will be maintained using BARCT (decontaminating, plastic sleeving and applying fixatives as needed) for contamination controls.

14.0 REFERENCES

BNWL, 19~~9~~66, *Characterization of Subsurface Contamination in the SX Tank Farm, BNWL-CC-701*, by J. R. Raymond and E. G. Shdo, Battelle-Northwest, Richland, Washington.

DSI-99a, "Volume of fines Collected During Air Drilling", DSI, Kent Reynolds, Waste Management Northwest, Inc., to Stan Hill, Waste Management Federal Services of Hanford, Inc., Richland, Washington, January 15, 1999.

DSI-99b, "Well Decommissioning", DSI, Kent Reynolds, Waste Management Northwest, Inc., to Stan Hill, Waste Management Federal Services of Hanford, Inc., Richland, Washington, February 22, 1999.

DOE-RL, 1998, *Tank Waste Remediation System Vadose Zone Program Plan*, DOE/RL-98-49, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1999, letter, 99-EAP-213, Mr. J. E. Rasmussen, U.S. Department of Energy, Richland Operations Office, to Mr. A. W. Conklin, Washington State Department of Health, "Technical Justification for a Temporary Deviation to American Society of Mechanical Engineers (ASME) AG-1, Section FC, 5100 High-Efficiency Particulate Air (HEPA) Filter Qualification Test Requirements", March 22, 1999.

EPA, 1993, *Subsurface Characterization and Monitoring Techniques*, Volume 1, EPA/625, R-93-003a, U.S. Environmental Protection Agency, Center for Environmental Research Information, Cincinnati, Ohio.

HNF, 1998, *Waste Tank Summary Report for Month Ending July 31, 1998*, HNF-EP-0182-124, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF, 1999a, *Radionuclide Inventories of Liquid Waste Sites at Hanford*, HNF-1744, Fluor Daniel Hanford, Inc., Richland, Washington, expected release June 1999.

HNF 1999b, *Control of Airborne Radioactive Emissions for Frequently Performed TWRS Work Activities (ALARACT Demonstrations)*, HNF-4327, Fluor Daniel Hanford, Inc., Richland, Washington, April 1999.

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E. A. Avallone and T. Baumeister III, "Marks' Standard Handbook for Mechanical Engineers", 9th Edition, McGraw Hill, 1987.

WDOH, 1992, Letter, Air 92-107, A. W. Conklin, Washington State Department of Health, to J. D. Bauer, U.S. Department of Energy, Richland Operations Office, no subject, October 5, 1992.

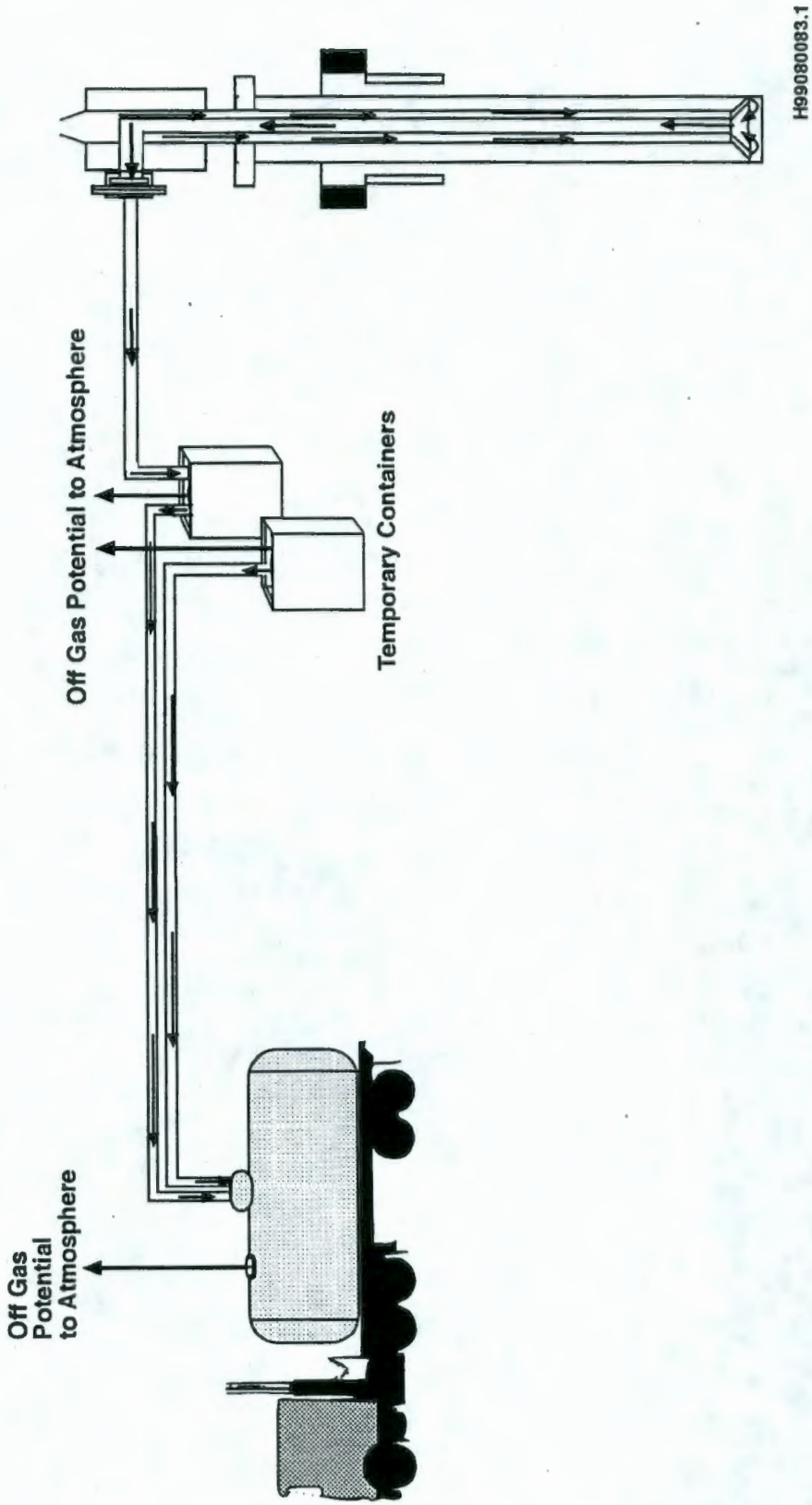

Figure 2. Flow Diagram for Handling Perched Water and Purgewater.

ESTIMATED EMISSIONS ASSOCIATED WITH PERCHED WATER, PURGEWATER AND GROUNDWATER SAMPLING					
(SUBSET OF PREVIOUSLY ESTIMATED EMISSIONS)					
TOTAL NUMBER OF EQUIVALENT BOREHOLES PER YEAR	10				
ESTIMATED TOTAL VOLUME PER EQUIVALENT BOREHOLE	2,000	GALLONS			
ESTIMATED TOTAL VOLUME PER EQUIVALENT BOREHOLE	7570.8	LITERS			
TOTAL VOLUME	75708	LITERS/YEAR			
RELEASE FRACTION	2.00E-03	(ASSUMES TWO TRANSFERS - FIRST INTO HOLDING CONTAINER AND THEN INTO TANKER TRUCK)			
ISOTOPE	**MAXIMUM CONCENTRATION (PICOCURIES/LITER)**	**ANNUAL POSSESSION QUANTITY (CURIES/YEAR)**	**UNABATED RELEASE (CURIES/YEAR)**	**CAP 88PC 200 EAST OFFSITE DOSE FACTOR (MILLIREM/CURIE)**	**UNABATED OFFSITE DOSE (MILLIREM/YEAR)**
TC-99	18,000	1.36E-03	2.73E-06	2.30E-02	6.27E-08

SUMMARY OF OVERALL EMISSIONS USING AIR DRILLING METHOD ONLY

ISOTOPE	TOTAL POSSESSION QUANTITY CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	1.16E-05	1.15E-05	1.15E-05	2.50E-05	2.88E-10	2.88E-10	0.00%	0.00%
14C	3.22E-06	3.19E-06	3.19E-06	1.90E-03	6.06E-09	6.06E-09	0.00%	0.02%
59Ni	7.77E-06	7.69E-06	3.93E-09	3.10E-04	2.38E-09	1.22E-12	0.00%	0.00%
63Ni	7.56E-04	7.48E-04	3.82E-07	2.60E-04	1.94E-07	9.93E-11	0.00%	0.00%
60Co	1.46E-05	1.45E-05	7.39E-09	2.50E-01	3.62E-06	1.85E-09	0.01%	0.01%
90Sr	3.13E-01	3.10E-01	1.58E-04	1.10E-01	3.41E-02	1.74E-05	49.00%	48.90%
90Y	3.13E-01	3.10E-01	1.58E-04	3.40E-04	1.05E-04	5.38E-08	0.15%	0.15%
93Zr	3.65E-06	3.61E-06	1.84E-09	1.30E-03	4.69E-09	2.40E-12	0.00%	0.00%
99Tc	1.42E-03	5.60E-05	2.75E-06	2.30E-02	1.29E-06	6.33E-08	0.00%	0.18%
106Ru	2.59E-08	2.56E-08	1.31E-11	1.60E-02	4.10E-10	2.09E-13	0.00%	0.00%
125Sb	1.10E-05	1.09E-05	5.55E-09	2.40E-03	2.61E-08	1.33E-11	0.00%	0.00%
126Sn	1.21E-06	1.19E-06	6.10E-10	4.70E-02	5.61E-08	2.87E-11	0.00%	0.00%
129I	2.60E-07	2.58E-07	1.32E-10	2.00E-01	5.15E-08	2.63E-11	0.00%	0.00%
134Cs	2.24E-07	2.22E-07	1.13E-10	1.00E-01	2.22E-08	1.13E-11	0.00%	0.00%
137Cs	2.80E-02	2.77E-02	1.42E-05	2.70E-02	7.49E-04	3.82E-07	1.08%	1.08%
151Sm	2.82E-03	2.79E-03	1.43E-06	7.50E-04	2.10E-06	1.07E-09	0.00%	0.00%
152Eu	6.25E-06	6.19E-06	3.16E-09	2.40E-01	1.48E-06	7.58E-10	0.00%	0.00%
154Eu	1.31E-04	1.30E-04	6.64E-08	2.00E-01	2.60E-05	1.33E-08	0.04%	0.04%
155Eu	3.95E-04	3.91E-04	2.00E-07	8.00E-03	3.13E-06	1.60E-09	0.00%	0.00%
226Ra	5.59E-10	5.53E-10	2.82E-13	4.60E-01	2.54E-10	1.30E-13	0.00%	0.00%
228Ra	2.90E-08	2.87E-08	1.47E-11	1.90E-01	5.46E-09	2.79E-12	0.00%	0.00%
227Ac	6.89E-09	6.82E-09	3.48E-12	1.50E+01	1.02E-07	5.22E-11	0.00%	0.00%
229Th	1.16E-09	1.16E-09	5.94E-13	1.60E+01	1.86E-08	9.51E-12	0.00%	0.00%
232Th	1.15E-09	1.14E-09	5.61E-13	8.00E+00	9.11E-09	4.65E-12	0.00%	0.00%
231Pa	7.16E-09	7.08E-09	3.62E-12	1.20E+01	8.50E-08	4.34E-11	0.00%	0.00%
232U	8.89E-08	8.79E-08	4.49E-11	1.10E+01	9.67E-07	4.94E-10	0.00%	0.00%
233U	3.41E-07	3.38E-07	1.72E-10	3.10E+00	1.05E-06	5.34E-10	0.00%	0.00%
234U	6.74E-06	6.67E-06	3.41E-09	3.10E+00	2.07E-05	1.06E-08	0.03%	0.03%
235U	2.98E-07	2.95E-07	1.51E-10	3.00E+00	8.85E-07	4.52E-10	0.00%	0.00%
236U	6.89E-08	6.82E-08	3.48E-11	2.90E+00	1.98E-07	1.01E-10	0.00%	0.00%
238U	6.79E-06	6.72E-06	3.43E-09	2.80E+00	1.88E-05	9.61E-09	0.03%	0.03%
237Np	5.37E-08	5.32E-08	2.71E-11	1.20E+01	6.38E-07	3.26E-10	0.00%	0.00%
238Pu	3.33E-05	3.29E-05	1.68E-08	7.60E+00	2.50E-04	1.28E-07	0.36%	0.36%
239Pu	3.04E-03	3.00E-03	1.53E-06	8.20E+00	2.46E-02	1.26E-05	35.43%	35.36%
240Pu	3.20E-04	3.17E-04	1.62E-07	8.20E+00	2.60E-03	1.33E-06	3.74%	3.73%
241Pu	1.89E-03	1.87E-03	9.57E-07	1.30E-01	2.44E-04	1.24E-07	0.35%	0.35%
242Pu	9.07E-09	8.97E-09	4.58E-12	7.80E+00	7.00E-08	3.57E-11	0.00%	0.00%
241Am	5.27E-04	5.22E-04	2.66E-07	1.30E+01	6.78E-03	3.46E-06	9.76%	9.74%
243Am	1.17E-08	1.16E-08	5.93E-12	1.30E+01	1.51E-07	7.71E-11	0.00%	0.00%
242Cm	4.12E-06	4.08E-06	2.08E-09	4.10E-01	1.67E-06	8.54E-10	0.00%	0.00%
243Cm	1.44E-07	1.42E-07	7.25E-11	8.50E+00	1.21E-06	6.16E-10	0.00%	0.00%
244Cm	1.34E-06	1.32E-06	6.76E-10	6.70E+00	8.87E-06	4.53E-09	0.01%	0.01%
TOTAL	6.65E-01	6.57E-01	3.53E-04		6.95E-02	3.56E-05	100.00%	100.00%

SUMMARY OF OVERALL EMISSIONS USING CLOSED END PROBE AND CONE PENETROMETER

ISOTOPE	TOTAL POSSESSION QUANTITY CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	3.79E-02	1.11E-05	1.11E-05	2.50E-05	2.77E-10	2.77E-10	0.00%	0.00%
14C	1.05E-02	3.07E-06	3.07E-06	1.90E-03	5.83E-09	5.83E-09	0.00%	0.00%
59Ni	2.53E-02	7.39E-06	7.39E-06	3.10E-04	2.29E-09	2.29E-09	0.00%	0.00%
63Ni	2.46E+00	7.19E-04	7.19E-04	2.60E-04	1.87E-07	1.87E-07	0.00%	0.00%
60Co	4.77E-02	1.39E-05	1.39E-05	2.50E-01	3.48E-06	3.48E-06	0.01%	0.01%
90Sr	1.02E+03	2.98E-01	2.98E-01	1.10E-01	3.27E-02	3.27E-02	49.00%	49.00%
90Y	1.02E+03	2.98E-01	2.98E-01	3.40E-04	1.01E-04	1.01E-04	0.15%	0.15%
93Zr	1.19E-02	3.47E-06	3.47E-06	1.30E-03	4.51E-09	4.51E-09	0.00%	0.00%
99Tc	1.77E-01	5.39E-05	5.39E-05	2.30E-02	1.24E-06	1.24E-06	0.00%	0.00%
106Ru	6.43E-05	2.46E-08	2.46E-08	1.60E-02	3.94E-10	3.94E-10	0.00%	0.00%
125Sb	3.58E-02	1.05E-05	1.05E-05	2.40E-03	2.51E-08	2.51E-08	0.00%	0.00%
126Sn	3.93E-03	1.15E-06	1.15E-06	4.70E-02	5.40E-08	5.40E-08	0.00%	0.00%
129I	8.48E-04	2.48E-07	2.48E-07	2.00E-01	4.95E-08	4.95E-08	0.00%	0.00%
134Cs	7.30E-04	2.13E-07	2.13E-07	1.00E-01	2.13E-08	2.13E-08	0.00%	0.00%
137Cs	9.13E+01	2.67E-02	2.67E-02	2.70E-02	7.20E-04	7.20E-04	1.08%	1.08%
151Sm	9.20E+00	2.69E-03	2.69E-03	7.50E-04	2.01E-06	2.01E-06	0.00%	0.00%
152Eu	2.04E-02	5.95E-06	5.95E-06	2.40E-01	1.43E-06	1.43E-06	0.00%	0.00%
154Eu	4.28E-01	1.25E-04	1.25E-04	2.00E-01	2.50E-05	2.50E-05	0.04%	0.04%
155Eu	1.29E+00	3.76E-04	3.76E-04	8.00E-03	3.01E-06	3.01E-06	0.00%	0.00%
226Ra	1.82E-06	5.31E-10	5.31E-10	4.60E-01	2.44E-10	2.44E-10	0.00%	0.00%
228Ra	9.46E-05	2.76E-08	2.76E-08	1.90E-01	5.25E-09	5.25E-09	0.00%	0.00%
227Ac	2.24E-05	6.55E-09	6.55E-09	1.50E+01	9.83E-08	9.83E-08	0.00%	0.00%
229Th	3.83E-06	1.12E-09	1.12E-09	1.60E+01	1.79E-08	1.79E-08	0.00%	0.00%
232Th	3.75E-06	1.09E-09	1.09E-09	8.00E+00	8.76E-09	8.76E-09	0.00%	0.00%
231Pa	2.33E-05	6.81E-09	6.81E-09	1.20E+01	8.17E-08	8.17E-08	0.00%	0.00%
232U	2.90E-04	8.45E-08	8.45E-08	1.10E+01	9.30E-07	9.30E-07	0.00%	0.00%
233U	1.11E-03	3.25E-07	3.25E-07	3.10E+00	1.01E-06	1.01E-06	0.00%	0.00%
234U	2.20E-02	6.41E-06	6.41E-06	3.10E+00	1.99E-05	1.99E-05	0.03%	0.03%
235U	9.72E-04	2.84E-07	2.84E-07	3.00E+00	8.51E-07	8.51E-07	0.00%	0.00%
236U	2.25E-04	6.56E-08	6.56E-08	2.90E+00	1.90E-07	1.90E-07	0.00%	0.00%
238U	2.21E-02	6.46E-06	6.46E-06	2.80E+00	1.81E-05	1.81E-05	0.03%	0.03%
237Np	1.75E-04	5.11E-08	5.11E-08	1.20E+01	6.13E-07	6.13E-07	0.00%	0.00%
238Pu	1.08E-01	3.17E-05	3.17E-05	7.60E+00	2.41E-04	2.41E-04	0.36%	0.36%
239Pu	9.89E+00	2.89E-03	2.89E-03	8.20E+00	2.37E-02	2.37E-02	35.43%	35.43%
240Pu	1.04E+00	3.05E-04	3.05E-04	8.20E+00	2.50E-03	2.50E-03	3.74%	3.74%
241Pu	6.17E+00	1.80E-03	1.80E-03	1.30E-01	2.34E-04	2.34E-04	0.35%	0.35%
242Pu	2.95E-05	8.63E-09	8.63E-09	7.80E+00	6.73E-08	6.73E-08	0.00%	0.00%
241Am	1.72E+00	5.02E-04	5.02E-04	1.30E+01	6.52E-03	6.52E-03	9.76%	9.76%
243Am	3.82E-05	1.12E-08	1.12E-08	1.30E+01	1.45E-07	1.45E-07	0.00%	0.00%
242Cm	1.34E-02	3.92E-06	3.92E-06	4.10E-01	1.61E-06	1.61E-06	0.00%	0.00%
243Cm	4.68E-04	1.37E-07	1.37E-07	8.50E+00	1.16E-06	1.16E-06	0.00%	0.00%
244Cm	4.36E-03	1.27E-06	1.27E-06	6.70E+00	8.53E-06	8.53E-06	0.01%	0.01%
TOTAL	2.16E+03	6.32E-01	6.32E-01		6.68E-02	6.68E-02	100.00%	100.00%

SUMMARY OF OVERALL EMISSIONS USING TRADITIONAL CABLE TOOL AND SONIC DRILLING

ISOTOPE	TOTAL POSSESSION QUANTITY CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	1.16E-02	1.16E-05	1.16E-05	2.50E-05	2.91E-10	2.91E-10	0.00%	0.00%
14C	3.22E-03	3.22E-06	3.22E-06	1.90E-03	6.13E-09	6.13E-09	0.00%	0.00%
59Ni	7.77E-03	7.77E-06	7.77E-06	3.10E-04	2.41E-09	2.41E-09	0.00%	0.00%
63Ni	7.56E-01	7.56E-04	7.56E-04	2.60E-04	1.96E-07	1.96E-07	0.00%	0.00%
60Co	1.46E-02	1.46E-05	1.46E-05	2.50E-01	3.66E-06	3.66E-06	0.01%	0.01%
90Sr	3.13E+02	3.13E-01	3.13E-01	1.10E-01	3.44E-02	3.44E-02	49.00%	49.00%
90Y	3.13E+02	3.13E-01	3.13E-01	3.40E-04	1.06E-04	1.06E-04	0.15%	0.15%
93Zr	3.65E-03	3.65E-06	3.65E-06	1.30E-03	4.74E-09	4.74E-09	0.00%	0.00%
99Tc	5.52E-02	5.66E-05	5.66E-05	2.30E-02	1.30E-06	1.30E-06	0.00%	0.00%
106Ru	2.59E-05	2.59E-08	2.59E-08	1.60E-02	4.14E-10	4.14E-10	0.00%	0.00%
125Sb	1.10E-02	1.10E-05	1.10E-05	2.40E-03	2.64E-08	2.64E-08	0.00%	0.00%
126Sn	1.21E-03	1.21E-06	1.21E-06	4.70E-02	5.67E-08	5.67E-08	0.00%	0.00%
129I	2.60E-04	2.60E-07	2.60E-07	2.00E-01	5.21E-08	5.21E-08	0.00%	0.00%
134Cs	2.24E-04	2.24E-07	2.24E-07	1.00E-01	2.24E-08	2.24E-08	0.00%	0.00%
137Cs	2.80E+01	2.80E-02	2.80E-02	2.70E-02	7.57E-04	7.57E-04	1.08%	1.08%
151Sm	2.82E+00	2.82E-03	2.82E-03	7.50E-04	2.12E-06	2.12E-06	0.00%	0.00%
152Eu	6.25E-03	6.25E-06	6.25E-06	2.40E-01	1.50E-06	1.50E-06	0.00%	0.00%
154Eu	1.31E-01	1.31E-04	1.31E-04	2.00E-01	2.63E-05	2.63E-05	0.04%	0.04%
155Eu	3.95E-01	3.95E-04	3.95E-04	8.00E-03	3.16E-06	3.16E-06	0.00%	0.00%
226Ra	5.59E-07	5.59E-10	5.59E-10	4.60E-01	2.57E-10	2.57E-10	0.00%	0.00%
228Ra	2.90E-05	2.90E-08	2.90E-08	1.90E-01	5.51E-09	5.51E-09	0.00%	0.00%
227Ac	6.89E-06	6.89E-09	6.89E-09	1.50E+01	1.03E-07	1.03E-07	0.00%	0.00%
229Th	1.18E-06	1.18E-09	1.18E-09	1.60E+01	1.88E-08	1.88E-08	0.00%	0.00%
232Th	1.15E-06	1.15E-09	1.15E-09	8.00E+00	9.21E-09	9.21E-09	0.00%	0.00%
231Pa	7.16E-06	7.16E-09	7.16E-09	1.20E+01	8.59E-08	8.59E-08	0.00%	0.00%
232U	8.89E-05	8.89E-08	8.89E-08	1.10E+01	9.78E-07	9.78E-07	0.00%	0.00%
233U	3.41E-04	3.41E-07	3.41E-07	3.10E+00	1.06E-06	1.06E-06	0.00%	0.00%
234U	6.74E-03	6.74E-06	6.74E-06	3.10E+00	2.09E-05	2.09E-05	0.03%	0.03%
235U	2.98E-04	2.98E-07	2.98E-07	3.00E+00	8.95E-07	8.95E-07	0.00%	0.00%
236U	6.89E-05	6.89E-08	6.89E-08	2.90E+00	2.00E-07	2.00E-07	0.00%	0.00%
238U	6.79E-03	6.79E-06	6.79E-06	2.80E+00	1.90E-05	1.90E-05	0.03%	0.03%
237Np	5.37E-05	5.37E-08	5.37E-08	1.20E+01	6.45E-07	6.45E-07	0.00%	0.00%
238Pu	3.33E-02	3.33E-05	3.33E-05	7.60E+00	2.53E-04	2.53E-04	0.36%	0.36%
239Pu	3.04E+00	3.04E-03	3.04E-03	8.20E+00	2.49E-02	2.49E-02	35.43%	35.43%
240Pu	3.20E-01	3.20E-04	3.20E-04	8.20E+00	2.63E-03	2.63E-03	3.74%	3.74%
241Pu	1.89E+00	1.89E-03	1.89E-03	1.30E-01	2.46E-04	2.46E-04	0.35%	0.35%
242Pu	9.07E-06	9.07E-09	9.07E-09	7.80E+00	7.07E-08	7.07E-08	0.00%	0.00%
241Am	5.27E-01	5.27E-04	5.27E-04	1.30E+01	6.86E-03	6.86E-03	9.76%	9.76%
243Am	1.17E-05	1.17E-08	1.17E-08	1.30E+01	1.53E-07	1.53E-07	0.00%	0.00%
242Cm	4.12E-03	4.12E-06	4.12E-06	4.10E-01	1.69E-06	1.69E-06	0.00%	0.00%
243Cm	1.44E-04	1.44E-07	1.44E-07	8.50E+00	1.22E-06	1.22E-06	0.00%	0.00%
244Cm	1.34E-03	1.34E-06	1.34E-06	6.70E+00	8.97E-06	8.97E-06	0.01%	0.01%
TOTAL	6.64E+02	6.64E-01	6.64E-01		7.03E-02	7.03E-02	100.00%	100.00%

DOE/RL-99-34
UC-630

Notice of Construction for Tank Waste Remediation System Vadose Zone Characterization

Date Published
May 1999

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for Public Release

RELEASE AUTHORIZATION

Document Number:	DOE/RL-99-34, Rev. 0
Document Title:	Notice of Construction for Tank Waste Remediation System Vadose Zone Characterization

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Printed in the United States of America.

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CONTENTS

1.0 INTRODUCTION 1

2.0 FACILITY LOCATION (REQUIREMENT 1) 2

3.0 RESPONSIBLE MANAGER (REQUIREMENT 2) 2

4.0 TYPE OF PROPOSED ACTION (REQUIREMENT 3) 2

5.0 STATE ENVIRONMENTAL POLICY ACT (REQUIREMENT 4) 3

6.0 PROCESS DESCRIPTION (REQUIREMENT 5) 3

7.0 ANNUAL POSSESSION QUANTITY AND PHYSICAL FORM (REQUIREMENTS 8, 10, and 11) 5

8.0 ABATEMENT TECHNOLOGY AND CONCEPTUAL DRAWING(S) (REQUIREMENTS 6 AND 7) 6

9.0 MONITORING SYSTEM (REQUIREMENT 9) 7

10.0 RELEASE RATES (REQUIREMENTS 12 AND 13) 8

11.0 OFFSITE IMPACT (REQUIREMENTS 14 AND 15) 9

12.0 COST FACTORS AND FACILITY LIFETIME (REQUIREMENTS 16 AND 17) 10

13.0 TECHNOLOGY STANDARDS (REQUIREMENT 18) 10

14.0 REFERENCES 10

ATTACHMENTS

A INSTRUCTIONS FOR BOREHOLE SAMPLING (WHC-SD-EN-AP-181, REV. 0) ..... ATT A-i

B TANK INVENTORY DATA ..... ATT B-i

C TANK ISOTOPE TO CESIUM-137 RATIOS ..... ATT C-i

D ANNUAL POSSESSION QUANTITY ..... ATT D-i

E POTENTIAL-TO-EMIT ASSUMPTIONS AND CALCULATIONS DRILLING BOREHOLES ..... ATT E-i

F POTENTIAL-TO-EMIT ASSUMPTIONS AND CALCULATIONS CLOSING BOREHOLES AND REMOVING CASING ..... ATT F-i

ATTACHMENTS (cont)

G SUMMARY OF POTENTIAL-TO-EMIT ASSUMPTIONS DRILLING BOREHOLES/CLOSING BOREHOLES AND REMOVING CASING ..... ATT G-i

H POTENTIAL-TO-EMIT EXAMPLE CALCULATION ..... ATT H-i

I TWRS ALARACT DEMONSTRATION FOR PACKAGING AND TRANSPORTATION OF EQUIPMENT AND VEHICLES ..... ATT I-i

J DISCUSSION OF BEST AVAILABLE RADIONUCLIDE CONTROL TECHNOLOGY ..... ATT J-i

FIGURE

Figure 1. Process Flow Diagram 12

TABLES

Table 1. Facility Locations. 2
Table 2. Average Allowable Concentrations of Cs-137. 9

NOTICE OF CONSTRUCTION FOR TANK WASTE REMEDIATION SYSTEM VADOSE ZONE CHARACTERIZATION

1.0 INTRODUCTION

The following description and any attachments and references are provided to the Washington State Department of Health (WDOH), Division of Radiation Protection, Air Emissions & Defense Waste Section as a notice of construction (NOC) in accordance with Washington Administrative Code (WAC) 246-247, Radiation Protection – Air Emissions. The WAC 246-247-060, "Applications, registration, and licensing", states "This section describes the information requirements for approval to construct, modify, and operate an emission unit. Any NOC requires the submittal of information listed in Appendix A." Appendix A (WAC 246-247-110) lists the requirements that must be addressed.

Additionally, the following description, attachments and references are provided to the U.S. Environmental Protection Agency (EPA) as an NOC, in accordance with Title 40 Code of Federal Regulations (CFR), Part 61, "National Emission Standards for Hazardous Air Pollutants." The information required for submittal to the EPA is specified in 40 CFR 61.07. The potential emissions from this activity are estimated to provide less than 0.1 millirem/year total effective dose equivalent (TEDE) to the hypothetical offsite maximally exposed individual (MEI), and commencement is needed within a short time frame. Therefore, this application is also intended to provide notification of the anticipated date of initial startup in accordance with the requirement listed in 40 CFR 61.09(a)(1), and it is requested that approval of this application will also constitute EPA acceptance of this initial start-up notification. Written notification of the actual date of initial startup, in accordance with the requirement listed in 40 CFR 61.09(a)(2) will be provided at a later date.

This NOC covers the activities associated with vadose zone characterization within the Single-Shell Tank Farms located in the 200-East and 200-West Areas of the Hanford Site. Vadose zone characterization activities include the drilling and sampling of soil from the surface to the depth of groundwater.

For the various characterization options covered under this NOC, the maximum TEDE to the hypothetical MEI is 7.03E-02 millirem per year.

2.0 FACILITY LOCATION (REQUIREMENT 1)

U. S. Department of Energy, Office of River Protection
825 Jadwin Avenue
P.O. Box 550
Richland, Washington 99352-3562

Vadose zone characterization work may be performed in any of the single-shell tank farms. The following is a listing of coordinates for the individual single-shell tank farms based on the location of a tank within the farm (center location if data was readily available) or an average of two tank coordinates that would result in a location near the center of the farm.

Table 1. Facility Locations.

Tank Farm	Latitude	Longitude	Reference Tank(s)
241-A	46° 33′ 11.6″ N	119° 31′ 2.3″ W	Average 241-A-103 & -104
241-AX	46° 33′ 15.7″ N	119° 31′ 29.6″ W	Average 241-AX-101 & -104
241-B	46° 33′ 52.3″ N	119° 32′ 13.9″ W	241-B-108
241-BX	46° 33′ 54.0″ N	119° 32′ 23.2″ W	Average 241-BX-101 & -112
241-BY	46° 33′ 58.5″ N	119° 32′ 36.1″ W	Average 241-BY-101 & -112
241-C	46° 33′ 28.2″ N	119° 31′ 12.0″ W	241-C-108
241-S	46° 32′ 22.9″ N	119° 37′ 88.8″ W	Average 241-S-101 & -112
241-SX	46° 32′ 13.7″ N	119° 37′ 43.0″ W	241-SX-113
241-T	46° 33′ 35.7″ N	119° 37′ 43.1″ W	241-T-108
241-TX	46° 33′ 20.0″ N	119° 37′ 44.9″ W	241-TX-110
241-TY	46° 33′ 26.4″ N	119° 37′ 45.6″ W	Average 241-TY-101 & -106
241-U	46° 32′ 41.9″ N	119° 37′ 43.7″ W	241-U-108

3.0 RESPONSIBLE MANAGER (REQUIREMENT 2)

The responsible manager for the activities described under this NOC is as follows:

Mr. R. T. French, Manager
U.S. Department of Energy, Office of River Protection
P.O. Box 550
Richland, Washington 99352
(509) 376-7591

4.0 TYPE OF PROPOSED ACTION (REQUIREMENT 3)

The proposed action results in the construction of new minor emission units. These will not represent significant modifications.

5.0 STATE ENVIRONMENTAL POLICY ACT (REQUIREMENT 4)

The proposed action is categorically exempt from the requirements of the State Environmental Policy Act under WAC 197-11-845.

6.0 PROCESS DESCRIPTION (REQUIREMENT 5)

To accomplish the goals of the vadose zone characterization program, there will be a need to perform subsurface sampling within selected single-shell tank farms identified in Table 1. Subsurface sampling and drilling techniques will be performed using the guidance document contained in Attachment A.

Up to ten equivalent boreholes may be drilled per year (consecutive 12-month period) by the methods described in this section of the NOC. An equivalent borehole for the purposes of this NOC is assumed to have a nominal top diameter of 10 inches for the first 50 feet and a nominal bottom diameter of 8 inches for the remaining 200 feet of pipe (average depth is 250 feet). Additionally, an equivalent borehole is assumed to contain a contaminated layer 20 feet long in the 10-inch portion of the equivalent borehole. Each of the proposed subsurface sampling and drilling methods has the potential to emit radionuclides into the air. Individual methods are to be selected based on the likely level (concentration) of contaminants to be encountered. The highest levels of contamination occur closest to the tanks; however, as the depth below the tank increases, the levels of contamination decrease substantially. The most conservative drilling approach (lowest potential to emit) will be applied first. Borehole logging will be used to determine when it is appropriate to apply drilling techniques that may have a higher potential to emit. Zones not sampled during advancement of the borehole due to having a high potential to exceed exposure guidelines may be sampled by various side-wall sampling techniques as the boreholes are decommissioned.

The most aggressive (greatest potential for particulate generation) option for drilling equivalent boreholes will involve the use of an air rotary type drill. The air rotary type drill is expected to suspend particulate matter into the cyclone and the torit®[1] (process equipment for material recovery) shown in Figure 1. According to the manufacturer, the torit has an efficiency of 99.96% for particulates with a median diameter of 0.4 microns. No abatement credit is taken for the cyclone or torit.

Samples from air rotary type drilling will be obtained from the "sampling sock" located on the side of the cyclone and/or from the drums underneath the cyclone and torit (see, Figure 1). The "sampling sock" is a polyethylene (or similar air tight material) bag that will catch material for chemical and radiochemical analyses. Geological description samples will be obtained from the drums. The drums will be labeled to allow correlating the material level in the drum to the depth in the borehole where the material resided. The material in the drums will be sampled by pulling a mini-core from the drum. Sampling and change-out of the drums will performed inside the containment structure with continuous HPT coverage. The radioactive material in the drums is expected to be at a very low level as assured by the administrative limits in Section 7.0 for use of the air rotary type drilling method.

Other possible borehole drilling techniques that may be used are briefly described below.

- Sonic drilling - a non-air assisted drill and drive system that mechanically removes the cuttings in a vibrated core barrel set up. The core barrel is vibrated down. This captures the soils in the barrel, the

[1] Torit is a registered trademark of Donaldson Company, Inc. – Minneapolis, MN

barrel is removed and extruded, the casing is advanced by vibration and the whole process is repeated.

- Closed end probe - a casing with closed end is driven into the ground by a number of methods- pile driver (percussion), vibrated (sonic), air hammer (driven from inside of the pipe by an air driven hammer, the circulation air is not in contact with the soil and therefore is not contaminated). At the maximum depth, the end of the probe is removed (either unscrewed or milled-drilled out) and the probe is extracted. Sampling is accomplished by rotating and driving a small sampler into the sidewall of the borehole as the probe is extracted. No air or circulating fluid is utilized for this sampling process. Several telescoped lengths of probe may be utilized to achieve total depth for this method.

- Traditional cable tool drilling from top to bottom. A core barrel is driven into the soil by mechanical impact, the barrel is removed, emptied and the casing is driven down by impact at surface. When the barrel is removed from the ground, the barrel is sleeved into plastic and the bottom is tied off. The barrel is then placed into the drum, the exterior of the barrel is hit with a hammer or other hard object to dislodge the soil into the plastic sleeving. The plastic sleeving is removed from the barrel, tied off at the top and placed into the drum. The soil samples from this activity will be contained in the plastic sleeving.

- Cone Penetrometer – consists of a probe containing either instrumentation to measure activity in the ground, or a soil sampler both of which is pushed into the ground by sheer weight. There is minimal potential for sudden or other air emissions from this technology. The equipment design and operation keeps personnel and environmental exposures to contamination very low (i.e., no drill tailings, no compressed air, pipe is pushed slowly, sensors provide real-time information, soil exposure to the air pathway is extremely minimal).

Other soil sampling techniques will include one or a combination of the following techniques;

- Air Rotary Split Spoon
- Cable Tool
- Cable Tool and Auger with a Split Spoon Core Barrel
- Sonic Core Barrel and Split Spoon
- Rotary Coring
- Sidewall Sampling

With the exception of sidewall sampling, a detailed description of the drilling and sampling techniques are discussed in chapter two of EPA 1993. Sidewall sampling of the borehole involves the use of a "whipstock" located at the end of the casing to deflect a sample tube from the vertical direction and direct it into the surrounding formation (maximum of 8 inches). Once the sample is captured, the drill rod with the sampler attached will be removed form the borehole using the drilling machine. At the surface, the sampler will be bagged or sleeved into plastic after retrieval and packaged in a container suitable for shipment to the laboratory for analysis.

Additionally, a maximum of 10 equivalent boreholes will be closed per year (boreholes with casing removal). For casing removal, the casing will be pulled into plastic sleeving. The casing will be cut into segments (nominal length of 10 feet) below the sleeving using a wheel cutter. The wheel cutter, similar to a tubing cutter, does not use a high-speed blade. Approximately one foot of casing will be exposed to the air during the cutting process. Cuttings will be captured in a draped plastic. The cut pieces of casing will be capped with plastic or the sleeving will be horsetailed and placed in a burial box. Using a tremie, the hole will be backfilled with clean (non-radioactive) materials (e.g., granular bentonite and/or grout). A

tremie is an apparatus that consists of a hopper or funnel at the top (ground level) end and a long metal tube for placing fill materials directly on the bottom of the borehole. Using a tremie reduces void spaces while backfilling the hole and reduces the potential to resuspend contaminated particulates. Casing removal activities will be performed outside of the containment structure. The closure of the equivalent boreholes may also be performed by backfilling the borehole using a tremie without pulling the casing.

7.0 ANNUAL POSSESSION QUANTITY AND PHYSICAL FORM
(REQUIREMENTS 8, 10, AND 11)

The annual possession quantity (APQ) was estimated based on drilling and closing ten equivalent boreholes per year with the soil containing an average of 330 microcuries of Cs-137 per gram of soil. The 330 microcuries of Cs-137 per gram of soil is based on a 100 percent saturation of the soil pore space (30 percent total porosity) by a waste solution (BNWL 1966). [Based on previous soil characterization activities, the highest actual measured Cs-137 concentration in the soil was 100 microcuries (100,000 nanocuries) per gram of soil (BNWL 1966).]

Other isotopes may have higher off-site dose consequences and they have been accounted for; however, Cs-137 was selected as the base isotope since it is readily detected in the soil. Attachment B provides a listing of known or assumed leaking tanks (HNF 1998) and the corresponding tank inventory from the database in the Tank Waste Information Network System 2 which is available on the internet (http://twins.pnl.gov:8001). A ratio of each isotope to Cs-137, based on curies, was calculated for each tank as shown in Attachment C. A comparison of the curie ratio for each isotope in each tank was performed with the average value being considered representative of the extent of soil contamination for other isotopes.

As shown in Attachment D, a maximum of 10 equivalent boreholes may be drilled per year. Each equivalent borehole will have a nominal top diameter of 10 inches for the first 50 feet and a nominal bottom diameter of 8 inches for the remaining 200 feet of boring (average depth is 250 feet). As a result of drilling, the soil has been observed to expand approximately 15% over what would be calculated based strictly on the volume of the equivalent borehole since the soil is no longer compacted. Based on previous drilling experience, the average vertical range of soil contamination is assumed to span an average of 20 feet per equivalent borehole (HNF 1999a). For conservatism, all contamination is assumed to occur in the 10-inch diameter section of the equivalent borehole.

Based on the previous assumptions, approximately 112 cubic feet of soil is removed per equivalent borehole. An estimated 13 cubic feet of the soil per equivalent borehole is assumed contaminated. Using the average isotope ratios multiplied by 330 microcuries of Cs-137 (average) per gram of soil and the total weight of soil [based on an average density of 97.5 pounds per cubic foot for loose dry sand and gravel, (Avallone and Baumeister)] the APQ of each isotope for drilling has been provided in Attachment D.

The APQ associated with the closure of 10 equivalent boreholes has also been provided in Attachment D. Under field conditions, the soil column abrasively scrubs the outside of the casing free of a soil layer leaving a few patches (up to 15% of the exposed surface area) of soil on the casing material (DSI 99b). The thin soil patches were assumed to consist of a thickness of 1/64-inch with the worst case composition of 330 microcuries of Cs-137 per gram of soil. For conservatism an additional 10% was added to the exterior contamination on the casing to account for any potential contamination on the interior of the casing. For boreholes that do not require casing removal, the APQ is assumed to be zero since the APQ was included in constructing the borehole.

A summary of the total APQ associated with the installation and closure of 10 equivalent boreholes per year has been provided in Attachment D (4.38E+04 curies per year). All isotopes are assumed to be in the form of particulate solids or liquids.

8.0 ABATEMENT TECHNOLOGY AND CONCEPTUAL DRAWING(S)
(REQUIREMENTS 6 AND 7)

Emissions from air rotary drilling activities will be contained using an active ventilation system attached to the process equipment and a passive vent system attached to the process equipment containment structure. The active ventilation system will have radioactive air emissions abated by one stage of high efficiency particulate air (HEPA) filter. The HEPA filter located downstream of the will be tested to provide a minimum collection efficiency of 99.95 percent for particulates with a median diameter of 0.3 microns. The containment structure will have a passive HEPA type filter that will provide high efficiency collection.

The average volumetric flowrate from the compressor to the equivalent borehole is estimated to be 1.2 cubic meters per second (2,400 cubic feet per minute) with approximately 0.6 cubic meters per second (1,200 cubic feet per minute) returning out the borehole into the cyclone. The difference in the flowrate is attributed to the soil column absorbing a fraction of the air volume which is gradually released into the process and abatement control equipment after the compressor is turned off.

The exhaust fan will have a maximum average velocity of 0.85 cubic meters per second (1,800 cubic feet per minute) with a range of 0.6 to 1.2 cubic meters per second (1,200 to 2,400 cubic feet per minute) to maintain the ducting between the cyclone and the HEPA filter at atmospheric or less than atmospheric pressure. The drill rig will be sealed to the casing so that particulates will be contained and routed to the process equipment (e.g., cyclone and torit) located inside the plastic containment structure. The flange on the well discharge head and on the inlet of the cyclone will be double flanged to reduce the potential for an unabated release to the atmosphere. Additionally, the flexible line connecting the well discharge head and the cyclone will be encased by another flexible line. The flexible encasement line and flanges will also be vented to the cyclone. The plastic containment structure surrounding the process control equipment will be fitted with one stage of HEPA type filtration. Figure 1 is a conceptual drawing of the proposed system.

When the borehole has been completed and the process equipment is ready to be removed, equipment will be broken down at the disconnect points and contaminated equipment openings will be sealed or plugged to minimize the spread of contamination. All work related to disconnecting and moving the equipment will be performed in accordance with TWRS as low as reasonably achievable control technology (ALARACT) demonstration number 12 (HNF-1999b), "TWRS ALARACT Demonstration for Packaging and Transportation of Equipment & Vehicles" (Attachment I).

Emission controls to be used during sonic drilling, cable tool drilling, cone penetrometer, use of the closed end probe, and casing removal will be decontamination by non-aggressive manual methods such as wiping, sleeving into plastic or having fixatives applied to prevent the spread of contamination if the smearable contamination levels are greater than 100,000 disintegrations per minute per 100 square centimeters for beta/gamma or 2,000 disintegrations per minute per 100 square centimeters for alpha.

During cable tool drilling, when the barrel is removed from the ground, the barrel will be sleeved into plastic and the bottom will be tied off. During sample removal, the exterior of the barrel is hit with a hammer or other hard object, the moist soil will dislodge into the plastic sleeving with minimal potential for emissions. The soil samples from this activity will remain in the plastic sleeving after the sleeving is

removed from the barrel. In the event that the soil does not dislodge from the barrel, the entire barrel will remain in the sleeving and the barrel will be placed in a suitable closed container for shipment to the laboratory or placed in a closed burial box.

Additionally, all other sample containers will be wrapped in plastic after retrieval and the casing will be sleeved into plastic during the removal process to prevent the spread of contamination.

A wind speed restriction of 20 miles per hour will be applied to drilling, sampling and casing removal work. This criterion applies to sustained wind speeds as determined by the Hanford Meteorological Station. The radiological conditions associated with the work activities will be controlled by following a radiation work package (RWP). Continuous Health Physics Technician coverage will be provided while drilling, sampling and removing casing.

9.0 MONITORING SYSTEM (REQUIREMENT 9)

Periodic confirmatory monitoring of emissions from borehole drilling using the air rotary drilling technique will be accomplished by a destructive or non-destructive analysis of the record filter combined with radiological field surveys during the work. The record filter, located downstream of the active ventilation HEPA filter, will receive all flow from the first filter and will have a minimum efficiency of 90 percent for particulates with a median diameter of 0.3 microns as specified by the manufacturer. The radiological analyses from the soil samples will be averaged to determine the isotopic distribution of Strontium-90 (Sr-90), Cs-137, Plutonium-239 (Pu-239) and Americium (Am-241). Sr-90, Pu-239 and Am-241 are the isotopes estimated to potentially contribute greater than 10% of the unabated offsite dose; whereas, Pu-239 and Sr-90 are the isotopes estimated to contribute greater than 25% of the offsite dose due to abated emissions. The record filter will be counted using a gamma spectrometer calibrated to Cs-137. Counting will be done annually using either a destructive or non-destructive technique.

The soil sample isotope ratios discussed above will be applied to Cs-137 on the record filter to confirm low emissions instead of the ratios used in Attachment C. The actual soil sample isotopic ratios are expected to be less than the overly conservative ratios contained within Attachment C since Pu-239 and Am-241 are not as soluble and will not transport through the entire leak plume as readily as Cs-137. The proposed periodic confirmatory method is capable of providing the required detection levels to verify low emissions. In addition, the HEPA filter housing will be field surveyed after the completion of each borehole to verify low emissions.

Periodic confirmatory monitoring of the passive HEPA type filter will be accomplished by performing a field survey of the filter housing to confirm low emissions. The field survey of the passive HEPA type filter will be performed after the completion of each borehole.

Fugitive emissions may result from cable tool and sonic drilling, use of the closed end probe and the cone penetrometer, the plastic containment structure during air rotary drilling, and during dismantlement/assembly or relocating the ventilation equipment, plastic containment structure, or process equipment. To confirm low emissions, periodic confirmatory monitoring will be accomplished by operating three fixed head samplers around the location of where the drilling and sampling operations are occurring. The fixed head samplers will be located within 100 feet of where the drilling and sampling work activities are occurring and will be operated whenever the work activities have the potential to emit radionuclides. After packaging the equipment and samples for shipment, Health Physics Technicians will perform surveys (swipes for removable contamination) in accordance with TWRS as low as reasonably achievable control technology (ALARACT) demonstration number 12 (HNF-1999b), "TWRS ALARACT Demonstration for Packaging and Transportation of Equipment & Vehicles" (Attachment I).

Fugitive emissions may also result from removing casing from the ground. To confirm low emissions, periodic confirmatory monitoring will be accomplished by operating three fixed head samplers around the location of the work activities. The fixed head samplers will also be located with 100 feet of where the casing removal activities are occurring and will be operated when the work activities have the potential to emit radionuclides.

10.0 RELEASE RATES (REQUIREMENTS 12 AND 13)

Up to ten equivalent boreholes may be drilled by the methods previously described in the NOC. Each of the proposed methods has the potential to emit radionuclides into the air. Individual methods are to be selected based on the highest concentration of contaminants likely to be encountered. The highest levels of contamination occur closest to the tanks. As the depth below the tank increases, the levels of contamination decrease substantially. Of the methods considered for use, the most conservative drilling approach (lowest potential to emit) will be applied first. Borehole logging will be used to determine when it is appropriate to apply drilling techniques that may have a higher potential to emit. Zones not sampled during advancement of the borehole due to having a high potential to exceed occupational exposure guidelines, may be sampled by various side-wall sampling techniques as the boreholes are decommissioned.

Based on the methods of drilling and the total APQ discussed in Section 7.0, handling limits were calculated for each of the available drilling methods to ensure that the estimated TEDE to the hypothetical MEI remains less than 0.08 millirem per 12 month consecutive period. Drilling method selection and subsequent monitoring of excavated material will define the number of boreholes that may be drilled in any year. The estimated emissions associated with the different drilling techniques are located in Appendix E. The assumptions used to estimate the emissions associated with the various drilling techniques and the administrative limits are discussed below.

Air Rotary – The administrative average handling limit is 5.0 nanocuries of cesium-137 (Cs-137) per gram of soil which results in a total handling limit of 2.8E-02 curies of Cs-137 per year. The administrative limit is based on previous drilling experience where the average vertical range of soil contamination is assumed to span an average of 20 feet per equivalent borehole (HNF 1999a). Using the average isotope ratios multiplied by the administrative average limit of 5.0 nanocuries of Cs-137 per gram of soil and the total weight of soil [based on an average density of 97.5 pounds per cubic foot for loose dry sand and gravel (Avallone and Baumeister)], the total annual handling limit and estimated emission for each isotope has been provided in Attachment E.

Cable Tool and Sonic Drilling – The administrative average handling limit is 5.0 microcuries of Cs-137 per gram of soil (total combined handling limit of 28 curies of Cs-137 per year). The total annual handling limit for the cable tool and sonic drilling were calculated similar to that for air drilling since all the material will be removed from the equivalent borehole and brought to the surface. Using the average isotope ratios multiplied by the administrative average limit of 5.0 microcuries of Cs-137 per gram of soil and the total weight of soil [based on an average density of 97.5 pounds per cubic foot for loose dry sand and gravel (Avallone and Baumeister)], the total annual handling limit for each isotope has been provided in the Attachment E.

Closed End Probe and Cone Penetrometer – The administrative handling limit was conservatively estimated based on the soil containing an average of 330 microcuries of Cs-137 per gram of soil (total combined annual handling limit of 71.8 curies of Cs-137 per year). The 330 microcuries of Cs-137 per gram of soil is based on a 100 percent saturation of the soil pore space (30 percent total porosity) by a

waste solution (BNWL 1966). The annual handling limit for the closed end probe and the cone penetrometer is based on the contaminated soil volume brought to the surface which occurs during sampling. These emissions are contained within Attachment E and assume the equivalent of 10, 4-inch diameter by 2 feet long (approximately 1.75 cubic feet) samples, with 25% of the sample (0.44 cubic feet) being contaminated with the worst case composition of 330 microcuries of Cs-137 per gram of soil.

Attachment F contains the estimated emissions associated with the closure of 10 equivalent boreholes. For boreholes that do not require casing removal, the emissions of radionuclides is assumed to be equal to zero since the radioactive material available for release was included in constructing the borehole.

Attachment G contains a summary of the emissions associated with the installation and closure of 10 equivalent boreholes per year using the air rotary method, the cable tool /sonic drilling, and the closed end probe/cone penetrometer. An example calculation has been provided in Attachment H.

The average soil concentration used to derive the emissions estimates discussed above is based on the total amount of Cs-137 in the actual borehole divided by the estimated volume of contaminated soil in the equivalent borehole (calculated in Appendix E) for the selected method. In the event that fewer than ten equivalent boreholes are drilled, the average limit may be adjusted upwards to match the total annual possession quantity associated with each method. If the limit is reached in fewer than 10 boreholes, no more boreholes may be drilled until the 12 consecutive month period falls below the handling limit. Conversely, if the limit would not be reached after drilling 10 boreholes, additional boreholes may be drilled until the annual handling limit is reached. Table 2 has been included below to demonstrate how the average limit would be adjusted based on drilling one, five, and ten equivalent boreholes per year.

Table 2. Average Allowable Concentrations of Cs-137.

	Estimated Volume of Contaminated Soil Per Equivalent Borehole (Appendix D)	One Borehole Per Year	Two Boreholes Per Year	Ten Boreholes Per Year
Air Rotary Drilling	12.54 cubic feet	5.0E-08 curies per gram of soil	1.0E-08 curies per gram of soil	5.0E-09 curies per gram of soil
Cable Tool or Sonic Drilling	12.54 cubic feet	5.0E-06 curies per gram of soil	5.0E-06 curies per gram of soil	5.0E-06 curies per gram of soil
Closed End Probe or Cone Penetrometer	0.44 cubic feet	3.3E-03 curies per gram of soil	6.6E-04 curies per gram of soil	3.3E-04 curies per gram of soil

11.0 OFFSITE IMPACT (REQUIREMENTS 14 AND 15)

A detailed summary of the estimated potential-to-emit TEDE to the hypothetical MEI for each radionuclide for the various drilling techniques, casing removal activities and overall total summary has been provided in Attachments E, F, and G, respectively. The MEI is 20,200 meters east southeast of the 200-East Area of the Hanford Site.

12.0 COST FACTORS AND FACILITY LIFETIME (REQUIREMENTS 16 AND 17)

Requirement 16 is not applicable because a best available radionuclide control technology (BARCT) demonstration is provided (Attachment J).

The maximum design life of the project is twenty years (July 15, 2019).

13.0 TECHNOLOGY STANDARDS (REQUIREMENT 18)

For air rotary drilling, the HEPA filter performance standards of ASME/ANSI N510, Section 10.5 will be met. The powered HEPA filter will have a minimum efficiency of 99.95 per cent for particles with a median diameter of 0.3 microns. ASME/ANSI AG-1 for the HEPA filter will be met as documented in a letter from the U.S. Department of Energy, Richland Operations Office, to the Washington State Department of Health (99-EAP-213). Other sections of ASME/ANSI 509 and 510 do not apply to this system due to its temporary configuration. The passive HEPA filter will be factory tested to a minimum efficiency of 99.95 per cent for particles with a median diameter of 0.3 microns and will provide a high efficiency of collection during passive ventilation. The systems will be visually inspected daily during operation and after any relocations to ensure the systems continues to operate as designed. Additionally, line pressure tests will be performed on the line between the well head and the cyclone and line between the torit and the fan prior to starting a new borehole. The line pressure test will be performed in accordance with ASME/ANSI N510.

In accordance with WAC 246-247-075(3), for emission units with a potential-to-emit of less than 0.1 millirem per year TEDE to the MEI, the option exists to estimate radionuclide emissions in accordance with 40 CFR 61 Appendix D, or other approved methods. Additionally, WDOH may require periodic confirmatory measurements during routine operations to verify low emissions. For the air rotary drilling, a destructive or nondestructive analysis of the record filters are proposed to be used for providing periodic confirmatory measurement to verify low emissions. Since the exhaust flow rate will not be needed to determine emissions, 40 CFR 60 Appendix A, Methods 1, 1A, 2, 2A, 2C, 2D, 4, 5, and 17 do not apply. In addition, ANSI N13.1 does not address the record filter system design because a sampling probe will not be used to measure emissions.

The air rotary drilling monitoring method will be compatible with NQA-1 as imposed by NESHAP Quality Assurance Project Plan for Radioactive Airborne Emissions, all of Sections 2.0, 3.0 and 5.0. ANSI/ASME NQA-2 is no longer an active National Standard and has been incorporated into NQA-1.

For cable tool drilling, sonic drilling, closed end probe, cone penetrometer, and casing removal activities, the technology standards do not apply since these will be fugitive emission sources. Emissions will be maintained using BARCT (decontaminating, plastic sleeving and applying fixatives as needed) for contamination controls.

14.0 REFERENCES

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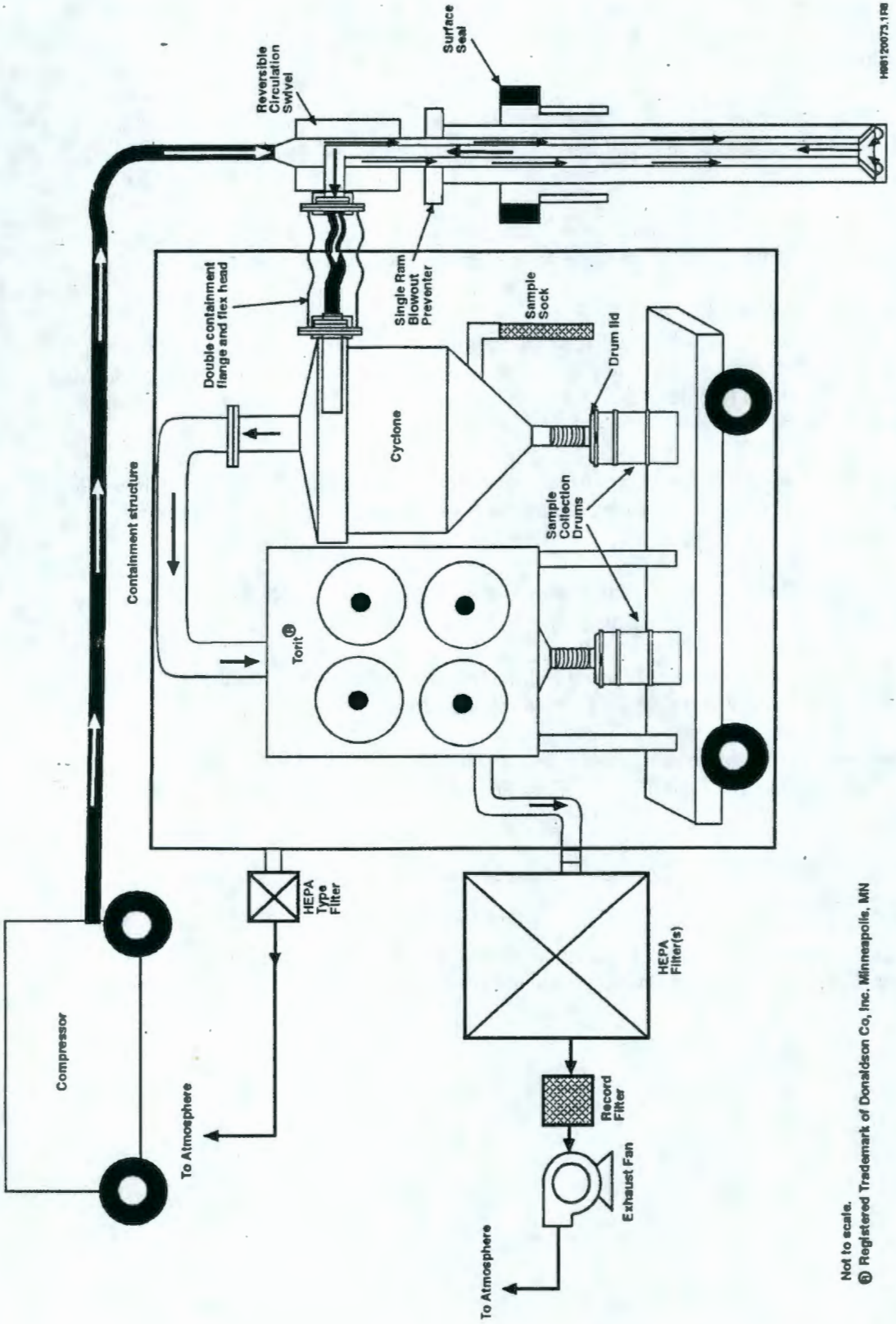

Figure 1. Process Flow Diagram

ATTACHMENT A

INSTRUCTIONS FOR BOREHOLE SAMPLING
(WHC-SD-EN-AP-181, REV. 0)

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INTRODUCTION

Geologic systems generally are complex with physical properties and trends that can be difficult to predict. Subsurface geology (including stratigraphy, mineralogy, geochemistry) exerts a fundamental control on groundwater flow and contaminant transport. Federal and state regulations (Title 40, Code of Federal Regulations (CFR) Part 265.90(a), 40 CFR 265.90(c)(1)(ii), 40 CFR 265.90(2)(i), 40 CFR 265.91(a), Washington Administrative Code (WAC) 173-303-282, WAC 173-303806, WAC 173-200-080, WAC 173-160-050) require characterization of subsurface hydrogeologic conditions to allow for defensible calculations of flow and transport conditions, and to asses the impacts of the geology on groundwater and vadose zone conditions.

The primary source for direct observation of subsurface geologic information is a borehole. However, direct observations from a borehole essentially are limited to the diameter and spacing of boreholes and the quality of the information derived from the drilling. Because it is impractical to drill a borehole every few feet to obtain data, it is necessary to maximize the data gathered during limited drilling operations. A technically defensible balance between the customer's data quality objectives and control of drilling costs through limited drilling can be achieved with proper conduct of operations.

This report presents the minimum criteria for geologic and hydrologic characterization and sampling that must be met during drilling. It outlines the sampling goals that need to be addressed when drilling boreholes, and the types of drilling techniques that work best to achieve these goals under the geologic conditions found at Hanford. This report provides general guidelines for: (1) how sampling methods are controlled by data needs, (2) how minimum sampling requirements change as knowledge and needs change, and (3) when drilling and sampling parameters need to be closely controlled with respect to the specific data needs. Consequently, the report is divided into two sections that center on: (1) a discussion of basic categories of subsurface characterization, sampling, and sampling techniques, and (2) guidelines for determining which drilling and sampling techniques meet required characterization and sampling objectives.

Data quality objectives for subsurface characterization in any given project are established in characterization plans, work plans, data sheets, and similar documentation. The guidelines outlined in this report are used to determine the appropriate drilling and sampling techniques necessary to achieve the stated objectives. This document is not intended to be used to establish the data quality objectives for a specific project, only to aid in achieving them.

SUBSURFACE SAMPLING

Subsurface sampling is the main driving force of any characterization/drilling program. Sampling during drilling can be grouped under general categories which relate to the data needs for a given project. These categories range from no sampling, to basic or gross scale sampling, to intermediate sampling, to detailed analysis. Depending on data needs and project objectives, different scales of sampling effort are necessary. Successful implementation of sampling, regardless of the type, is highly dependant on input from an experienced drilling engineer and the project geologist.

Sampling Categories

The basic rational, typical techniques, and situations for the different categories of sampling are outlined below:

1. No Sampling - In some situations a projects data quality objectives may not involve geologic/physical sampling. Under these circumstances it would be appropriate to not do any geologic sampling.

2. Basic Sampling - Basic sampling (also referred to as gross or grab sampling) is used to provide enough information to identify basic geologic features such as formation, member, and unit and to differentiate between major sediment types or facies. Under some circumstances, these samples also may be adequate for chemical and radiological screening. Basic samples typically consist of cuttings bailed from the borehole and/or removed from an air/fluid circulation stream. The geologist's ability to accurately interpret the geologic features represented by particular cuttings is directly dependant upon drilling factors such as lagtime, hole cleaning, over drilling, and excessive milling. Generally, basic sampling is done in areas were sufficient data already exists to meet project data needs, in areas were only confirmation of the most basic geologic information is needed, and as a scoping tool in areas where reconnaissance or exploratory drilling is being conducted.

3. Intermediate Scale - Intermediate sampling is done in areas where a moderate amount of data already exists and where project goals call for specific, limited technically defendable sampling. Such objectives include, but are not limited to, verification of stratigraphic picks and facies types previously interpreted from cuttings and the collection of certain types of samples for specific analysis. Commonly, this type of characterization may require that samples be called for anytime there is a need to establish a level of control or defensibility not attainable with drill cuttings alone. Appropriate techniques for this sampling would include split spoons, sonic core barrel methods, and rotary coring.

4. Detailed - Detailed sampling, generally in the form of coring (e.g., rotary or sonic), usually is undertaken in areas where there is little

or no accurate data to meet project data quality objectives. These needs range from physical data about formation geologic properties that is only obtainable from intact samples to specific sample requirements for analytical evaluation. Specific sample techniques are controlled by the types of samples needed and the geologic conditions (e.g., cemented vs. uncemented, or gravelly vs. silty).

Establishing Sampling Categories

Determining which sampling category is used during any given project is dependant on a clear definition of the data quality objectives. In order to determine the objectives, one must first evaluate the nature and quality of existing data applicable to a given project. Based on this evaluation specific project data needs (e.g., the data quality objectives) are identified and the requirements for borehole sampling established.

The existing data and data needs are usually identified in characterization and work plans written prior to the beginning of a drilling project. Data sheets for individual wells take the information from the work and characterization plans to identify drilling and sampling goals (e.g. sample categories) for a well, establish the type of sample required, and indicate the approximate sample intervals. The project geologist, in consultation with the client, is responsible for determining overall sampling needs, and the effectiveness and reliability of the samples retrieved during the project.

The following discussion lists two examples of how sampling categories are used in combination to achieve specific data quality objectives:

1. For many projects adequate well coverage and data to address most, if not all, data quality objectives already exists. In these situations new drilling and sampling will center on correlating the geology encountered in the new wells to preexisting wells, and sampling will consist dominantly of category 2 methods. Some category 3 sampling to verify stratigraphic/facies picks will be undertaken if it is determined to be necessary. Occasionally, category 4 sampling will undertaken if site specific data quality objectives must be met. In some cases if no additional information is required no sampling would be needed (i.e., sampling category 1).

2. For some projects little or no data applicable to the project objectives may exist. Consequently, drilling for this project relies heavily on sampling categories 3 and 4 in order to establish site specific data and tie the new site to other, previously characterized locations.

During any given project, the scale of the sampling effort is likely to change. For example, as data from drilling is assimilated, the level of the sampling effort may decrease (e.g., from categories 4 to 3) as data quality objectives are met. Another example of conditions under which a

scale-down in sampling may occur is in situations where drilling conditions are such that intact cores (category 4) simply can not be obtained. Under many circumstances a scale up in sampling effort is necessary. This typically happens when previously unforeseen geologic conditions are encountered during drilling and it is determined that more detailed sampling is necessary to meet the project data quality objectives.

SAMPLING TECHNIQUES

Sampling techniques and sampling categories are closely related and, in practice, essentially inseparable. Inappropriate sampling techniques for the geologic conditions encountered limits the ability to recover a representative sample, and consequently leads to decreased accuracy and reliability in the analysis performed. During subsurface geologic sampling, data needs and formation conditions must be considered when determining the appropriate drilling/sampling techniques to collect the required data.

Tables 1 and 2 compare various field and analytical samples to different drilling techniques to show which techniques are more appropriate for the kind of analysis planned. These comparisons take the form of a yes (Y) or no (N) to show whether a particular drilling method has a reasonable chance of acquiring a sample adequate for a given analysis or data need. In many cases the yes/no response is marked by a number that corresponds to a footnote following the tables. These footnotes list basic considerations that need to be taken into account for the specific drilling techniques and sampling requirements. These considerations center on two fundamental areas of critical importance to the acquisition of representative subsurface samples: (1) geologic or formation conditions, and (2) drilling technique and rig operation.

Table 1 lists the descriptive parameters that well site geologists commonly consider when providing general subsurface geologic descriptions. In addition, the parameters listed in Table 1 generally represent the minimum data requirements necessary for the field geologist to identify subsurface samples that meet sampling criteria established in the characterization plans and data sheets.

Table 2 lists analyses typically done on borehole samples and compares them to the various drilling techniques. This table shows that a number of drilling techniques are not appropriate for the types of analysis requested for many of the samples collected on the Hanford Site. The table can be used to establish the drilling technique needed to acquire samples for the analyses required to meet the project data quality objectives. If the drilling criteria for the specific analyses outlined in Table 2 cannot be met, the data quality objectives for the project will not be met. In such cases the selected drilling/sampling techniques need to be reassessed.

Table 1. Field Criteria

	Auger, solid stem	Cable Tool, HT	Cable Tool and Auger, spl. spoon, core barrel	Sonic core barrel and split spoon	Air Rotary, cuttings	Air Rotary, split spoon	Mud Rotary	Rotary Coring
Relative Moisture (see EII 9.1)	N[2]	N	Y[1]	N[9]	N	Y[6]	N	Y[1]
Cements (Ca, Si, Fe)	Y[10]/N[2]	Y[11]	Y[4]	Y	Y[3,10]	Y[4]	Y[10]	Y
Colors (<1 ft)	N[2]	N	Y	Y/N[5]	Y[3,12]	Y	Y[12]	Y
Lith., textures (1 phi)	N	N	Y[4]	Y/N[5]	Y[3,12]	Y[4]	Y[12]	Y
Lith., bedding (2 ft)[14]	N[13]	N[13]	Y	Y/N[5]	Y[3]	Y	N-uncon. Yconsol/[12]	Y
Mineralogy (±5%)	N[2]	N[6,12]	Y[4]	Y	Y[3]	Y[4]	N	Y

Explanations of parameters used in Table 1.

Cements - The basic nature and characteristics of cementing agents need to be identified because of their fundamental control on hydrologic properties such as high and low flow zones. Cementing agents typically present include calcium carbonate, silica, ferro-magnesium oxides, and muds.

Colors - Color changes are often an important indicator of unit and facies changes. As such they need to be readily identified. Changes in color need to be identified within 1 foot of actual occurrence.

Lith., textures - Lithologic texture essentially refers to grain size. Grain size variations down to 1 phi have to be identifiable in the sand to small pebble range.

Lith., bedding - Resolution of stratigraphic features within 2 ft of their actual occurrence is necessary to identify facies changes important to hydrologic flow systems and to pick major formational and stratigraphic unit contacts.

Mineralogy - In fine-grained sand and larger sizes the field geologist should be able to identify major mineral types (e.g. basalt, quartz, feldspar, micas, etc.) and estimate abundance by volume to ±10%. Below the fine-grained sand size geologist cannot identify mineralogy by hand lens.

Table 2. Analytical Criteria

	Auger, solid stem	Cable Tool, HT	Cable Tool and Auger, spl.spoon, core barrel	Sonic core barrel and split spoon	Air Rotary, Cuttings	Air Rotary, split spoon	Mud Rotary cuttings	Rotary Coring
Moisture	N	N	Y[1]	N[9]	N	Y	N	Y[1,7]
$CaCO_3$, Cements	N[2]	N	Y	Y	Y[3]	Y	Y	Y
Sieve	N[2]	N	Y[4]	Y	N	Y[4]	N	Y
Specific Gravity	N	N	Y[4]	Y/N[5]	N	Y[4]	N	Y
Density, Porosity (>3.5")	N	N	Y[4]	Y/N[5]	N	Y[4]	N	Y
Unsat & Sat K (>3.5")	N	N	Y[4]	Y/N[5]	N	Y[4]	N	Y
Moisture Retention	N	N	Y[4]	Y/N[5]	N	Y[4]	N	Y
XRD Min.	N[2]	N	Y[4,8]	Y	Y[3]	Y[4,8]	Y[3]	Y
XRF Geochem.	N[2]	N	Y[4,8]	Y	Y[3]	Y[4,8]	Y[3]	Y
Thin Sec.	N[2]	N	Y[4,8]	Y	Y[3]	Y[4,8]	Y[3]	Y
Chemical	N[2]	N	Y	Y - nonvol. N - volatile	N	Y	N	Y[7]

Density, Porosity and Unsat. and Sat. K - A minimum 3.5 inch diameter sample needs to acquired on sample runs less than 10 feet long. If sampling runs longer than 10 ft are being done sample minimum diameter will be 2.5 inch.

Footnotes to Tables 1 and 2.

1. If fluid not added.

2. Mixing of cuttings with borehole wall during transport of cuttings up auger flights limits use.

3. Assumes a reasonable lag time of no more than 20% over calculated lag time based on an uphole velocity of 6000 ft/min, less than 1 ft of slough in the borehole, absence of significant overmilled material, and position of drill bit is as per manufacturers spec for the system in use.

4. Best applied in unconsolidated to consolidated muds and sands. Will not work well in gravelly or cemented deposits because driving the sampler into these sediment types will break and fracture formation materials. Anything recovered from the sampler under these circumstances will not be intact.

5. Sonic core barrel samples in many cases show evidence of having expanded at some point during drilling (e.g. rig will drill 5 ft but sample will fill a 10 ft of core barrel). Expansion commonly results in the destruction of bedding features. As yet, the cause and extent of expansion is not clearly understood, making it difficult to determine if many samples are representative of true formation conditions. Whether or not expansion has occurred needs to be determined in order to decide if a yes or no applies.

6. Fines are generated while driving the sampler because of abrasion and breaking of formation materials. Also have to have clean boreholes to insure recovery of representative sample.

7. Mud rotary core may alter.

8. In crystalline and homogeneous sedimentary rocks should work well. In heterogeneous deposits have to assume an ability to separate grains broken during drilling from those that are unbroken. As a consequence, this may only be usable in gravel-poor formations and uncemented strata.

9. Temperatures measured during drilling are too high for reliable estimates of moisture content and sampling of volatile materials.

10. Can use observed differences in drilling responses, e.g. chattering, torque, changing advance rate, bucking, etc; to determine at least the presence or absence of cement.

11. Gross scale observations (changes over several feet), based on advance rate. Small scale features such as individual beds and changes over just a few feet are difficult to identify.

12. Gross scale resolution of such things as beds over several feet thick and formational and member contacts is based on first arrivals of a particular parameter. Small scale features such as individual beds and changes over just a few feet are difficult to identify.

13. The exception is formational and high contrast member/unit contacts that are based on major, large scale parameters such as very different colors, textures, etc.

14. Resolution of bedding is incumbent upon whether or not features are actually present. Knowing this is dependant upon good regional and facies knowledge typically acquired from outcrop analogues and intact cores.

CONCLUSIONS

Accurate subsurface characterization is dependant on the acquisition of representative geologic samples. To acquire such samples, the appropriate drilling technology must be matched to a projects stated data needs. These data needs, presented as part of the data quality objectives, should be found in planning documents (such as the characterization plan, drilling plan, and data sheets) for any given project. The guidelines outlined in this report can then be used by the project staff, in consultation with the client, to determine the specific drilling techniques necessary to obtain the stated data quality objectives for subsurface characterization.

ATTACHMENT B

TANK INVENTORY DATA

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Constituent Name	Units	A-103	A-104	A-105	AX-102	AX-104	B-101	B-103	B-105	B-107	B-110	B-111
3H	Ci	3.00E+02	6.06E-01	9.18E+00	3.24E+01	3.38E+00	3.27E+00	7.67E-01	1.79E+00	3.58E+00	1.48E+00	1.32E+01
14C	Ci	4.92E+00	1.18E+00	1.71E+00	5.10E+00	6.30E-01	5.46E-01	1.41E-01	2.62E-01	6.03E-01	2.81E-01	1.70E+00
59Ni	Ci	3.66E+00	1.18E+01	8.48E+00	1.57E+00	3.12E+00	1.58E+01	1.34E-01	3.12E-01	1.15E-01	1.34E+00	1.16E+01
63Ni	Ci	3.60E+02	1.16E+03	8.52E+02	1.61E+02	3.13E+02	1.57E+03	1.21E+01	2.80E+01	1.04E+01	1.35E+02	1.17E+03
60Co	Ci	2.35E+01	4.85E+02	2.36E+00	6.61E+00	3.47E+02	8.63E-01	2.48E-02	5.80E-02	8.17E+00	3.74E-01	4.12E+00
90Sr	Ci	1.48E+05	2.93E+06	4.71E+06	1.72E+05	2.95E+06	2.23E+03	1.29E+03	6.73E+03	3.81E+04	1.35E+05	2.64E+05
90Y	Ci	1.48E+05	2.93E+06	4.71E+06	1.72E+05	2.95E+06	2.23E+03	1.29E+03	6.73E+03	3.81E+04	1.35E+05	2.64E+05
93Zr	Ci	2.53E+01	2.24E+01	3.68E+01	2.33E+01	1.36E+01	2.15E+01	1.14E-01	2.63E-01	2.89E-01	5.82E+00	5.05E+01
99Tc	Ci	2.36E+02	8.29E+00	1.21E+01	3.77E+01	9.53E+01	3.51E+00	7.90E-01	1.82E+00	1.75E+01	2.07E+01	1.21E+02
106Ru	Ci	1.08E-02	1.33E-03	1.00E-02	5.85E-01	1.01E-02	7.06E-01	9.51E-09	2.29E-08	8.43E-05	4.33E-03	3.76E-02
125Sb	Ci	2.73E+02	4.83E+02	2.42E+02	3.08E+01	2.81E+02	5.16E+00	2.22E-02	5.25E-02	3.03E+00	1.67E+00	1.52E+01
126Sn	Ci	7.94E+00	8.71E+00	1.25E+01	8.35E+00	4.61E+00	7.79E+00	3.61E-02	8.32E-02	8.89E-02	1.98E+00	1.71E+01
129I	Ci	2.64E-03	1.60E-02	2.35E-02	7.28E-02	8.64E-03	6.75E-03	1.49E-03	3.43E-03	7.93E+00	4.50E-02	3.41E-02
134Cs	Ci	5.33E+00	2.00E-01	5.62E-01	5.04E-01	2.07E-01	3.15E-02	5.84E-04	1.43E-03	3.26E+00	8.87E-02	7.74E-01
137Cs	Ci	2.93E+05	7.77E+04	1.73E+05	5.57E+04	6.16E+04	1.59E+04	9.30E+03	2.45E+04	2.17E+04	1.86E+04	1.68E+05
151Sm	Ci	1.85E+04	2.05E+04	2.99E+04	1.55E+04	1.10E+04	1.42E+04	8.95E+01	2.06E+02	2.14E+02	4.73E+03	4.10E+04
152Eu	Ci	7.17E+00	7.85E+00	9.13E+00	2.11E+01	3.36E+00	3.19E+01	1.70E-02	4.04E-02	5.66E-02	1.45E+00	1.25E+01
154Eu	Ci	9.44E+02	2.86E+03	7.37E+03	1.66E+03	1.86E+03	1.57E+03	4.37E-01	1.03E+00	2.99E+01	8.30E+01	1.81E+02
155Eu	Ci	4.35E+02	5.13E+02	6.80E+02	1.03E+03	1.78E+03	1.65E+03	1.36E+00	3.08E+00	4.62E+01	1.08E+02	9.32E+02
226Ra	Ci	2.57E-04	7.65E-04	5.32E-04	2.34E-04	1.96E-04	7.04E-04	8.22E-06	1.58E-05	7.76E-06	8.47E-05	7.29E-04
228Ra	Ci	4.93E-01	8.48E-05	4.81E-09	3.79E-02	1.77E-09	1.47E-08	7.46E-11	1.59E-10	1.06E-02	7.91E-10	2.52E-03
227Ac	Ci	1.51E-03	3.99E-03	2.87E-03	1.14E-03	1.06E-03	3.16E-03	3.79E-05	8.07E-05	9.82E-04	4.56E-04	3.93E-03
229Th	Ci	1.14E-02	3.93E-05	7.51E-07	8.82E-04	2.77E-07	1.73E-06	1.45E-08	3.09E-08	3.78E-04	1.25E-07	5.91E-05
232Th	Ci	5.34E-02	9.15E-06	4.34E-10	3.86E-03	1.60E-10	1.95E-10	3.28E-11	7.54E-11	1.28E-03	7.18E-11	3.11E-04
231Pa	Ci	5.88E-03	5.48E-03	6.46E-03	5.91E-04	2.38E-03	1.98E-04	7.71E-05	1.74E-04	1.51E-03	1.03E-03	8.85E-03
232U	Ci	1.64E+00	5.37E-03	9.88E-08	1.11E-01	4.67E-06	1.92E-05	8.84E-06	6.99E-05	1.16E-05	1.25E-06	2.68E-03
233U	Ci	6.27E+00	2.08E-02	2.33E-09	4.26E-01	1.10E-07	9.89E-07	4.69E-07	3.30E-06	1.17E-05	6.80E-08	1.03E-02
234U	Ci	9.99E-01	1.67E-02	1.22E-03	8.75E-02	5.76E-02	1.14E+00	5.63E-01	3.22E+00	7.35E-01	8.57E-02	6.93E-02
235U	Ci	3.95E-02	6.92E-04	5.08E-05	3.50E-03	2.40E-03	5.10E-02	2.52E-02	1.43E-01	3.31E-02	3.84E-03	3.04E-03
236U	Ci	3.22E-02	4.58E-04	3.32E-05	2.86E-03	1.57E-03	9.08E-03	4.28E-03	3.06E-02	4.69E-03	6.21E-04	8.13E-04
238U	Ci	8.88E-01	1.61E-02	1.19E-03	7.84E-02	5.61E-02	1.16E+00	5.71E-01	3.27E+00	7.45E-01	8.68E-02	7.01E-02
237Np	Ci	1.25E+00	2.62E-02	2.59E-02	1.33E-01	9.54E-03	1.47E-02	4.86E-03	1.12E-02	1.84E-02	1.40E-01	7.61E-02
238Pu	Ci	7.23E+00	1.36E+01	6.78E+00	6.07E+01	1.10E+01	5.41E+01	3.91E-01	1.68E-01	1.67E-01	4.02E+00	3.26E+00
239Pu	Ci	2.40E+02	7.23E+02	1.76E+02	4.15E+02	2.86E+02	5.15E+02	7.06E+01	3.10E+01	5.21E+01	8.96E+01	9.27E+01
240Pu	Ci	4.15E+01	1.14E+02	3.35E+01	1.48E+02	5.45E+01	1.50E+02	5.48E+00	2.38E+00	3.08E+00	9.76E+00	1.59E+01
241Pu	Ci	5.03E+02	9.95E+02	4.83E+02	4.20E+03	7.85E+02	3.75E+03	1.35E+01	5.68E+00	2.03E+00	8.20E+01	2.09E+02
242Pu	Ci	2.74E-03	4.33E-03	2.79E-03	3.03E-02	4.54E-03	2.65E-02	5.95E-05	2.50E-05	6.20E-06	4.59E-04	1.20E-03
241Am	Ci	2.32E+02	1.75E+02	2.76E+02	1.33E+03	9.65E+02	1.11E+03	1.35E+00	4.76E-01	1.05E-01	9.08E+01	7.41E+01
243Am	Ci	8.19E-03	3.80E-03	8.48E-03	1.48E-01	2.96E-02	1.16E-01	9.27E-06	3.29E-06	3.95E-07	2.78E-03	2.27E-03
242Cm	Ci	5.65E-01	1.87E-01	2.52E-01	1.79E+00	8.81E-01	1.61E+00	2.04E-03	7.43E-04	1.19E-04	8.31E-02	6.77E-02
243Cm	Ci	5.09E-02	1.03E-02	1.94E-02	2.18E-01	6.77E-02	1.90E-01	4.17E-05	1.52E-05	2.15E-06	6.40E-02	2.00E-02
244Cm	Ci	4.11E-01	8.06E-02	5.96E-01	8.96E+00	2.08E+00	7.25E+00	2.18E-04	7.76E-05	1.49E-05	1.54E+00	4.80E-01

APPENDIX B

Constituent Name	B-112	B-201	B-203	B-204	BX-101	BX-102	BX-108	BX-110	BX-111	BY-103	BY-105	BY-106
3H	9.36E+00	5.63E-04	1.01E-03	9.86E-04	1.40E+00	9.31E-02	5.21E-02	2.11E+01	6.80E+01	1.93E+02	1.68E+02	2.70E+02
14C	2.54E-01	4.35E-02	3.12E-04	3.05E-04	1.35E-01	2.30E-01	1.11E-02	5.47E+00	1.77E+01	5.03E+01	4.37E+01	7.01E+01
59Ni	2.24E-01	4.96E-05	8.86E-05	8.68E-05	9.31E+00	8.79E-03	3.15E-03	5.96E-01	2.46E+00	5.37E+00	6.78E+00	8.84E+00
63Ni	2.22E+01	4.57E-03	8.17E-03	8.01E-03	9.22E+02	7.77E-01	2.84E-01	5.90E+01	2.44E+02	5.33E+02	6.53E+02	8.65E+02
60Co	2.28E+00	5.60E-05	1.00E-04	9.81E-05	7.18E+00	1.02E+01	2.43E-03	5.07E+00	2.16E+01	4.71E+01	4.06E+01	6.55E+01
90Sr	2.62E+04	2.87E+02	3.25E+01	3.19E+01	6.12E+04	2.04E+04	1.43E+04	2.01E+04	2.29E+04	7.96E+04	6.20E+05	4.96E+05
90Y	2.62E+04	2.87E+02	3.26E+01	3.19E+01	6.12E+04	2.04E+04	1.43E+04	2.01E+04	2.29E+04	7.96E+04	6.20E+05	4.96E+05
93Zr	9.20E-01	1.75E-04	3.12E-04	3.06E-04	2.33E-01	3.10E-02	1.11E-02	2.26E+00	9.34E+00	2.04E+01	1.78E+01	2.85E+01
99Tc	1.04E+01	2.67E-01	2.16E-03	2.12E-03	9.05E+00	5.99E+00	4.96E+00	3.06E+01	9.83E+01	2.80E+02	2.43E+02	3.91E+02
106Ru	4.28E-04	4.20E-11	7.50E-11	7.35E-11	7.85E-02	3.54E-06	9.50E-10	1.01E-03	4.30E-03	9.40E-03	8.10E-03	1.31E-02
125Sb	1.02E+01	6.46E-05	1.15E-04	1.13E-04	1.28E+00	1.39E-02	2.19E-03	2.27E+01	9.66E+01	2.11E+02	1.82E+02	2.94E+02
126Sn	2.84E-01	5.55E-05	9.91E-05	9.72E-05	7.87E-02	9.68E-03	3.51E-03	7.00E-01	2.89E+00	6.31E+00	5.51E+00	8.82E+00
129I	5.72E-03	2.29E-06	4.08E-06	4.00E-06	1.20E-02	5.37E-03	1.45E-04	5.92E-02	1.90E-01	5.42E-01	4.70E-01	7.56E-01
134Cs	1.05E-01	2.78E-06	4.97E-06	4.87E-06	3.59E-03	7.75E-04	8.88E-05	2.47E-01	1.05E+00	2.29E+00	1.99E+00	3.20E+00
137Cs	1.27E+04	1.10E+02	3.69E+01	3.62E+01	1.75E+04	8.10E+03	2.05E+03	6.71E+04	7.64E+04	2.26E+05	5.22E+05	7.04E+05
151Sm	6.58E+02	1.39E-01	2.49E-01	2.44E-01	1.84E+02	2.46E+01	8.72E+00	1.62E+03	6.69E+03	1.46E+04	1.27E+04	2.04E+04
152Eu	2.87E-01	1.82E-04	3.25E-04	3.19E-04	7.42E+00	1.79E-02	3.06E-03	7.33E-01	3.04E+00	6.64E+00	6.05E+00	9.43E+00
154Eu	2.11E+01	6.02E-01	1.61E-03	1.57E-03	5.22E+00	9.74E-02	4.31E-02	8.57E+01	3.64E+02	7.95E+02	6.86E+02	1.11E+03
155Eu	1.74E+01	1.64E-02	2.94E-02	2.88E-02	4.26E+02	1.71E+00	2.40E-01	4.47E+01	1.84E+02	4.03E+02	3.72E+02	5.74E+02
226Ra	8.86E-06	8.22E-09	1.47E-08	1.44E-08	3.25E-04	1.20E-05	6.75E-07	2.57E-05	4.03E-05	2.03E-04	1.94E-04	2.90E-04
228Ra	1.09E-01	5.29E-13	9.44E-13	9.25E-13	1.87E-03	1.02E-03	1.30E-11	2.70E-01	1.15E+00	2.52E+00	2.17E+00	3.50E+00
227Ac	1.21E-04	4.34E-08	7.75E-08	7.59E-08	1.39E-03	3.15E-03	3.44E-06	3.28E-04	1.32E-03	8.48E-03	2.55E-03	4.04E-03
229Th	2.51E-03	1.02E-10	1.83E-10	1.79E-10	4.37E-05	4.61E-04	2.51E-09	6.24E-03	1.15E-02	5.89E-02	5.01E-02	8.08E-02
232Th	4.51E-03	4.62E-14	8.25E-14	8.08E-14	2.31E-04	4.75E-05	3.19E-12	9.98E-03	1.84E-02	9.30E-02	8.01E-02	1.29E-01
231Pa	6.23E-04	1.00E-07	1.79E-07	1.75E-07	7.36E-05	4.65E-03	7.43E-06	1.63E-03	2.93E-03	2.31E-02	1.29E-02	2.07E-02
232U	4.48E-02	1.42E-07	9.57E-08	9.38E-08	9.65E-04	1.12E-03	1.01E-05	4.99E-02	7.60E-01	1.69E+00	7.72E+00	8.53E-01
233U	1.72E-01	6.47E-09	4.37E-09	4.28E-09	3.54E-03	4.34E-03	5.11E-07	1.91E-01	2.91E+00	6.47E+00	2.96E+01	3.27E+00
234U	1.28E-02	7.07E-03	4.77E-03	4.68E-03	3.48E+00	2.61E-01	5.69E-01	2.60E+00	4.20E-01	5.14E-01	7.43E+00	2.32E-01
235U	4.79E-04	3.15E-04	2.12E-04	2.08E-04	1.57E-01	1.17E-02	2.54E-02	9.08E-02	1.70E-02	1.93E-02	3.17E-01	8.61E-03
236U	4.11E-04	6.17E-05	4.16E-05	4.08E-05	2.22E-02	1.80E-03	4.68E-03	2.05E-02	9.00E-03	1.69E-02	1.04E-01	7.71E-03
238U	1.08E-02	7.18E-03	4.84E-03	4.75E-03	3.53E+00	2.63E-01	5.78E-01	2.78E+00	3.84E-01	4.34E-01	7.14E+00	1.93E-01
237Np	1.44E-02	7.51E-06	1.34E-05	1.31E-05	5.04E-03	1.30E-03	4.74E-04	1.04E-01	1.94E-01	9.40E-01	8.19E-01	1.31E+00
238Pu	6.89E-03	9.49E-01	3.02E-01	3.64E-01	4.68E+00	1.01E+00	3.32E-02	1.58E+00	7.98E-01	1.78E+00	2.88E+00	1.46E+00
239Pu	3.56E-01	1.42E+02	4.37E+01	5.27E+01	8.22E+01	4.25E+01	4.79E+00	1.58E+02	3.07E+01	6.76E+01	1.04E+02	5.24E+01
240Pu	4.97E-02	1.25E+01	3.83E+00	4.62E+00	1.78E+01	7.52E+00	4.25E-01	1.45E+01	5.04E+00	1.18E+01	1.77E+01	8.97E+00
241Pu	4.62E-01	4.13E+01	1.27E+01	1.53E+01	3.28E+02	8.12E+01	1.34E+00	4.83E+01	5.68E+01	1.34E+02	2.07E+02	1.05E+02
242Pu	2.21E-06	1.91E-04	5.86E-05	7.07E-05	2.14E-03	2.28E-04	6.08E-06	2.20E-04	2.73E-04	5.41E-04	9.96E-04	5.05E-04
241Am	1.07E-01	4.26E+00	3.57E-01	4.31E-01	1.73E+02	1.76E+02	5.05E+00	4.82E-01	1.36E+01	6.59E+01	1.43E+02	1.23E+02
243Am	3.71E-06	3.46E-05	2.90E-06	3.50E-06	1.31E-02	1.14E-03	3.48E-05	7.81E-06	4.69E-04	2.28E-03	4.92E-03	4.23E-03
242Cm	1.91E-06	4.16E-02	3.49E-03	4.20E-03	3.39E-01	1.83E+00	1.40E-02	8.65E-04	2.33E-04	1.17E-03	1.75E-02	6.93E-03
243Cm	3.92E-08	9.04E-03	7.51E-05	9.05E-05	3.61E-02	4.78E-02	2.86E-04	6.51E-05	4.78E-06	2.62E-05	3.59E-04	1.42E-04
244Cm	5.42E-07	2.17E-01	7.38E-05	8.90E-05	9.68E-01	3.74E-02	8.21E-04	5.38E-05	6.58E-05	3.08E-04	8.06E-04	6.21E-04

Constituent Name	BY-107	BY-108	C-101	C-110	C-111	C-201	C-202	C-203	C-204	S-104	SX-104	SX-107
3H	7.46E+01	3.29E+01	4.27E-01	1.07E+00	1.66E-01	4.41E-03	8.19E-04	1.52E-02	8.00E-03	6.15E+00	5.68E+02	3.47E+01
14C	1.93E+01	8.35E+00	8.91E-02	3.16E-01	3.15E-02	1.14E-02	1.13E-03	4.24E-02	2.18E-02	1.64E+00	7.67E+01	1.85E+00
59Ni	3.07E+00	3.09E+00	1.76E-02	1.75E-02	2.24E-01	4.23E-01	4.23E-01	4.24E-01	4.23E-01	1.02E+01	1.20E+01	1.13E+01
63Ni	2.96E+02	2.87E+02	1.63E+00	1.53E+00	2.02E+01	4.15E+01	4.15E+01	4.15E+01	4.15E+01	9.71E+02	1.15E+03	1.10E+03
60Co	1.80E+01	7.64E+00	2.84E-02	8.55E-03	9.09E-03	1.36E-03	1.19E-03	1.90E-03	1.54E-03	6.67E+00	8.40E+01	1.52E+00
90Sr	3.36E+04	1.95E+05	1.07E+03	4.69E+03	1.14E+06	1.70E+04	1.46E+04	9.32E+03	3.76E+02	5.49E+05	5.28E+05	1.98E+05
90Y	3.36E+04	1.95E+05	1.07E+03	4.69E+03	1.14E+06	1.70E+04	1.46E+04	9.32E+03	3.76E+02	5.49E+05	5.28E+05	1.98E+05
93Zr	7.90E+00	3.53E+00	6.24E-02	6.15E-02	3.15E-02	2.31E-02	2.18E-02	2.69E-02	2.43E-02	2.10E+01	4.45E+01	1.59E+01
99Tc	1.08E+02	4.69E+01	4.34E-01	3.41E+01	2.19E-01	1.68E-02	7.95E-03	4.33E-02	2.56E-02	4.42E+01	5.48E+02	1.42E+01
106Ru	3.58E-03	1.51E-03	1.78E-05	2.01E-10	6.59E-08	9.41E-06	9.42E-06	9.40E-06	9.41E-06	1.46E-03	1.50E-02	3.28E-04
125Sb	8.04E+01	3.40E+01	8.51E-02	4.61E-03	1.35E-02	4.66E-03	4.57E-03	4.95E-03	4.76E-03	2.31E+01	3.59E+02	5.16E+00
126Sn	2.45E+00	1.10E+00	2.00E-02	1.92E-02	1.00E-02	8.28E-03	7.88E-03	9.47E-03	8.68E-03	6.81E+00	1.39E+01	4.85E+00
129I	2.09E-01	9.07E-02	8.25E-04	7.90E-04	4.13E-04	3.18E-05	1.54E-05	8.12E-05	4.83E-05	1.16E-01	1.06E+00	2.70E-02
134Cs	8.82E-01	3.87E-01	4.46E-03	7.32E-05	1.64E-03	4.52E-06	4.42E-06	4.82E-06	4.62E-06	1.42E+00	5.84E+00	3.75E-01
137Cs	2.41E+05	3.51E+05	1.73E+03	1.86E+04	1.20E+04	1.76E+02	9.18E+01	3.18E+02	1.34E+02	1.10E+05	5.22E+05	5.33E+04
151Sm	5.68E+03	2.55E+03	4.85E+01	4.88E+01	2.46E+01	1.95E+01	1.85E+01	2.26E+01	2.05E+01	1.58E+04	3.23E+04	1.34E+04
152Eu	2.74E+00	1.42E+00	1.68E-01	5.99E-03	4.09E-02	3.25E-01	3.25E-01	3.26E-01	3.25E-01	8.29E+00	1.32E+01	1.24E+01
154Eu	3.03E+02	6.96E+01	5.72E-01	1.15E-01	1.80E-01	1.91E-01	1.89E-01	1.98E-01	1.93E-01	1.60E+02	1.38E+03	3.66E+01
155Eu	1.70E+02	9.14E+01	1.20E+01	9.05E-01	2.89E+00	2.12E+01	2.12E+01	2.13E+01	2.13E+01	4.10E+02	7.32E+02	6.28E+02
226Ra	8.54E-05	4.71E-05	4.01E-06	5.50E-06	1.88E-06	3.72E-05	3.68E-05	3.88E-05	3.78E-05	7.28E-04	8.29E-04	9.61E-04
228Ra	9.59E-01	4.05E-01	5.09E-03	8.15E-11	1.31E-10	2.09E-10	2.06E-10	2.19E-10	2.12E-10	9.60E-03	2.89E-01	1.01E-03
227Ac	1.14E-03	5.36E-04	1.56E-02	2.77E-05	9.57E-06	1.81E-04	1.80E-04	1.85E-04	1.82E-04	3.62E-03	4.41E-03	4.32E-03
229Th	2.21E-02	9.36E-03	2.31E-03	1.57E-08	2.54E-08	3.79E-08	3.73E-08	3.97E-08	3.85E-08	2.31E-04	6.79E-03	2.58E-05
232Th	3.54E-02	1.50E-02	2.37E-04	1.91E-11	8.83E-12	6.65E-13	2.69E-13	1.86E-12	1.06E-12	1.29E-04	1.93E-02	1.36E-05
231Pa	5.73E-03	2.54E-03	2.31E-02	5.78E-05	2.06E-05	6.06E-06	4.86E-06	9.67E-06	7.27E-06	6.60E-03	1.18E-02	4.15E-03
232U	5.91E+00	1.68E+01	8.89E-02	8.25E-06	2.96E-05	8.44E-09	2.65E-08	1.53E-08	6.41E-09	8.64E-02	2.60E+00	7.38E-02
233U	2.27E+01	6.42E+01	3.45E-01	4.94E-07	1.33E-06	5.05E-10	6.97E-10	9.15E-10	3.84E-10	3.30E-01	9.95E+00	2.82E-01
234U	3.10E+00	4.86E+00	1.41E+00	6.96E-01	1.39E+00	7.12E-04	3.80E-04	1.29E-03	5.41E-04	4.36E+00	3.58E+00	2.01E+00
235U	1.25E-01	1.83E-01	6.07E-02	3.13E-02	6.18E-02	3.20E-05	1.60E-05	5.80E-05	2.43E-05	1.82E-01	1.45E-01	8.17E-02
236U	6.86E-02	1.54E-01	2.46E-02	4.44E-03	1.24E-02	4.55E-06	8.84E-06	8.23E-06	3.45E-06	1.26E-01	1.17E-01	7.67E-02
238U	2.85E+00	4.10E+00	1.40E+00	7.04E-01	1.41E+00	7.21E-04	3.77E-04	1.31E-03	5.48E-04	4.07E+00	3.24E+00	1.77E+00
237Np	3.64E-01	1.62E-01	2.78E-03	2.55E-03	1.35E-03	7.71E-05	2.41E-05	2.36E-04	1.30E-04	2.80E-01	2.03E+00	6.62E-02
238Pu	9.24E-01	8.57E+00	8.55E+00	2.38E-01	3.31E+00	2.93E+00	7.63E-01	6.98E-01	9.16E-03	7.49E+00	6.03E+00	8.56E+00
239Pu	3.58E+01	5.13E+01	4.16E+02	7.46E+01	2.16E+02	1.24E+02	3.22E+01	2.96E+01	3.87E-01	4.50E+02	2.96E+02	2.50E+02
240Pu	5.85E+00	8.40E+00	6.97E+01	4.40E+00	3.25E+01	2.04E+01	5.30E+00	4.85E+00	6.36E-02	6.52E+01	4.56E+01	4.25E+01
241Pu	6.57E+01	9.51E+01	6.65E+02	2.81E+00	2.40E+02	2.12E+02	5.51E+01	5.04E+01	6.61E-01	4.22E+02	3.80E+02	4.31E+02
242Pu	3.16E-04	4.58E-04	2.07E-03	8.60E-06	9.15E-04	1.04E-03	2.71E-04	2.48E-04	3.25E-06	1.95E-03	1.95E-03	2.36E-03
241Am	1.59E+01	2.47E+01	5.49E+02	2.13E-02	5.29E-02	4.18E+01	1.09E+01	9.96E+00	1.31E-01	7.45E+01	1.54E+02	2.09E+02
243Am	5.44E-04	3.71E-04	4.81E-03	5.96E-08	4.25E-07	1.00E-03	2.61E-04	2.39E-04	3.13E-06	2.30E-03	5.27E-03	9.27E-03
242Cm	2.75E-03	6.66E-03	9.56E+00	2.40E-05	7.61E-04	6.73E-02	1.75E-02	1.60E-02	2.10E-04	6.71E-02	3.76E-01	5.20E-01
243Cm	5.64E-05	1.36E-04	2.24E-01	3.56E-07	1.67E-05	3.69E-03	9.61E-04	8.79E-04	1.15E-05	1.54E-03	3.07E-02	4.97E-02
244Cm	1.02E-04	1.28E-04	1.80E-01	9.12E-07	1.69E-05	1.79E-03	4.67E-04	4.27E-04	5.60E-06	1.23E-03	2.91E-01	1.48E+00

Constituent Name	SX-108	SX-109	SX-110	SX-111	SX-112	SX-113	SX-114	SX-115	T-101	T-103	T-106	T-107
3H	1.77E+01	1.74E+02	4.31E+01	6.29E+01	3.82E+01	2.21E-01	1.34E+02	5.73E+00	6.18E+00	1.70E+00	6.35E-02	2.19E-01
14C	1.02E+00	8.99E+00	2.06E+00	3.16E+00	1.97E+00	1.71E-02	6.74E+00	3.11E-01	1.18E+00	3.04E-01	9.25E-03	5.61E-02
59Ni	9.40E+00	1.23E+01	1.06E+01	1.60E+01	1.07E+01	1.12E-01	1.54E+01	4.92E-01	6.33E-02	1.64E-02	2.63E-03	1.60E-02
63Ni	9.08E+02	1.19E+03	1.05E+03	1.57E+03	1.05E+03	1.05E+01	1.51E+03	4.65E+01	6.26E+00	1.62E+00	2.44E-01	1.40E+00
60Co	7.15E-01	7.98E+00	2.03E+00	2.88E+00	1.71E+00	6.75E-03	6.21E+00	2.54E-01	1.34E+00	3.40E-01	3.94E-03	7.82E-03
90Sr	1.09E+06	1.10E+06	1.17E+05	2.37E+05	1.75E+05	3.87E+03	2.67E+05	2.27E+04	1.18E+05	2.71E+04	3.05E+03	1.07E+05
90Y	1.09E+06	1.10E+06	1.17E+05	2.37E+05	1.75E+05	3.87E+03	2.67E+05	2.27E+04	1.18E+05	2.71E+04	3.05E+03	1.07E+05
93Zr	1.05E+01	3.29E+01	2.14E+01	2.82E+01	1.70E+01	1.71E-02	3.71E+01	7.98E-01	4.52E-01	1.17E-01	9.64E-03	5.62E-02
99Tc	7.65E+00	6.97E+01	1.63E+01	2.47E+01	1.53E+01	1.20E-01	5.26E+01	2.38E+00	8.24E+00	2.09E+00	6.70E-02	3.88E-01
106Ru	1.32E-04	1.83E-03	5.03E-04	6.77E-04	3.89E-04	1.89E-08	1.47E-03	5.41E-05	2.26E-04	6.78E-05	3.66E-07	1.84E-10
125Sb	2.21E+00	2.83E+01	7.49E+00	1.03E+01	6.01E+00	9.92E-03	2.24E+01	8.65E-01	5.85E+00	1.49E+00	8.97E-03	4.22E-03
126Sn	3.19E+00	1.05E+01	6.53E+00	8.63E+00	5.21E+00	5.58E-03	1.16E+01	2.59E-01	1.38E-01	3.59E-02	3.05E-03	1.75E-02
129I	1.46E-02	1.32E-01	3.10E-02	4.68E-02	2.90E-02	2.30E-04	9.98E-02	4.52E-03	1.59E-02	4.04E-03	1.27E-04	7.22E-04
134Cs	1.73E-01	1.81E+00	5.56E-01	7.47E-01	4.35E-01	2.05E-04	1.50E+00	5.29E-02	2.01E-02	8.26E-03	3.85E-04	6.69E-05
137Cs	6.92E+04	2.58E+05	3.15E+04	6.37E+04	4.71E+04	1.04E+03	2.02E+05	6.11E+03	9.30E+04	2.84E+04	1.98E+03	1.22E+04
151Sm	8.96E+03	2.57E+04	1.80E+04	2.36E+04	1.43E+04	1.30E+01	3.00E+04	6.02E+02	3.24E+02	8.38E+01	7.39E+00	4.46E+01
152Eu	9.46E+00	1.43E+01	1.46E+01	1.99E+01	1.25E+01	5.29E-02	2.04E+01	3.60E-01	2.75E-01	6.81E-02	1.66E-02	5.47E-03
154Eu	1.74E+01	1.91E+02	4.88E+01	6.93E+01	4.13E+01	1.63E-01	1.49E+02	6.08E+00	1.98E+01	5.08E+00	8.66E-02	1.05E-01
155Eu	4.76E+02	7.25E+02	7.45E+02	1.01E+03	6.36E+02	2.50E+00	1.04E+03	1.77E+01	1.64E+01	4.55E+00	9.48E-01	8.28E-01
226Ra	7.87E-04	9.67E-04	9.51E-04	1.40E-03	9.22E-04	8.17E-06	1.32E-03	3.52E-05	4.48E-06	1.36E-06	3.22E-07	5.03E-06
228Ra	1.58E-08	1.13E-02	1.79E-03	2.50E-03	1.37E-03	7.00E-11	7.93E-03	3.58E-04	6.48E-05	3.48E-03	3.26E-11	7.45E-11
227Ac	3.50E-03	4.77E-03	4.32E-03	6.33E-03	4.16E-03	3.60E-05	6.21E-03	1.71E-04	2.25E-05	1.06E-02	1.66E-06	2.54E-05
229Th	1.29E-06	2.73E-04	4.43E-05	6.22E-05	3.43E-05	1.34E-08	1.92E-04	8.62E-06	3.05E-06	1.57E-03	3.32E-09	1.44E-08
232Th	5.77E-10	1.52E-04	2.40E-05	3.36E-05	1.84E-05	4.47E-12	1.06E-04	4.79E-06	2.15E-05	1.68E-04	3.70E-12	1.74E-11
231Pa	2.67E-03	9.77E-03	5.59E-03	7.42E-03	4.47E-03	5.43E-06	1.03E-02	2.51E-04	9.55E-05	1.57E-02	3.83E-06	5.28E-05
232U	1.31E-04	3.51E-01	6.12E-02	1.13E-01	7.65E-02	1.48E-06	2.01E-01	1.17E-02	2.98E-03	1.79E-01	1.36E-05	8.75E-05
233U	4.19E-06	1.34E+00	2.34E-01	4.33E-01	2.93E-01	5.64E-08	7.69E-01	4.48E-02	9.60E-03	6.97E-01	4.82E-07	5.24E-06
234U	2.30E+00	6.54E+00	1.23E+00	2.46E+00	1.80E+00	3.37E-02	3.77E+00	2.31E-01	8.47E+00	1.46E+00	3.18E-01	7.38E+00
235U	9.61E-02	2.64E-01	4.96E-02	9.92E-02	7.28E-02	1.45E-03	1.52E-01	9.39E-03	3.28E-01	6.18E-02	1.33E-02	3.32E-01
236U	6.46E-02	2.69E-01	5.46E-02	1.02E-01	7.25E-02	5.34E-04	1.58E-01	9.08E-03	4.93E-01	3.15E-02	9.77E-03	4.72E-02
238U	2.17E+00	5.64E+00	1.04E+00	2.11E+00	1.56E+00	3.44E-02	3.23E+00	2.02E-01	6.21E+00	1.41E+00	2.87E-01	7.48E+00
237Np	3.94E-02	3.07E-01	6.63E-02	1.07E-01	6.83E-02	7.77E-04	2.25E-01	1.11E-02	2.94E-02	7.38E-03	4.75E-04	2.33E-03
238Pu	6.85E+00	7.35E+00	9.38E+00	1.31E+01	8.42E+00	5.00E-02	1.20E+01	2.04E-01	2.49E+01	4.01E+00	1.66E-01	4.46E-01
239Pu	2.22E+02	2.22E+02	1.85E+02	3.13E+02	2.23E+02	3.57E+00	2.62E+02	1.24E+01	6.92E+02	1.67E+02	6.66E+00	1.40E+02
240Pu	3.68E+01	3.74E+01	3.56E+01	5.65E+01	3.90E+01	5.11E-01	4.87E+01	1.82E+00	1.14E+02	2.97E+01	1.01E+00	8.24E+00
241Pu	3.50E+02	3.72E+02	4.51E+02	6.43E+02	4.18E+02	3.00E+00	5.83E+02	1.18E+01	1.02E+03	3.21E+02	7.56E+00	5.27E+00
242Pu	1.89E-03	2.02E-03	2.58E-03	3.61E-03	2.32E-03	1.38E-05	3.30E-03	5.59E-05	2.70E-03	9.05E-04	2.47E-05	1.61E-05
241Am	1.52E+02	2.19E+02	2.80E+02	3.61E+02	2.20E+02	6.12E-02	3.67E+02	2.83E+00	1.53E+00	4.00E-01	8.85E+00	1.38E+01
243Am	6.78E-03	8.70E-03	1.24E-02	1.60E-02	9.72E-03	5.72E-07	1.58E-02	8.63E-05	5.90E-05	1.51E-05	7.13E-05	3.86E-05
242Cm	4.03E-01	3.49E-01	6.42E-01	8.49E-01	5.29E-01	1.22E-03	7.50E-01	3.69E-03	5.98E-03	1.67E-03	6.88E-02	1.56E-02
243Cm	3.76E-02	3.32E-02	6.51E-02	8.39E-02	5.14E-02	2.79E-05	7.54E-02	8.45E-05	4.50E-04	1.20E-04	1.55E-03	2.31E-04
244Cm	1.11E+00	9.85E-01	1.97E+00	2.52E+00	1.54E+00	2.04E-05	2.28E+00	6.57E-05	4.66E-03	1.16E-03	2.12E-03	5.91E-04

Constituent Name	T-108	T-109	T-111	TX-105	TX-107	TX-110	TX-113	TX-114	TX-115	TX-116	TX-117	TY-101
3H	2.87E-01	6.56E-01	5.45E-02	3.54E+02	3.13E+00	2.20E+02	2.42E+02	2.74E+02	3.30E+02	1.19E+02	1.68E+02	6.67E-01
14C	4.57E-02	9.78E-02	1.98E-02	5.05E+01	5.16E-01	3.07E+01	3.42E+01	3.86E+01	4.70E+01	1.75E+01	2.44E+01	6.38E-01
59Ni	8.07E-02	1.99E-01	1.10E-01	3.85E+00	3.54E-02	2.30E+00	2.60E+00	3.10E+00	3.58E+00	2.43E+00	2.66E+00	4.00E-01
63Ni	7.26E+00	1.79E+01	1.20E+01	3.78E+02	3.44E+00	2.25E+02	2.54E+02	3.02E+02	3.51E+02	2.29E+02	2.55E+02	3.63E+01
60Co	9.71E-03	2.21E-02	8.00E-01	5.53E+01	4.91E-01	3.48E+01	3.80E+01	4.30E+01	5.15E+01	1.87E+01	2.62E+01	2.47E+00
90Sr	1.58E+03	2.45E+03	1.09E+04	1.68E+05	1.71E+03	1.20E+05	1.33E+05	1.42E+05	1.57E+05	6.60E+04	8.60E+04	7.47E+03
90Y	1.58E+03	2.45E+03	1.09E+04	1.68E+05	1.71E+03	1.20E+05	1.33E+05	1.42E+05	1.57E+05	6.60E+04	8.61E+04	7.47E+03
93Zr	4.65E-02	9.99E-02	1.98E-02	2.55E+01	2.44E-01	1.67E+01	1.80E+01	2.04E+01	2.38E+01	8.80E+00	1.24E+01	1.26E-01
99Tc	3.22E-01	6.92E-01	1.70E+01	3.60E+02	3.16E+00	2.19E+02	2.43E+02	2.75E+02	3.35E+02	1.25E+02	1.74E+02	5.39E+00
106Ru	3.49E-09	8.74E-09	1.90E-09	9.88E-03	9.51E-05	6.81E-03	7.17E-03	8.12E-03	9.24E-03	3.03E-03	4.25E-03	1.33E-08
125Sb	8.45E-03	2.00E-02	4.20E-03	2.35E+02	2.13E+00	1.52E+02	1.64E+02	1.85E+02	2.19E+02	7.85E+01	1.10E+02	0.00E+00
126Sn	1.47E-02	3.16E-02	6.27E-03	7.84E+00	7.53E-02	5.14E+00	5.55E+00	6.28E+00	7.32E+00	2.70E+00	3.81E+00	3.98E-02
129I	6.05E-04	1.30E-03	2.59E-04	6.94E-01	6.09E-03	4.22E-01	4.69E-01	5.30E-01	6.46E-01	2.41E-01	3.36E-01	3.44E-02
134Cs	3.76E-04	9.28E-04	1.79E-04	4.05E+00	5.32E-02	2.60E+00	2.63E+00	6.40E+00	3.84E+00	1.31E+00	1.27E+01	7.92E-03
137Cs	9.98E+02	1.13E+03	3.34E+02	4.37E+05	2.42E+04	3.05E+05	3.09E+05	4.08E+05	4.07E+05	2.47E+05	3.15E+05	1.72E+02
151Sm	3.65E+01	7.83E+01	1.55E+01	1.83E+04	1.76E+02	1.20E+04	1.29E+04	1.46E+04	1.71E+04	6.32E+03	8.89E+03	9.82E+01
152Eu	1.05E-02	2.47E-02	1.76E-02	5.67E+00	6.37E-02	4.49E+00	4.50E+00	5.10E+00	5.34E+00	1.93E+00	2.68E+00	6.06E-02
154Eu	1.69E-01	3.92E-01	8.13E-02	8.91E+02	8.36E+00	5.96E+02	6.35E+02	7.19E+02	8.31E+02	2.94E+02	4.13E+02	5.49E-01
155Eu	8.54E-01	1.90E+00	1.28E+00	3.36E+02	3.98E+00	2.68E+02	2.69E+02	3.04E+02	3.17E+02	1.17E+02	1.62E+02	4.26E+00
226Ra	2.96E-06	5.91E-06	1.14E-06	2.51E-04	6.37E-06	1.58E-04	1.75E-04	2.00E-04	2.31E-04	1.11E-04	1.41E-04	6.67E-06
228Ra	4.83E-11	9.87E-11	6.08E-11	4.09E-01	3.35E-03	2.36E-01	2.68E-01	3.02E-01	3.80E-01	1.67E-01	3.16E-01	1.91E-10
227Ac	1.52E-05	3.04E-05	5.83E-06	1.63E-03	2.48E-05	1.02E-03	1.14E-03	1.29E-03	1.51E-03	7.06E-04	9.48E-04	3.44E-05
229Th	9.35E-09	1.91E-08	1.18E-08	9.48E-03	7.76E-05	5.47E-03	6.21E-03	7.01E-03	8.81E-03	3.88E-03	7.29E-03	3.72E-08
232Th	1.35E-11	2.86E-11	5.64E-12	2.51E-02	2.06E-04	1.45E-02	1.65E-02	1.86E-02	2.33E-02	1.03E-02	1.92E-02	3.54E-11
231Pa	3.27E-05	6.61E-05	1.27E-05	7.17E-03	7.34E-05	4.54E-03	4.99E-03	5.65E-03	6.68E-03	2.81E-03	4.02E-03	7.56E-05
232U	7.00E-06	1.34E-06	3.79E-05	1.82E-01	6.40E-04	4.82E-01	7.68E-02	3.34E-01	1.90E+00	9.14E-02	1.72E-01	1.34E-05
233U	3.84E-07	6.36E-08	1.95E-06	6.98E-01	2.45E-03	1.85E+00	2.94E-01	1.28E+00	7.28E+00	3.50E-01	6.58E-01	6.15E-07
234U	4.84E-01	6.28E-02	2.22E+00	5.19E-01	1.59E-01	1.25E+00	6.42E-01	5.93E-01	1.56E+00	8.17E-01	5.70E-01	5.62E-01
235U	2.17E-02	2.78E-03	9.90E-02	2.26E-02	7.15E-03	5.37E-02	2.81E-02	2.51E-02	6.25E-02	3.59E-02	2.48E-02	2.48E-02
236U	3.49E-03	5.88E-04	1.78E-02	7.19E-03	1.03E-03	2.08E-02	7.98E-03	1.19E-02	5.04E-02	9.20E-03	7.83E-03	5.72E-03
238U	4.91E-01	6.38E-02	2.25E+00	5.07E-01	1.61E-01	1.22E+00	6.44E-01	5.68E-01	1.38E+00	8.21E-01	5.64E-01	5.71E-01
237Np	1.97E-03	4.26E-03	8.47E-04	1.30E+00	1.15E-02	7.86E-01	8.78E-01	9.92E-01	1.21E+00	4.58E-01	6.36E-01	5.39E-03
238Pu	1.35E-01	8.11E-02	1.81E+00	2.09E+00	2.05E-02	1.50E+00	1.83E+00	1.81E+00	1.95E+00	1.12E+00	1.25E+00	9.76E-01
239Pu	2.47E+01	1.35E+01	2.76E+02	7.54E+01	8.10E-01	5.71E+01	9.25E+01	7.54E+01	7.04E+01	9.89E+01	8.17E+01	1.28E+02
240Pu	1.90E+00	1.10E+00	2.37E+01	1.25E+01	1.25E-01	9.14E+00	1.28E+01	1.14E+01	1.17E+01	9.96E+00	9.43E+00	1.21E+01
241Pu	4.56E+00	2.98E+00	7.10E+01	1.37E+02	1.35E+00	9.88E+01	1.14E+02	1.18E+02	1.29E+02	6.06E+01	7.40E+01	4.17E+01
242Pu	2.01E-05	1.33E-05	3.19E-04	7.49E-04	7.43E-06	5.43E-04	6.16E-04	6.42E-04	7.00E-04	3.08E-04	3.81E-04	1.90E-04
241Am	2.71E-01	1.79E-01	9.20E+01	9.44E+01	8.83E-01	6.25E+01	6.77E+01	7.65E+01	8.82E+01	2.77E+01	3.97E+01	2.64E-01
243Am	1.84E-06	1.24E-06	6.43E-04	3.18E-03	3.10E-05	2.22E-03	2.33E-03	2.64E-03	2.98E-03	9.41E-04	1.35E-03	1.86E-06
242Cm	6.08E-04	4.08E-04	8.08E-01	2.19E-01	2.39E-03	1.73E-01	1.73E-01	1.96E-01	2.06E-01	7.04E-02	9.97E-02	1.14E-03
243Cm	1.24E-05	8.35E-06	1.66E-02	2.03E-02	2.20E-04	1.60E-02	1.60E-02	1.81E-02	1.91E-02	6.35E-03	9.09E-03	2.34E-05
244Cm	4.04E-05	2.73E-05	1.52E-02	2.10E-01	2.01E-03	1.44E-01	1.52E-01	1.72E-01	1.97E-01	6.43E-02	8.98E-02	4.27E-05

APPENDIX B

Constituent Name	TY-103	TY-104	TY-105	TY-106	U-101	U-104	U-110	AVERAGE VALUE, CURIES
3H	2.45E+01	1.74E-01	3.24E+00	8.63E-03	7.91E-02	3.80E+01	2.94E-01	6.18E+01
14C	1.04E+00	9.36E-01	1.05E+00	1.03E-01	2.27E-01	4.88E+00	3.52E-01	8.97E+00
59Ni	4.41E-01	1.05E-01	1.27E-01	3.39E-04	8.01E-03	5.65E-01	2.39E-02	3.50E+00
63Ni	4.20E+01	9.61E+00	1.15E+01	3.06E-02	7.03E-01	5.50E+01	2.10E+00	3.42E+02
60Co	1.53E+00	2.22E+00	6.65E+00	2.73E-04	3.92E-03	4.30E+00	1.17E-02	2.28E+01
90Sr	9.43E+04	3.18E+04	2.56E+05	9.76E+03	4.25E+04	7.72E+04	3.42E+05	3.09E+05
90Y	9.43E+04	3.18E+04	2.56E+05	9.76E+03	4.25E+04	7.72E+04	3.42E+05	3.09E+05
93Zr	1.78E+00	3.49E-02	4.49E-01	1.20E-03	2.82E-02	2.99E+00	8.41E-02	9.89E+00
99Tc	1.64E+01	9.06E+00	4.40E+01	1.07E+01	1.94E-01	3.27E+01	7.35E+00	6.82E+01
106Ru	6.29E-04	4.13E-09	4.27E-08	1.14E-10	9.24E-11	7.02E-04	2.75E-10	2.36E-02
125Sb	1.56E+01	8.59E-03	9.49E-02	2.53E-04	2.12E-03	1.59E+01	6.30E-03	5.93E+01
126Sn	5.48E-01	1.11E-02	1.42E-01	3.79E-04	8.79E-03	9.10E-01	2.62E-02	3.18E+00
129I	4.82E-02	4.58E-04	4.60E-02	1.56E-05	3.62E-04	6.29E-02	1.08E-03	2.36E-01
134Cs	2.57E-01	3.04E-03	8.90E-04	3.17E-06	2.26E-06	8.24E-01	6.59E-05	1.04E+00
137Cs	1.49E+04	1.10E+04	1.05E+04	1.59E+03	1.14E+04	5.15E+04	2.65E+04	1.10E+05
151Sm	1.28E+03	2.73E+01	3.52E+02	9.37E-01	2.24E+01	2.13E+03	6.66E+01	7.56E+03
152Eu	5.52E-01	5.28E-02	4.42E-01	2.73E-03	5.23E-03	6.07E-01	1.09E-02	4.41E+00
154Eu	5.91E+01	1.64E-01	1.85E+00	4.92E-03	5.27E-02	7.81E+01	1.57E-01	4.04E+02
155Eu	3.56E+01	3.84E+00	3.33E+01	2.06E-01	7.91E-01	3.82E+01	1.65E+00	2.71E+02
226Ra	2.18E-05	1.72E-06	2.58E-05	6.86E-08	1.14E-05	5.01E-05	1.72E-05	2.31E-04
228Ra	3.05E-02	1.84E-10	1.69E-09	1.04E-11	7.13E-11	2.61E-03	1.48E-10	2.13E-01
227Ac	1.36E-04	8.86E-06	1.32E-04	3.51E-07	2.86E-05	2.63E-04	5.52E-05	1.82E-03
229Th	7.04E-04	3.57E-08	3.27E-07	2.02E-09	1.37E-08	1.52E-04	2.86E-08	4.78E-03
232Th	1.85E-03	9.72E-12	1.28E-10	3.40E-13	8.74E-12	6.97E-04	2.60E-11	9.01E-03
231Pa	5.41E-04	1.96E-05	2.86E-04	7.62E-07	2.65E-05	1.01E-03	7.89E-05	3.75E-03
232U	1.16E-01	4.54E-05	2.02E-04	4.51E-06	4.42E-06	3.52E-03	4.42E-05	6.48E-01
233U	4.45E-01	2.08E-06	9.99E-06	2.23E-07	2.64E-07	1.35E-02	2.64E-06	2.48E+00
234U	5.92E+00	1.89E+00	1.07E+01	2.39E-01	3.73E-01	7.17E-01	3.73E+00	1.71E+00
235U	2.61E-01	8.33E-02	4.76E-01	1.06E-02	1.68E-02	3.22E-02	1.68E-01	7.21E-02
236U	6.27E-02	1.93E-02	9.19E-02	2.06E-03	2.38E-03	4.89E-03	2.38E-02	3.82E-02
238U	6.01E+00	1.92E+00	1.09E+01	2.43E-01	3.77E-01	7.24E-01	3.77E+00	1.61E+00
237Np	9.23E-02	1.51E-03	1.92E-02	5.11E-05	1.17E-03	1.23E-01	3.48E-03	2.33E-01
238Pu	1.86E+00	3.88E-01	5.02E-01	2.17E-02	2.31E-01	2.01E-01	7.75E-01	5.01E+00
239Pu	1.68E+02	4.83E+01	7.64E+01	3.30E+00	7.25E+01	7.99E+00	2.43E+02	1.44E+02
240Pu	1.80E+01	4.71E+00	6.56E+00	2.83E-01	4.27E+00	1.19E+00	1.43E+01	2.37E+01
241Pu	9.69E+01	1.70E+01	1.98E+01	8.52E-01	2.73E+00	1.20E+01	9.16E+00	3.01E+02
242Pu	4.82E-04	7.78E-05	8.90E-05	3.84E-06	8.35E-06	5.95E-05	2.80E-05	1.73E-03
241Am	3.35E+01	9.71E+00	8.62E-01	2.29E-03	2.57E+00	9.60E+00	8.89E+01	1.27E+02
243Am	1.12E-03	6.93E-05	6.01E-06	1.60E-08	7.17E-06	2.92E-04	2.49E-04	6.93E-03
242Cm	9.68E-02	1.19E-01	8.09E-03	5.00E-05	5.52E-03	1.80E-02	1.34E-01	3.68E-01
243Cm	7.53E-03	2.45E-03	1.66E-04	1.02E-06	8.19E-05	1.37E-03	1.98E-03	2.32E-02
244Cm	7.51E-02	1.65E-03	1.42E-04	3.79E-07	1.10E-04	1.69E-02	3.80E-03	5.48E-01

ATTACHMENT C

TANK ISOTOPE TO CESIUM-137 RATIOS

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ISOTOPE TO CS-137 RATIO FOR EACH TANK														
Constituent Name	Units	A-103	A-104	A-105	AX-102	AX-104	B-101	B-103	B-105	B-107	B-110	B-111	B-112	B-201
3H	Ci/Ci	1.02E-03	7.80E-06	5.31E-05	5.82E-04	5.49E-05	2.06E-04	8.25E-05	7.31E-05	1.65E-04	7.96E-05	7.86E-05	7.37E-04	5.12E-06
14C	Ci/Ci	1.68E-05	1.52E-05	9.88E-06	9.16E-05	1.02E-05	3.43E-05	1.52E-05	1.07E-05	2.78E-05	1.51E-05	1.01E-05	2.00E-05	3.95E-04
59Ni	Ci/Ci	1.25E-05	1.52E-04	4.90E-05	2.82E-05	5.06E-05	9.94E-04	1.44E-05	1.27E-05	5.30E-06	7.20E-05	6.90E-05	1.76E-05	4.51E-07
63Ni	Ci/Ci	1.23E-03	1.49E-02	4.92E-03	2.89E-03	5.08E-03	9.87E-02	1.30E-03	1.14E-03	4.79E-04	7.26E-03	6.96E-03	1.75E-03	4.15E-05
60Co	Ci/Ci	8.02E-05	6.24E-03	1.36E-05	1.19E-04	5.63E-03	5.43E-05	2.67E-06	2.37E-06	3.76E-04	2.01E-05	2.45E-05	1.80E-04	5.09E-07
90Sr	Ci/Ci	5.05E-01	3.77E+01	2.72E+01	3.09E+00	4.79E+01	1.40E-01	1.39E-01	2.75E-01	1.76E+00	7.26E+00	1.57E+00	2.06E+00	2.61E+00
90Y	Ci/Ci	5.05E-01	3.77E+01	2.72E+01	3.09E+00	4.79E+01	1.40E-01	1.39E-01	2.75E-01	1.76E+00	7.26E+00	1.57E+00	2.06E+00	2.61E+00
93Zr	Ci/Ci	8.63E-05	2.88E-04	2.13E-04	4.18E-04	2.21E-04	1.35E-03	1.23E-05	1.07E-05	1.33E-05	3.13E-04	3.01E-04	7.24E-05	1.59E-06
99Tc	Ci/Ci	8.05E-04	1.07E-04	6.99E-05	6.77E-04	1.55E-03	2.21E-04	8.49E-05	7.43E-05	8.06E-04	1.11E-03	7.20E-04	8.19E-04	2.43E-03
106Ru	Ci/Ci	3.69E-08	1.71E-08	5.78E-08	1.05E-05	1.64E-07	4.44E-05	1.02E-12	9.35E-13	3.88E-09	2.33E-07	2.24E-07	3.37E-08	3.82E-13
125Sb	Ci/Ci	9.32E-04	6.22E-03	1.40E-03	5.53E-04	4.56E-03	3.25E-04	2.39E-06	2.14E-06	1.40E-04	8.98E-05	9.05E-05	8.03E-04	5.87E-07
126Sn	Ci/Ci	2.71E-05	1.12E-04	7.23E-05	1.50E-04	7.48E-05	4.90E-04	3.88E-06	3.40E-06	4.10E-06	1.06E-04	1.02E-04	2.24E-05	5.05E-07
129I	Ci/Ci	9.01E-09	2.06E-07	1.36E-07	1.31E-06	1.40E-07	4.25E-07	1.60E-07	1.40E-07	3.65E-04	2.42E-06	2.03E-07	4.50E-07	2.08E-08
134Cs	Ci/Ci	1.82E-05	2.57E-06	3.25E-06	9.05E-06	3.36E-06	1.98E-06	6.28E-08	5.84E-08	1.50E-04	4.77E-06	4.61E-06	8.27E-06	2.53E-08
137Cs	Ci/Ci	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
151Sm	Ci/Ci	6.31E-02	2.64E-01	1.73E-01	2.78E-01	1.79E-01	8.93E-01	9.62E-03	8.41E-03	9.86E-03	2.54E-01	2.44E-01	5.18E-02	1.26E-03
152Eu	Ci/Ci	2.45E-05	1.01E-04	5.28E-05	3.79E-04	5.45E-05	2.01E-03	1.83E-06	1.65E-06	2.61E-06	7.80E-05	7.44E-05	2.26E-05	1.65E-06
154Eu	Ci/Ci	3.22E-03	3.68E-02	4.26E-02	2.98E-02	3.02E-02	9.87E-02	4.70E-05	4.20E-05	1.38E-03	4.46E-03	1.08E-03	1.66E-03	5.47E-03
155Eu	Ci/Ci	1.48E-03	6.60E-03	3.93E-03	1.85E-02	2.89E-02	1.04E-01	1.46E-04	1.26E-04	2.13E-03	5.81E-03	5.55E-03	1.37E-03	1.49E-04
226Ra	Ci/Ci	8.77E-10	9.85E-09	3.08E-09	4.20E-09	3.18E-09	4.43E-08	8.84E-10	6.45E-10	3.58E-10	4.55E-09	4.34E-09	6.98E-10	7.47E-11
228Ra	Ci/Ci	1.68E-06	1.09E-09	2.78E-14	6.80E-07	2.87E-14	9.25E-13	8.02E-15	6.49E-15	4.88E-07	4.25E-14	1.50E-08	8.58E-06	4.81E-15
227Ac	Ci/Ci	5.15E-09	5.14E-08	1.66E-08	2.05E-08	1.72E-08	1.99E-07	4.08E-09	3.29E-09	4.53E-08	2.45E-08	2.34E-08	9.53E-09	3.95E-10
229Th	Ci/Ci	3.89E-08	5.06E-10	4.34E-12	1.58E-08	4.50E-12	1.09E-10	1.56E-12	1.26E-12	1.74E-08	6.72E-12	3.52E-10	1.98E-07	9.27E-13
232Th	Ci/Ci	1.82E-07	1.18E-10	2.51E-15	6.93E-08	2.60E-15	1.23E-14	3.53E-15	3.08E-15	5.90E-08	3.86E-15	1.85E-09	3.55E-07	4.20E-16
231Pa	Ci/Ci	2.01E-08	7.05E-08	3.73E-08	1.06E-08	3.86E-08	1.25E-08	8.29E-09	7.10E-09	6.96E-08	5.54E-08	5.27E-08	4.91E-08	9.09E-10
232U	Ci/Ci	5.60E-06	6.91E-08	5.71E-13	1.99E-06	7.58E-11	1.21E-09	9.51E-10	2.85E-09	5.35E-10	6.72E-11	1.60E-08	3.53E-06	1.29E-09
233U	Ci/Ci	2.14E-05	2.68E-07	1.35E-14	7.65E-06	1.79E-12	6.22E-11	5.04E-11	1.35E-10	5.39E-10	3.66E-12	6.13E-08	1.35E-05	5.88E-11
234U	Ci/Ci	3.41E-06	2.15E-07	7.05E-09	1.57E-06	9.35E-07	7.17E-05	6.05E-05	1.31E-04	3.39E-05	4.61E-06	4.13E-07	1.01E-06	6.43E-05
235U	Ci/Ci	1.35E-07	8.91E-09	2.94E-10	6.28E-08	3.90E-08	3.21E-06	2.71E-06	5.84E-06	1.53E-06	2.06E-07	1.81E-08	3.77E-08	2.86E-06
236U	Ci/Ci	1.10E-07	5.89E-09	1.92E-10	5.13E-08	2.55E-08	5.71E-07	4.60E-07	1.25E-06	2.16E-07	3.34E-08	4.84E-09	3.24E-08	5.61E-07
238U	Ci/Ci	3.03E-06	2.07E-07	6.88E-09	1.41E-06	9.11E-07	7.30E-05	6.14E-05	1.33E-04	3.43E-05	4.67E-06	4.17E-07	8.50E-07	6.53E-05
237Np	Ci/Ci	4.27E-06	3.37E-07	1.50E-07	2.39E-06	1.55E-07	9.25E-07	5.23E-07	4.57E-07	8.48E-07	7.53E-06	4.53E-07	1.13E-06	6.83E-08
238Pu	Ci/Ci	2.47E-05	1.75E-04	3.92E-05	1.09E-03	1.79E-04	3.40E-03	4.20E-05	6.86E-06	7.70E-06	2.16E-04	1.94E-05	5.43E-07	8.63E-03
239Pu	Ci/Ci	8.19E-04	9.31E-03	1.02E-03	7.45E-03	4.64E-03	3.24E-02	7.59E-03	1.27E-03	2.40E-03	4.82E-03	5.52E-04	2.80E-05	1.29E+00
240Pu	Ci/Ci	1.42E-04	1.47E-03	1.94E-04	2.66E-03	8.85E-04	9.43E-03	5.89E-04	9.71E-05	1.42E-04	5.25E-04	9.46E-05	3.91E-06	1.14E-01
241Pu	Ci/Ci	1.72E-03	1.28E-02	2.79E-03	7.54E-02	1.27E-02	2.36E-01	1.45E-03	2.32E-04	9.35E-05	4.41E-03	1.24E-03	3.64E-05	3.75E-01
242Pu	Ci/Ci	9.35E-09	5.57E-08	1.61E-08	5.44E-07	7.37E-08	1.67E-06	6.40E-09	1.02E-09	2.86E-10	2.47E-08	7.14E-09	1.74E-10	1.74E-06
241Am	Ci/Ci	7.92E-04	2.25E-03	1.60E-03	2.39E-02	1.57E-02	6.98E-02	1.45E-04	1.94E-05	4.84E-06	4.88E-03	4.41E-04	8.43E-06	3.87E-02
243Am	Ci/Ci	2.80E-08	4.89E-08	4.90E-08	2.66E-06	4.81E-07	7.30E-06	9.97E-10	1.34E-10	1.82E-11	1.49E-07	1.35E-08	2.92E-10	3.15E-07
242Cm	Ci/Ci	1.93E-06	2.41E-06	1.46E-06	3.21E-05	1.43E-05	1.01E-04	2.19E-07	3.03E-08	5.48E-09	4.47E-06	4.03E-07	1.50E-10	3.78E-04
243Cm	Ci/Ci	1.74E-07	1.33E-07	1.12E-07	3.91E-06	1.10E-06	1.19E-05	4.48E-09	6.20E-10	9.91E-11	3.44E-06	1.19E-07	3.09E-12	8.22E-05
244Cm	Ci/Ci	1.40E-06	1.04E-06	3.45E-06	1.61E-04	3.38E-05	4.58E-04	2.34E-08	3.17E-09	6.87E-10	8.28E-05	2.86E-06	4.27E-11	1.97E-03

ISOTOPE TO CS-137														
Constituent Name	B-203	B-204	BX-101	BX-102	BX-108	BX-110	BX-111	BY-103	BY-105	BY-106	BY-107	BY-108	C-101	C-110
3H	2.74E-05	2.72E-05	8.00E-05	1.15E-05	2.54E-05	3.14E-04	8.90E-04	8.54E-04	3.22E-04	3.84E-04	3.10E-04	9.37E-05	2.47E-04	5.75E-05
14C	8.46E-06	8.43E-06	7.71E-06	2.84E-05	5.41E-06	8.15E-05	2.32E-04	2.23E-04	8.37E-05	9.96E-05	8.01E-05	2.38E-05	5.15E-05	1.70E-05
59Ni	2.40E-06	2.40E-06	5.32E-04	1.09E-06	1.54E-06	8.88E-06	3.22E-05	2.38E-05	1.30E-05	1.26E-05	1.27E-05	8.80E-06	1.02E-05	9.41E-07
63Ni	2.21E-04	2.21E-04	5.27E-02	9.59E-05	1.39E-04	8.79E-04	3.19E-03	2.36E-03	1.25E-03	1.23E-03	1.23E-03	8.18E-04	9.42E-04	8.23E-05
60Co	2.71E-06	2.71E-06	4.10E-04	1.26E-03	1.19E-06	7.56E-05	2.83E-04	2.08E-04	7.78E-05	9.30E-05	7.47E-05	2.18E-05	1.64E-05	4.60E-07
90Sr	8.81E-01	8.81E-01	3.50E+00	2.52E+00	6.98E+00	3.00E-01	3.00E-01	3.52E-01	1.19E+00	7.05E-01	1.39E-01	5.56E-01	6.18E-01	2.52E-01
90Y	8.83E-01	8.81E-01	3.50E+00	2.52E+00	6.98E+00	3.00E-01	3.00E-01	3.52E-01	1.19E+00	7.05E-01	1.39E-01	5.56E-01	6.18E-01	2.52E-01
93Zr	8.46E-06	8.45E-06	1.33E-05	3.83E-06	5.41E-06	3.37E-05	1.22E-04	9.03E-05	3.41E-05	4.05E-05	3.28E-05	1.01E-05	3.81E-05	3.31E-06
99Tc	5.85E-05	5.86E-05	5.17E-04	7.40E-04	2.42E-03	4.56E-04	1.29E-03	1.24E-03	4.66E-04	5.55E-04	4.48E-04	1.34E-04	2.51E-04	1.83E-03
106Ru	2.03E-12	2.03E-12	4.49E-06	4.37E-10	4.63E-13	1.51E-08	5.63E-08	4.16E-08	1.55E-08	1.86E-08	1.49E-08	4.30E-09	1.03E-08	1.08E-14
125Sb	3.12E-06	3.12E-06	7.31E-05	1.72E-06	1.07E-06	3.38E-04	1.26E-03	9.34E-04	3.49E-04	4.18E-04	3.34E-04	9.69E-05	4.92E-05	2.48E-07
126Sn	2.69E-06	2.69E-06	4.50E-06	1.20E-06	1.71E-06	1.04E-05	3.78E-05	2.79E-05	1.06E-05	1.25E-05	1.02E-05	3.13E-06	1.16E-05	1.03E-06
129I	1.11E-07	1.10E-07	6.86E-07	6.63E-07	7.07E-08	8.82E-07	2.49E-06	2.40E-06	9.00E-07	1.07E-06	8.67E-07	2.58E-07	4.77E-07	4.25E-08
134Cs	1.35E-07	1.35E-07	2.05E-07	9.57E-08	4.33E-08	3.68E-06	1.37E-05	1.01E-05	3.81E-06	4.55E-06	3.66E-06	1.10E-06	2.58E-06	3.94E-09
137Cs	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
151Sm	6.75E-03	6.74E-03	1.05E-02	3.04E-03	4.25E-03	2.41E-02	8.76E-02	6.46E-02	2.43E-02	2.90E-02	2.36E-02	7.26E-03	2.80E-02	2.62E-03
152Eu	8.81E-06	8.81E-06	4.24E-04	2.21E-06	1.49E-06	1.09E-05	3.98E-05	2.94E-05	1.16E-05	1.34E-05	1.14E-05	4.05E-06	9.71E-05	3.22E-07
154Eu	4.36E-05	4.34E-05	2.98E-04	1.20E-05	2.10E-05	1.28E-03	4.76E-03	3.52E-03	1.31E-03	1.58E-03	1.26E-03	1.98E-04	3.31E-04	6.18E-06
155Eu	7.97E-04	7.96E-04	2.43E-02	2.11E-04	1.17E-04	6.66E-04	2.41E-03	1.78E-03	7.13E-04	8.15E-04	7.05E-04	2.60E-04	6.94E-03	4.87E-05
226Ra	3.98E-10	3.98E-10	1.86E-08	1.48E-09	3.29E-10	3.83E-10	5.27E-10	8.98E-10	3.72E-10	4.12E-10	3.54E-10	1.34E-10	2.32E-09	2.96E-10
228Ra	2.56E-14	2.56E-14	1.07E-07	1.26E-07	6.34E-15	4.02E-06	1.51E-05	1.12E-05	4.16E-06	4.97E-06	3.98E-06	1.15E-06	2.94E-06	4.38E-15
227Ac	2.10E-09	2.10E-09	7.94E-08	3.89E-07	1.68E-09	4.89E-09	1.73E-08	3.75E-08	4.89E-09	5.74E-09	4.73E-09	1.53E-09	9.02E-06	1.49E-09
229Th	4.96E-12	4.94E-12	2.50E-09	5.69E-08	1.22E-12	9.30E-08	1.51E-07	2.61E-07	9.60E-08	1.15E-07	9.17E-08	2.67E-08	1.34E-06	8.44E-13
232Th	2.24E-15	2.23E-15	1.32E-08	5.86E-09	1.56E-15	1.49E-07	2.41E-07	4.12E-07	1.53E-07	1.83E-07	1.47E-07	4.27E-08	1.37E-07	1.03E-15
231Pa	4.85E-09	4.83E-09	4.21E-09	5.74E-07	3.62E-09	2.43E-08	3.84E-08	1.02E-07	2.47E-08	2.94E-08	2.38E-08	7.24E-09	1.34E-05	3.11E-09
232U	2.59E-09	2.59E-09	5.51E-08	1.38E-07	4.93E-09	7.44E-07	9.95E-06	7.48E-06	1.48E-05	1.21E-06	2.45E-05	4.79E-05	5.14E-05	4.44E-10
233U	1.18E-10	1.18E-10	2.02E-07	5.36E-07	2.49E-10	2.85E-06	3.81E-05	2.86E-05	5.67E-05	4.64E-06	9.42E-05	1.83E-04	1.99E-04	2.66E-11
234U	1.29E-04	1.29E-04	1.99E-04	3.22E-05	2.78E-04	3.87E-05	5.50E-06	2.27E-06	1.42E-05	3.30E-07	1.29E-05	1.38E-05	8.15E-04	3.74E-05
235U	5.75E-06	5.75E-06	8.97E-06	1.44E-06	1.24E-05	1.35E-06	2.23E-07	8.54E-08	6.07E-07	1.22E-08	5.19E-07	5.21E-07	3.51E-05	1.68E-06
236U	1.13E-06	1.13E-06	1.27E-06	2.22E-07	2.28E-06	3.06E-07	1.18E-07	7.48E-08	1.99E-07	1.10E-08	2.85E-07	4.39E-07	1.42E-05	2.39E-07
238U	1.31E-04	1.31E-04	2.02E-04	3.25E-05	2.82E-04	4.14E-05	5.03E-06	1.92E-06	1.37E-05	2.74E-07	1.18E-05	1.17E-05	8.09E-04	3.78E-05
237Np	3.63E-07	3.62E-07	2.88E-07	1.60E-07	2.31E-07	1.55E-06	2.54E-06	4.16E-06	1.57E-06	1.86E-06	1.51E-06	4.62E-07	1.61E-06	1.37E-07
238Pu	8.18E-03	1.01E-02	2.67E-04	1.25E-04	1.62E-05	2.35E-05	1.04E-05	7.88E-06	5.52E-06	2.07E-06	3.83E-06	2.44E-05	4.94E-03	1.28E-05
239Pu	1.18E+00	1.46E+00	4.70E-03	5.25E-03	2.34E-03	2.35E-03	4.02E-04	2.99E-04	1.99E-04	7.44E-05	1.49E-04	1.46E-04	2.40E-01	4.01E-03
240Pu	1.04E-01	1.28E-01	1.02E-03	9.28E-04	2.07E-04	2.16E-04	6.60E-05	5.22E-05	3.39E-05	1.27E-05	2.43E-05	2.39E-05	4.03E-02	2.37E-04
241Pu	3.44E-01	4.23E-01	1.87E-02	1.00E-02	6.54E-04	7.20E-04	7.43E-04	5.93E-04	3.97E-04	1.49E-04	2.73E-04	2.71E-04	3.84E-01	1.51E-04
242Pu	1.59E-06	1.95E-06	1.22E-07	2.81E-08	2.97E-09	3.28E-09	3.57E-09	2.39E-09	1.91E-09	7.17E-10	1.31E-09	1.30E-09	1.20E-06	4.62E-10
241Am	9.67E-03	1.19E-02	9.89E-03	2.17E-02	2.46E-03	7.18E-06	1.78E-04	2.92E-04	2.74E-04	1.75E-04	6.60E-05	7.04E-05	3.17E-01	1.15E-06
243Am	7.86E-08	9.67E-08	7.49E-07	1.41E-07	1.70E-08	1.16E-10	6.14E-09	1.01E-08	9.43E-09	6.01E-09	2.26E-09	1.06E-09	2.78E-06	3.20E-12
242Cm	9.46E-05	1.16E-04	1.94E-05	2.26E-04	6.83E-06	1.29E-08	3.05E-09	5.18E-09	3.35E-08	9.84E-09	1.14E-08	1.90E-08	5.53E-03	1.29E-09
243Cm	2.04E-06	2.50E-06	2.06E-06	5.90E-06	1.40E-07	9.70E-10	6.26E-11	1.16E-10	6.88E-10	2.02E-10	2.34E-10	3.87E-10	1.29E-04	1.91E-11
244Cm	2.00E-06	2.46E-06	5.53E-05	4.62E-06	4.00E-07	8.02E-10	8.61E-10	1.36E-09	1.54E-09	8.82E-10	4.23E-10	3.65E-10	1.04E-04	4.90E-11

ISOTOPE TO CS-137														
Constituent Name	C-111	C-201	C-202	C-203	C-204	S-104	SX-104	SX-107	SX-108	SX-109	SX-110	SX-111	SX-112	SX-113
3H	1.38E-05	2.51E-05	8.92E-06	4.78E-05	5.97E-05	5.59E-05	1.09E-03	6.51E-04	2.56E-04	6.74E-04	1.37E-03	9.87E-04	8.11E-04	2.13E-04
14C	2.63E-06	6.48E-05	1.23E-05	1.33E-04	1.63E-04	1.49E-05	1.47E-04	3.47E-05	1.47E-05	3.48E-05	6.54E-05	4.96E-05	4.18E-05	1.64E-05
59Ni	1.87E-05	2.40E-03	4.61E-03	1.33E-03	3.16E-03	9.27E-05	2.30E-05	2.12E-04	1.36E-04	4.77E-05	3.37E-04	2.51E-04	2.27E-04	1.08E-04
63Ni	1.68E-03	2.36E-01	4.52E-01	1.31E-01	3.10E-01	8.83E-03	2.20E-03	2.06E-02	1.31E-02	4.61E-03	3.33E-02	2.46E-02	2.23E-02	1.01E-02
60Co	7.58E-07	7.73E-06	1.30E-05	5.97E-06	1.15E-05	6.06E-05	1.61E-04	2.85E-05	1.03E-05	3.09E-05	6.44E-05	4.52E-05	3.63E-05	6.49E-06
90Sr	9.50E+01	9.65E+01	1.59E+02	2.93E+01	2.81E+00	4.99E+00	1.01E+00	3.71E+00	1.58E+01	4.26E+00	3.71E+00	3.72E+00	3.72E+00	3.72E+00
90Y	9.50E+01	9.65E+01	1.59E+02	2.93E+01	2.81E+00	4.99E+00	1.01E+00	3.71E+00	1.58E+01	4.26E+00	3.71E+00	3.72E+00	3.72E+00	3.72E+00
93Zr	2.63E-06	1.31E-04	2.37E-04	8.46E-05	1.81E-04	1.91E-04	8.52E-05	2.98E-04	1.52E-04	1.28E-04	6.79E-04	4.43E-04	3.61E-04	1.64E-05
99Tc	1.83E-05	9.55E-05	8.66E-05	1.36E-04	1.91E-04	4.02E-04	1.05E-03	2.66E-04	1.11E-04	2.70E-04	5.17E-04	3.88E-04	3.25E-04	1.15E-04
106Ru	5.49E-12	5.35E-08	1.03E-07	2.96E-08	7.02E-08	1.33E-08	2.87E-08	6.15E-09	1.91E-09	7.09E-09	1.60E-08	1.06E-08	8.26E-09	1.82E-11
125Sb	1.13E-06	2.65E-05	4.98E-05	1.56E-05	3.55E-05	2.10E-04	6.88E-04	9.68E-05	3.19E-05	1.10E-04	2.38E-04	1.62E-04	1.28E-04	9.54E-06
126Sn	8.33E-07	4.70E-05	8.58E-05	2.98E-05	6.48E-05	6.19E-05	2.66E-05	9.10E-05	4.61E-05	4.07E-05	2.07E-04	1.35E-04	1.11E-04	5.37E-06
129I	3.44E-08	1.81E-07	1.68E-07	2.55E-07	3.60E-07	1.05E-06	2.03E-06	5.07E-07	2.11E-07	5.12E-07	9.84E-07	7.35E-07	6.16E-07	2.21E-07
134Cs	1.37E-07	2.57E-08	4.81E-08	1.52E-08	3.45E-08	1.29E-05	1.12E-05	7.04E-06	2.50E-06	7.02E-06	1.77E-05	1.17E-05	9.24E-06	1.97E-07
137Cs	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
151Sm	2.05E-03	1.11E-01	2.02E-01	7.11E-02	1.53E-01	1.44E-01	6.19E-02	2.51E-01	1.29E-01	9.96E-02	5.71E-01	3.70E-01	3.04E-01	1.25E-02
152Eu	3.41E-06	1.85E-03	3.54E-03	1.03E-03	2.43E-03	7.54E-05	2.53E-05	2.33E-04	1.37E-04	5.54E-05	4.63E-04	3.12E-04	2.65E-04	5.09E-05
154Eu	1.50E-05	1.09E-03	2.06E-03	6.23E-04	1.44E-03	1.45E-03	2.64E-03	6.87E-04	2.51E-04	7.40E-04	1.55E-03	1.09E-03	8.77E-04	1.57E-04
155Eu	2.41E-04	1.20E-01	2.31E-01	6.70E-02	1.59E-01	3.73E-03	1.40E-03	1.18E-02	6.88E-03	2.81E-03	2.37E-02	1.59E-02	1.35E-02	2.40E-03
226Ra	1.57E-10	2.11E-07	4.01E-07	1.22E-07	2.82E-07	6.62E-09	1.59E-09	1.80E-08	1.14E-08	3.75E-09	3.02E-08	2.20E-08	1.96E-08	7.86E-09
228Ra	1.09E-14	1.19E-12	2.24E-12	6.89E-13	1.58E-12	8.73E-08	5.54E-07	1.89E-08	2.28E-13	4.36E-08	5.68E-08	3.92E-08	2.91E-08	6.73E-14
227Ac	7.98E-10	1.03E-06	1.96E-06	5.82E-07	1.36E-06	3.29E-08	8.45E-09	8.11E-08	5.06E-08	1.85E-08	1.37E-07	9.94E-08	8.83E-08	3.46E-08
229Th	2.12E-12	2.15E-10	4.06E-10	1.25E-10	2.87E-10	2.10E-09	1.30E-08	4.84E-10	1.86E-11	1.06E-09	1.41E-09	9.76E-10	7.28E-10	1.29E-11
232Th	7.36E-16	3.78E-15	2.93E-15	5.85E-15	7.91E-15	1.17E-09	3.70E-08	2.55E-10	8.34E-15	5.89E-10	7.62E-10	5.27E-10	3.91E-10	4.30E-15
231Pa	1.72E-09	3.44E-08	5.29E-08	3.04E-08	5.43E-08	6.00E-08	2.26E-08	7.79E-08	3.86E-08	3.79E-08	1.77E-07	1.16E-07	9.49E-08	5.22E-09
232U	2.47E-09	4.80E-11	2.89E-10	4.81E-11	4.78E-11	7.85E-07	4.98E-06	1.38E-06	1.89E-09	1.36E-06	1.94E-06	1.77E-06	1.62E-06	1.42E-09
233U	1.11E-10	2.87E-12	7.59E-12	2.88E-12	2.87E-12	3.00E-06	1.91E-05	5.29E-06	6.05E-11	5.19E-06	7.43E-06	6.80E-06	6.22E-06	5.42E-11
234U	1.16E-04	4.05E-06	4.14E-06	4.06E-06	4.04E-06	3.96E-05	6.86E-06	3.77E-05	3.32E-05	2.53E-05	3.90E-05	3.86E-05	3.82E-05	3.24E-05
235U	5.15E-06	1.82E-07	1.74E-07	1.82E-07	1.81E-07	1.65E-06	2.78E-07	1.53E-06	1.39E-06	1.02E-06	1.57E-06	1.56E-06	1.55E-06	1.39E-06
236U	1.03E-06	2.59E-08	9.63E-08	2.59E-08	2.57E-08	1.15E-06	2.24E-07	1.44E-06	9.34E-07	1.04E-06	1.73E-06	1.60E-06	1.54E-06	5.13E-07
238U	1.18E-04	4.10E-06	4.11E-06	4.12E-06	4.09E-06	3.70E-05	6.21E-06	3.32E-05	3.14E-05	2.19E-05	3.30E-05	3.31E-05	3.31E-05	3.31E-05
237Np	1.13E-07	4.38E-07	2.63E-07	7.42E-07	9.70E-07	2.55E-06	3.89E-06	1.24E-06	5.69E-07	1.19E-06	2.10E-06	1.68E-06	1.45E-06	7.47E-07
238Pu	2.76E-04	1.66E-02	8.31E-03	2.19E-03	6.84E-05	6.81E-05	1.16E-05	1.61E-04	9.90E-05	2.85E-05	2.98E-04	2.06E-04	1.79E-04	4.81E-05
239Pu	1.80E-02	7.05E-01	3.51E-01	9.31E-02	2.89E-03	4.09E-03	5.67E-04	4.69E-03	3.21E-03	8.60E-04	5.87E-03	4.91E-03	4.73E-03	3.43E-03
240Pu	2.71E-03	1.16E-01	5.77E-02	1.53E-02	4.75E-04	5.93E-04	8.74E-05	7.97E-04	5.32E-04	1.45E-04	1.13E-03	8.87E-04	8.28E-04	4.91E-04
241Pu	2.00E-02	1.20E+00	6.00E-01	1.58E-01	4.93E-03	3.84E-03	7.28E-04	8.09E-03	5.06E-03	1.44E-03	1.43E-02	1.01E-02	8.87E-03	2.88E-03
242Pu	7.63E-08	5.91E-06	2.95E-06	7.80E-07	2.43E-08	1.77E-08	3.74E-09	4.43E-08	2.73E-08	7.83E-09	8.19E-08	5.67E-08	4.93E-08	1.33E-08
241Am	4.41E-06	2.38E-01	1.19E-01	3.13E-02	9.78E-04	6.77E-04	2.95E-04	3.92E-03	2.20E-03	8.49E-04	8.89E-03	5.67E-03	4.67E-03	5.88E-05
243Am	3.54E-11	5.68E-06	2.84E-06	7.52E-07	2.34E-08	2.09E-08	1.01E-08	1.74E-07	9.80E-08	3.37E-08	3.94E-07	2.51E-07	2.06E-07	5.50E-10
242Cm	6.34E-08	3.82E-04	1.91E-04	5.03E-05	1.57E-06	6.10E-07	7.20E-07	9.76E-06	5.82E-06	1.35E-06	2.04E-05	1.33E-05	1.12E-05	1.17E-06
243Cm	1.39E-09	2.10E-05	1.05E-05	2.76E-06	8.58E-08	1.40E-08	5.88E-08	9.32E-07	5.43E-07	1.29E-07	2.07E-06	1.32E-06	1.09E-06	2.68E-08
244Cm	1.41E-09	1.02E-05	5.09E-06	1.34E-06	4.18E-08	1.12E-08	5.57E-07	2.78E-05	1.60E-05	3.82E-06	6.25E-05	3.96E-05	3.27E-05	1.96E-08

ISOTOPE TO CS-137														
Constituent Name	SX-114	SX-115	T-101	T-103	T-106	T-107	T-108	T-109	T-111	TX-105	TX-107	TX-110	TX-113	TX-114
3H	6.63E-04	9.38E-04	6.65E-05	5.99E-05	3.21E-05	1.80E-05	2.88E-04	5.81E-04	1.63E-04	8.10E-04	1.29E-04	7.21E-04	7.83E-04	6.72E-04
14C	3.34E-05	5.09E-05	1.27E-05	1.07E-05	4.67E-06	4.60E-06	4.58E-05	8.65E-05	5.93E-05	1.16E-04	2.13E-05	1.01E-04	1.11E-04	9.46E-05
59Ni	7.62E-05	6.05E-05	6.81E-07	5.77E-07	1.33E-06	1.31E-06	8.09E-05	1.76E-04	3.29E-04	8.81E-06	1.46E-06	7.54E-06	8.41E-06	7.60E-06
63Ni	7.48E-03	7.61E-03	6.73E-05	5.70E-05	1.23E-04	1.15E-04	7.27E-03	1.58E-02	3.59E-02	8.65E-04	1.42E-04	7.38E-04	8.22E-04	7.40E-04
60Co	3.07E-05	4.16E-05	1.44E-05	1.20E-05	1.99E-06	6.41E-07	9.73E-06	1.96E-05	2.40E-03	1.27E-04	2.03E-05	1.14E-04	1.23E-04	1.05E-04
90Sr	1.32E+00	3.72E+00	1.27E+00	9.54E-01	1.54E+00	8.77E+00	1.58E+00	2.17E+00	3.26E+01	3.84E-01	7.07E-02	3.93E-01	4.30E-01	3.48E-01
90Y	1.32E+00	3.72E+00	1.27E+00	9.54E-01	1.54E+00	8.77E+00	1.58E+00	2.17E+00	3.26E+01	3.84E-01	7.07E-02	3.93E-01	4.30E-01	3.48E-01
93Zr	1.84E-04	1.31E-04	4.86E-06	4.12E-06	4.87E-06	4.61E-06	4.66E-05	8.84E-05	5.93E-05	5.84E-05	1.01E-05	5.48E-05	5.83E-05	5.00E-05
99Tc	2.60E-04	3.90E-04	8.86E-05	7.36E-05	3.38E-05	3.18E-05	3.23E-04	6.12E-04	5.09E-02	8.24E-04	1.31E-04	7.18E-04	7.86E-04	6.74E-04
106Ru	7.28E-09	8.85E-09	2.43E-09	2.39E-09	1.85E-10	1.51E-14	3.50E-12	7.73E-12	5.69E-12	2.26E-08	3.93E-09	2.23E-08	2.32E-08	1.99E-08
125Sb	1.11E-04	1.42E-04	6.29E-05	5.25E-05	4.53E-06	3.46E-07	8.47E-06	1.77E-05	1.26E-05	5.38E-04	8.80E-05	4.98E-04	5.31E-04	4.53E-04
126Sn	5.74E-05	4.24E-05	1.48E-06	1.26E-06	1.54E-06	1.43E-06	1.47E-05	2.80E-05	1.88E-05	1.79E-05	3.11E-06	1.69E-05	1.80E-05	1.54E-05
129I	4.94E-07	7.40E-07	1.71E-07	1.42E-07	6.41E-08	5.92E-08	6.06E-07	1.15E-06	7.75E-07	1.59E-06	2.52E-07	1.38E-06	1.52E-06	1.30E-06
134Cs	7.43E-06	8.66E-06	2.16E-07	2.91E-07	1.94E-07	5.48E-09	3.77E-07	8.21E-07	5.36E-07	9.27E-06	2.20E-06	8.52E-06	8.51E-06	1.57E-05
137Cs	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
151Sm	1.49E-01	9.85E-02	3.48E-03	2.95E-03	3.73E-03	3.66E-03	3.66E-02	6.93E-02	4.64E-02	4.19E-02	7.27E-03	3.93E-02	4.17E-02	3.58E-02
152Eu	1.01E-04	5.89E-05	2.96E-06	2.40E-06	8.38E-06	4.48E-07	1.05E-05	2.19E-05	5.27E-05	1.30E-05	2.63E-06	1.47E-05	1.46E-05	1.25E-05
154Eu	7.38E-04	9.95E-04	2.13E-04	1.79E-04	4.37E-05	8.61E-06	1.69E-04	3.47E-04	2.43E-04	2.04E-03	3.45E-04	1.95E-03	2.06E-03	1.76E-03
155Eu	5.15E-03	2.90E-03	1.76E-04	1.60E-04	4.79E-04	6.79E-05	8.56E-04	1.68E-03	3.83E-03	7.69E-04	1.64E-04	8.79E-04	8.71E-04	7.45E-04
226Ra	6.53E-09	5.76E-09	4.82E-11	4.79E-11	1.63E-10	4.12E-10	2.97E-09	5.23E-09	3.41E-09	5.74E-10	2.63E-10	5.18E-10	5.66E-10	4.90E-10
228Ra	3.93E-08	5.86E-08	6.97E-10	1.23E-07	1.65E-14	6.11E-15	4.84E-14	8.73E-14	1.82E-13	9.36E-07	1.38E-07	7.74E-07	8.67E-07	7.40E-07
227Ac	3.07E-08	2.80E-08	2.42E-10	3.73E-07	8.38E-10	2.08E-09	1.52E-08	2.69E-08	1.75E-08	3.73E-09	1.02E-09	3.34E-09	3.69E-09	3.16E-09
229Th	9.50E-10	1.41E-09	3.28E-11	5.53E-08	1.68E-12	1.18E-12	9.37E-12	1.69E-11	3.53E-11	2.17E-08	3.21E-09	1.79E-08	2.01E-08	1.72E-08
232Th	5.25E-10	7.84E-10	2.31E-10	5.92E-09	1.87E-15	1.43E-15	1.35E-14	2.53E-14	1.69E-14	5.74E-08	8.51E-09	4.75E-08	5.34E-08	4.56E-08
231Pa	5.10E-08	4.11E-08	1.03E-09	5.53E-07	1.93E-09	4.33E-09	3.28E-08	5.85E-08	3.80E-08	1.64E-08	3.03E-09	1.49E-08	1.61E-08	1.38E-08
232U	9.95E-07	1.91E-06	3.20E-08	6.30E-06	6.87E-09	7.17E-09	7.01E-09	1.19E-09	1.13E-07	4.16E-07	2.64E-08	1.58E-06	2.49E-07	8.19E-07
233U	3.81E-06	7.33E-06	1.03E-07	2.45E-05	2.43E-10	4.30E-10	3.85E-10	5.63E-11	5.84E-09	1.60E-06	1.01E-07	6.07E-06	9.51E-07	3.14E-06
234U	1.87E-05	3.78E-05	9.11E-05	5.14E-05	1.61E-04	6.05E-04	4.85E-04	5.56E-05	6.65E-03	1.19E-06	6.57E-06	4.10E-06	2.08E-06	1.45E-06
235U	7.52E-07	1.54E-06	3.53E-06	2.18E-06	6.72E-06	2.72E-05	2.17E-05	2.46E-06	2.96E-04	5.17E-08	2.95E-07	1.76E-07	9.09E-08	6.15E-08
236U	7.82E-07	1.49E-06	5.30E-06	1.11E-06	4.93E-06	3.87E-06	3.50E-06	5.20E-07	5.33E-05	1.65E-08	4.26E-08	6.82E-08	2.58E-08	2.92E-08
238U	1.60E-05	3.31E-05	6.68E-05	4.96E-05	1.45E-04	6.13E-04	4.92E-04	5.65E-05	6.74E-03	1.16E-06	6.65E-06	4.00E-06	2.08E-06	1.39E-06
237Np	1.11E-06	1.82E-06	3.16E-07	2.60E-07	2.40E-07	1.91E-07	1.97E-06	3.77E-06	2.54E-06	2.97E-06	4.75E-07	2.58E-06	2.84E-06	2.43E-06
238Pu	5.94E-05	3.34E-05	2.68E-04	1.41E-04	8.38E-05	3.66E-05	1.35E-04	7.18E-05	5.42E-03	4.78E-06	8.47E-07	4.92E-06	5.92E-06	4.44E-06
239Pu	1.30E-03	2.03E-03	7.44E-03	5.88E-03	3.36E-03	1.15E-02	2.47E-02	1.19E-02	8.26E-01	1.73E-04	3.35E-05	1.87E-04	2.99E-04	1.85E-04
240Pu	2.41E-04	2.98E-04	1.23E-03	1.05E-03	5.10E-04	6.75E-04	1.90E-03	9.73E-04	7.10E-02	2.86E-05	5.17E-06	3.00E-05	4.14E-05	2.79E-05
241Pu	2.89E-03	1.93E-03	1.10E-02	1.13E-02	3.82E-03	4.32E-04	4.57E-03	2.64E-03	2.13E-01	3.14E-04	5.58E-05	3.24E-04	3.69E-04	2.89E-04
242Pu	1.63E-08	9.15E-09	2.90E-08	3.19E-08	1.25E-08	1.32E-09	2.01E-08	1.18E-08	9.55E-07	1.71E-09	3.07E-10	1.78E-09	1.99E-09	1.57E-09
241Am	1.82E-03	4.63E-04	1.65E-05	1.41E-05	4.47E-03	1.13E-03	2.72E-04	1.58E-04	2.75E-01	2.16E-04	3.65E-05	2.05E-04	2.19E-04	1.88E-04
243Am	7.82E-08	1.41E-08	6.34E-10	5.32E-10	3.60E-08	3.16E-09	1.84E-09	1.10E-09	1.93E-06	7.28E-09	1.28E-09	7.28E-09	7.54E-09	6.47E-09
242Cm	3.71E-06	6.04E-07	6.43E-08	5.88E-08	3.47E-05	1.28E-06	6.09E-07	3.61E-07	2.42E-03	5.01E-07	9.88E-08	5.67E-07	5.60E-07	4.80E-07
243Cm	3.73E-07	1.38E-08	4.84E-09	4.23E-09	7.83E-07	1.89E-08	1.24E-08	7.39E-09	4.97E-05	4.65E-08	9.09E-09	5.25E-08	5.18E-08	4.44E-08
244Cm	1.13E-05	1.08E-08	5.01E-08	4.08E-08	1.07E-06	4.84E-08	4.05E-08	2.42E-08	4.55E-05	4.81E-07	8.31E-08	4.72E-07	4.92E-07	4.22E-07

ISOTOPE TO CS-137												
Constituent Name	TX-115	TX-116	TX-117	TY-101	TY-103	TY-104	TY-105	TY-106	U-101	U-104	U-110	AVERAGE ISOTOPE/Cs-137 RATIO
3H	8.11E-04	4.82E-04	5.33E-04	3.88E-03	1.64E-03	1.58E-05	3.09E-04	5.43E-06	6.94E-06	7.38E-04	1.11E-05	4.15E-04
14C	1.15E-04	7.09E-05	7.75E-05	3.71E-03	6.98E-05	8.51E-05	1.00E-04	6.48E-05	1.99E-05	9.48E-05	1.33E-05	1.15E-04
59Ni	8.80E-06	9.84E-06	8.44E-06	2.33E-03	2.96E-05	9.55E-06	1.21E-05	2.13E-07	7.03E-07	1.10E-05	9.02E-07	2.77E-04
63Ni	8.62E-04	9.27E-04	8.10E-04	2.11E-01	2.82E-03	8.74E-04	1.10E-03	1.92E-05	6.17E-05	1.07E-03	7.92E-05	2.70E-02
60Co	1.27E-04	7.57E-05	8.32E-05	1.44E-02	1.03E-04	2.02E-04	6.33E-04	1.72E-07	3.44E-07	8.35E-05	4.42E-07	5.22E-04
90Sr	3.86E-01	2.67E-01	2.73E-01	4.34E+01	6.33E+00	2.89E+00	2.44E+01	6.14E+00	3.73E+00	1.50E+00	1.29E+01	1.12E+01
90Y	3.86E-01	2.67E-01	2.73E-01	4.34E+01	6.33E+00	2.89E+00	2.44E+01	6.14E+00	3.73E+00	1.50E+00	1.29E+01	1.12E+01
93Zr	5.85E-05	3.56E-05	3.94E-05	7.33E-04	1.19E-04	3.17E-06	4.28E-05	7.55E-07	2.47E-06	5.81E-05	3.17E-06	1.30E-04
99Tc	8.23E-04	5.06E-04	5.52E-04	3.13E-02	1.10E-03	8.24E-04	4.19E-03	6.73E-03	1.70E-05	6.35E-04	2.77E-04	1.92E-03
106Ru	2.27E-08	1.23E-08	1.35E-08	7.73E-11	4.22E-08	3.75E-13	4.07E-12	7.17E-14	8.11E-15	1.36E-08	1.04E-14	9.23E-07
125Sb	5.38E-04	3.18E-04	3.49E-04	0.00E+00	1.05E-03	7.81E-07	9.04E-06	1.59E-07	1.86E-07	3.09E-04	2.38E-07	3.92E-04
126Sn	1.80E-05	1.09E-05	1.21E-05	2.31E-04	3.68E-05	1.01E-06	1.35E-05	2.38E-07	7.71E-07	1.77E-05	9.89E-07	4.31E-05
129I	1.59E-06	9.76E-07	1.07E-06	2.00E-04	3.23E-06	4.16E-08	4.38E-06	9.81E-09	3.18E-08	1.22E-06	4.08E-08	9.28E-06
134Cs	9.43E-06	5.30E-06	4.03E-05	4.60E-05	1.72E-05	2.76E-07	8.48E-08	1.99E-09	1.98E-10	1.60E-05	2.49E-09	7.99E-06
137Cs	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
151Sm	4.20E-02	2.56E-02	2.82E-02	5.71E-01	8.59E-02	2.48E-03	3.35E-02	5.89E-04	1.96E-03	4.14E-02	2.51E-03	1.01E-01
152Eu	1.31E-05	7.81E-06	8.51E-06	3.52E-04	3.70E-05	4.80E-06	4.21E-05	1.72E-06	4.59E-07	1.18E-05	4.11E-07	2.23E-04
154Eu	2.04E-03	1.19E-03	1.31E-03	3.19E-03	3.97E-03	1.49E-05	1.76E-04	3.09E-06	4.62E-06	1.52E-03	5.92E-06	4.69E-03
155Eu	7.79E-04	4.74E-04	5.14E-04	2.48E-02	2.39E-03	3.49E-04	3.17E-03	1.30E-04	6.94E-05	7.42E-04	6.23E-05	1.41E-02
226Ra	5.68E-10	4.49E-10	4.48E-10	3.88E-08	1.46E-09	1.56E-10	2.46E-09	4.31E-11	1.00E-09	9.73E-10	6.49E-10	1.99E-08
228Ra	9.34E-07	6.76E-07	1.00E-06	1.11E-12	2.05E-06	1.67E-14	1.61E-13	6.54E-15	6.25E-15	5.07E-08	5.58E-15	1.04E-06
227Ac	3.71E-09	2.86E-09	3.01E-09	2.00E-07	9.13E-09	8.05E-10	1.26E-08	2.21E-10	2.51E-09	5.11E-09	2.08E-09	2.46E-07
229Th	2.16E-08	1.57E-08	2.31E-08	2.16E-10	4.72E-08	3.25E-12	3.11E-11	1.27E-12	1.20E-12	2.95E-09	1.08E-12	4.19E-08
232Th	5.72E-08	4.17E-08	6.10E-08	2.06E-13	1.24E-07	8.84E-16	1.22E-14	2.14E-16	7.67E-16	1.35E-08	9.81E-16	4.10E-08
231Pa	1.64E-08	1.14E-08	1.28E-08	4.40E-07	3.63E-08	1.78E-09	2.72E-08	4.79E-10	2.32E-09	1.96E-08	2.98E-09	2.55E-07
232U	4.67E-06	3.70E-07	5.46E-07	7.79E-08	7.79E-06	4.13E-09	1.92E-08	2.84E-09	3.88E-10	6.83E-08	1.67E-09	3.17E-06
233U	1.79E-05	1.42E-06	2.09E-06	3.58E-09	2.99E-05	1.89E-10	9.51E-10	1.40E-10	2.32E-11	2.62E-07	9.96E-11	1.22E-05
234U	3.83E-06	3.31E-06	1.81E-06	3.27E-03	3.97E-04	1.72E-04	1.02E-03	1.50E-04	3.27E-05	1.39E-05	1.41E-04	2.41E-04
235U	1.54E-07	1.45E-07	7.87E-08	1.44E-04	1.75E-05	7.57E-06	4.53E-05	6.67E-06	1.47E-06	6.25E-07	6.34E-06	1.06E-05
236U	1.24E-07	3.72E-08	2.49E-08	3.33E-05	4.21E-06	1.75E-06	8.75E-06	1.30E-06	2.09E-07	9.50E-08	8.98E-07	2.46E-06
238U	3.39E-06	3.32E-06	1.79E-06	3.32E-03	4.03E-04	1.75E-04	1.04E-03	1.53E-04	3.31E-05	1.41E-05	1.42E-04	2.42E-04
237Np	2.97E-06	1.85E-06	2.02E-06	3.13E-05	6.19E-06	1.37E-07	1.83E-06	3.21E-08	1.03E-07	2.39E-06	1.31E-07	1.92E-06
238Pu	4.79E-06	4.53E-06	3.97E-06	5.67E-03	1.25E-04	3.53E-05	4.78E-05	1.36E-05	2.03E-05	3.90E-06	2.92E-05	1.19E-03
239Pu	1.73E-04	4.00E-04	2.59E-04	7.44E-01	1.13E-02	4.39E-03	7.28E-03	2.08E-03	6.36E-03	1.55E-04	9.17E-03	1.08E-01
240Pu	2.87E-05	4.03E-05	2.99E-05	7.03E-02	1.21E-03	4.28E-04	6.25E-04	1.78E-04	3.75E-04	2.31E-05	5.40E-04	1.14E-02
241Pu	3.17E-04	2.45E-04	2.35E-04	2.42E-01	6.50E-03	1.55E-03	1.89E-03	5.36E-04	2.39E-04	2.33E-04	3.46E-04	6.76E-02
242Pu	1.72E-09	1.25E-09	1.21E-09	1.10E-06	3.23E-08	7.07E-09	8.48E-09	2.42E-09	7.32E-10	1.16E-09	1.06E-09	3.23E-07
241Am	2.17E-04	1.12E-04	1.26E-04	1.53E-03	2.25E-03	8.83E-04	8.21E-05	1.44E-06	2.25E-04	1.86E-04	3.35E-03	1.88E-02
243Am	7.32E-09	3.81E-09	4.29E-09	1.08E-08	7.52E-08	6.30E-09	5.72E-10	1.01E-11	6.29E-10	5.67E-09	9.40E-09	4.19E-07
242Cm	5.06E-07	2.85E-07	3.17E-07	6.63E-06	6.50E-06	1.08E-05	7.70E-07	3.14E-08	4.84E-07	3.50E-07	5.06E-06	1.47E-04
243Cm	4.69E-08	2.57E-08	2.89E-08	1.36E-07	5.05E-07	2.23E-07	1.58E-08	6.42E-10	7.18E-09	2.66E-08	7.47E-08	5.12E-06
244Cm	4.84E-07	2.60E-07	2.85E-07	2.48E-07	5.04E-06	1.50E-07	1.35E-08	2.38E-10	9.65E-09	3.28E-07	1.43E-07	4.77E-05

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ATTACHMENT D

ANNUAL POSSESSION QUANTITY

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ANNUAL POSSESSION QUANTITY FOR DRILLING			
NUMBER OF BOREHOLES PER YEAR	10		
AVERAGE DEPTH OF CONTAMINATED SOIL PER BOREHOLE (OCCURS AT 10-INCH BOREHOLE DIAMETER)	20	FEET	
VOLUME OF CONTAMINATED SOIL (20 FEET LAYER IN 10-INCH BOREHOLE)	10.91	FEET^3	
MAXIMUM VOLUME OF CONTAMINATED SOIL PER BOREHOLE + 15% EXPANSION	12.54	FEET^3	
MAXIMUM VOLUME OF CONTAMINATED SOIL PER YEAR + 15% EXPANSION	125.45	FEET^3	
DENSITY OF SOIL	97.5	POUNDS/FEET^3	(AVERAGE FOR LOOSE, DRY SAND & GRAVEL - MARKS STANDARD HANDBOOK FOR MECHANICAL ENGINEERS)
TOTAL WEIGHT OF CONTAMINATED SOIL PER YEAR	1.22E+04	POUNDS/YEAR	
TOTAL WEIGHT OF CONTAMINATED SOIL PER YEAR	5.55E+06	GRAMS/YEAR	
MAXIMUM AVERAGE Cs-137 CONCENTRATION SOIL IN CONTAMINATED LAYER	3.30E-04	CURIES PER GRAM OF SOIL	
ISOTOPE	AVERAGE TANK Cs-137 RATIO	AVERAGE CURIES PER GRAM OF SOIL	TOTAL POSSESSION QUANTITY CURIES PER YEAR
3H	4.15E-04	1.37E-07	7.60E-01
14C	1.15E-04	3.79E-08	2.11E-01
59Ni	2.77E-04	9.15E-08	5.07E-01
63Ni	2.70E-02	8.90E-06	4.93E+01
60Co	5.22E-04	1.72E-07	9.55E-01
90Sr	1.12E+01	3.68E-03	2.04E+04
90Y	1.12E+01	3.68E-03	2.04E+04
93Zr	1.30E-04	4.29E-08	2.38E-01
99Tc	1.92E-03	6.34E-07	3.52E+00
106Ru	9.23E-07	3.05E-10	1.69E-03
125Sb	3.92E-04	1.29E-07	7.18E-01
126Sn	4.31E-05	1.42E-08	7.88E-02
129I	9.28E-06	3.06E-09	1.70E-02
134Cs	7.99E-06	2.64E-09	1.46E-02
137Cs	1.00E+00	3.30E-04	1.83E+03
151Sm	1.01E-01	3.32E-05	1.84E+02
152Eu	2.23E-04	7.36E-08	4.08E-01
154Eu	4.69E-03	1.55E-06	8.58E+00
155Eu	1.41E-02	4.65E-06	2.58E+01
226Ra	1.99E-08	6.58E-12	3.65E-05
228Ra	1.04E-06	3.42E-10	1.90E-03
227Ac	2.46E-07	8.11E-11	4.50E-04
229Th	4.19E-08	1.38E-11	7.68E-05
232Th	4.10E-08	1.35E-11	7.52E-05
231Pa	2.55E-07	8.43E-11	4.67E-04
232U	3.17E-06	1.05E-09	5.80E-03
233U	1.22E-05	4.02E-09	2.23E-02
234U	2.41E-04	7.94E-08	4.40E-01
235U	1.06E-05	3.51E-09	1.95E-02
236U	2.46E-06	8.11E-10	4.50E-03
238U	2.42E-04	8.00E-08	4.44E-01
237Np	1.92E-06	6.32E-10	3.51E-03
238Pu	1.19E-03	3.92E-07	2.17E+00
239Pu	1.08E-01	3.57E-05	1.98E+02
240Pu	1.14E-02	3.77E-06	2.09E+01
241Pu	6.76E-02	2.23E-05	1.24E+02
242Pu	3.23E-07	1.07E-10	5.92E-04
241Am	1.88E-02	6.21E-06	3.44E+01
243Am	4.19E-07	1.38E-10	7.67E-04
242Cm	1.47E-04	4.85E-08	2.69E-01
243Cm	5.12E-06	1.69E-09	9.37E-03
244Cm	4.77E-05	1.58E-08	8.74E-02
TOTAL			4.34E+04

ANNUAL POSSESSION QUANTITY FOR CLOSING BOREHOLES			
NUMBER OF BOREHOLES DECOMMISIONED PER YEAR	10		
LENGTH OF 10-INCH NOMINAL DIAMETER CASING PER BOREHOLE	50	FEET	
LENGTH OF 8-INCH NOMINAL DIAMETER CASING PER BOREHOLE	200	FEET	
TOTAL SURFACE AREA OF EQUIVALENT BOREHOLE	97.08	FEET^2	
ASSUMED CONTAMINATED SOIL THICKNESS	1/64	INCH	
OUTSIDE UNIFORM SOIL COVERAGE VOLUME PER BOREHOLE	0.72	FEET^3	
OUTSIDE UNIFORM SOIL COVERAGE VOLUME PER YEAR	7.17	FEET^3	
OUTSIDE FRACTION OF SURFACE CONTAMINATED	0.15		
INSIDE FRACTION OF SURFACE CONTAMINATED	0.015		
ESTIMATED SOIL COVERAGE VOLUME	1.183	FEET^3	
DENSITY OF SOIL	110	POUNDS/FEET^3	(AVERAGE FOR LOOSE, DRY SAND & GRAVEL - MARKS STANDARD HANDBOOK FOR MECHANICAL ENGINEERS)
WEIGHT OF SOIL	130.17	POUNDS	
WEIGHT OF SOIL	59,044.05	GRAMS	
ISOTOPE	AVERAGE CURIES PER GRAM OF SOIL	TOTAL POSSESSION QUANTITY CURIES PER YEAR	
3H	1.37E-07	8.09E-03	
14C	3.79E-08	2.24E-03	
59Ni	9.15E-08	5.40E-03	
63Ni	8.90E-06	5.25E-01	
60Co	1.72E-07	1.02E-02	
90Sr	3.68E-03	2.18E+02	
90Y	3.68E-03	2.18E+02	
93Zr	4.29E-08	2.54E-03	
99Tc	6.34E-07	3.74E-02	
106Ru	3.05E-10	1.80E-05	
125Sb	1.29E-07	7.64E-03	
126Sn	1.42E-08	8.39E-04	
129I	3.06E-09	1.81E-04	
134Cs	2.64E-09	1.56E-04	
137Cs	3.30E-04	1.95E+01	
151Sm	3.32E-05	1.96E+00	
152Eu	7.36E-08	4.35E-03	
154Eu	1.55E-06	9.13E-02	
155Eu	4.65E-06	2.75E-01	
226Ra	6.58E-12	3.88E-07	
228Ra	3.42E-10	2.02E-05	
227Ac	8.11E-11	4.79E-06	
229Th	1.38E-11	8.17E-07	
232Th	1.35E-11	8.00E-07	
231Pa	8.43E-11	4.97E-06	
232U	1.05E-09	6.18E-05	
233U	4.02E-09	2.37E-04	
234U	7.94E-08	4.69E-03	
235U	3.51E-09	2.07E-04	
236U	8.11E-10	4.79E-05	
238U	8.00E-08	4.72E-03	
237Np	6.32E-10	3.73E-05	
238Pu	3.92E-07	2.31E-02	
239Pu	3.57E-05	2.11E+00	
240Pu	3.77E-06	2.23E-01	
241Pu	2.23E-05	1.32E+00	
242Pu	1.07E-10	6.30E-06	
241Am	6.21E-06	3.67E-01	
243Am	1.38E-10	8.16E-06	
242Cm	4.85E-08	2.87E-03	
243Cm	1.69E-09	9.98E-05	
244Cm	1.58E-08	9.30E-04	
TOTAL		4.61E+02	

TOTAL ANNUAL POSSESSION QUANTITY		
ISOTOPE	TOTAL ANNUAL POSSESSION QUANTITY CURIES PER YEAR	
3H	7.68E-01	
14C	2.13E-01	
59Ni	5.13E-01	
63Ni	4.99E+01	
60Co	9.66E-01	
90Sr	2.07E+04	
90Y	2.07E+04	
93Zr	2.41E-01	
99Tc	3.55E+00	
106Ru	1.71E-03	
125Sb	7.25E-01	
126Sn	7.97E-02	
129I	1.72E-02	
134Cs	1.48E-02	
137Cs	1.85E+03	
151Sm	1.86E+02	
152Eu	4.13E-01	
154Eu	8.67E+00	
155Eu	2.61E+01	
226Ra	3.69E-05	
228Ra	1.92E-03	
227Ac	4.55E-04	
229Th	7.76E-05	
232Th	7.60E-05	
231Pa	4.72E-04	
232U	5.87E-03	
233U	2.25E-02	
234U	4.45E-01	
235U	1.97E-02	
236U	4.55E-03	
238U	4.48E-01	
237Np	3.55E-03	
238Pu	2.20E+00	
239Pu	2.00E+02	
240Pu	2.11E+01	
241Pu	1.25E+02	
242Pu	5.98E-04	
241Am	3.48E+01	
243Am	7.75E-04	
242Cm	2.72E-01	
243Cm	9.47E-03	
244Cm	8.83E-02	
TOTAL	4.38E+04	

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ATTACHMENT E

POTENTIAL-TO-EMIT ASSUMPTIONS AND CALCULATIONS DRILLING BOREHOLES

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SOURCE TERM FOR AIR ROTARY CORE DRILLING BASED ON SCALING TO TANK ISOTOPE/Cs-137 RATIOS

NUMBER OF BOREHOLES PER YEAR	10	
RELEASE FRACTION	1.00	
LENGTH OF 10-INCH NOMINAL DIAMETER CASING PER BOREHOLE	50	FEET
LENGTH OF 8-INCH NOMINAL DIAMETER CASING PER BOREHOLE	200	FEET
VOLUME OF SOIL REMOVED PER BOREHOLE PLUS 15% EXPANSION	111.65	FEET^3
AVERAGE DEPTH OF CONTAMINATED SOIL PER BOREHOLE (OCCURS AT 10-INCH BOREHOLE DIAMETER)	20	FEET
VOLUME OF CONTAMINATED SOIL (20 FEET LAYER IN 10-INCH BOREHOLE)	10.91	FEET^3
MAXIMUM VOLUME OF CONTAMINATED SOIL PER BOREHOLE + 15% EXPANSION	12.54	FEET^3
MAXIMUM VOLUME OF CONTAMINATED SOIL PER YEAR + 15% EXPANSION	125.45	FEET^3
DENSITY OF SOIL	97.5	POUNDS/FEET^3 (AVERAGE FOR LOOSE, DRY SAND & GRAVEL - MARKS STANDARD HANDBOOK FOR MECHANICAL ENGINEERS)
TOTAL WEIGHT OF CONTAMINATED SOIL AVAILABLE TO CHALLENGE HEPA FILTER PER YEAR	1.22E+04	POUNDS/YEAR
TOTAL WEIGHT OF CONTAMINATED SOIL AVAILABLE TO CHALLENGE HEPA FILTER PER YEAR	5.55E+06	GRAMS/YEAR
MAXIMUM AVERAGE Cs-137 CONCENTRATION SOIL IN CONTAMINATED LAYER	5.00E-09	CURIES PER GRAM OF SOIL
NUMBER OF HEPA FILTERS IN SERIES	1	
HEPA FILTER EFFICIENCY	99.95%	

ISOTOPE	AVERAGE TANK Cs-137 RATIO	AVERAGE CURIES PER GRAM OF SOIL	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	4.15E-04	2.08E-12	1.15E-05	1.15E-05	1.15E-05	2.50E-05	2.88E-10	2.88E-10	0.000%	0.001%
14C	1.15E-04	5.75E-13	3.19E-06	3.19E-06	3.19E-06	1.90E-03	6.06E-09	6.06E-09	0.000%	0.017%
59Ni	2.77E-04	1.39E-12	7.69E-06	7.69E-06	3.84E-09	3.10E-04	2.38E-09	1.19E-12	0.000%	0.000%
63Ni	2.70E-02	1.35E-10	7.48E-04	7.48E-04	3.74E-07	2.60E-04	1.94E-07	9.72E-11	0.000%	0.000%
60Co	5.22E-04	2.61E-12	1.45E-05	1.45E-05	7.24E-09	2.50E-01	3.62E-06	1.81E-09	0.005%	0.005%
90Sr	1.12E+01	5.58E-08	3.10E-01	3.10E-01	1.55E-04	1.10E-01	3.41E-02	1.70E-05	49.000%	48.991%
90Y	1.12E+01	5.58E-08	3.10E-01	3.10E-01	1.55E-04	3.40E-04	1.05E-04	5.26E-08	0.151%	0.151%
93Zr	1.30E-04	6.51E-13	3.61E-06	3.61E-06	1.81E-09	1.30E-03	4.69E-09	2.35E-12	0.000%	0.000%
99Tc	1.92E-03	9.60E-12	5.33E-05	5.33E-05	2.66E-08	2.30E-02	1.23E-06	6.13E-10	0.002%	0.002%
106Ru	9.23E-07	4.61E-15	2.56E-08	2.56E-08	1.28E-11	1.60E-02	4.10E-10	2.05E-13	0.000%	0.000%
125Sb	3.92E-04	1.96E-12	1.09E-05	1.09E-05	5.44E-09	2.40E-03	2.61E-08	1.30E-11	0.000%	0.000%
126Sn	4.31E-05	2.15E-13	1.19E-06	1.19E-06	5.97E-10	4.70E-02	5.61E-08	2.81E-11	0.000%	0.000%
129I	9.28E-06	4.64E-14	2.58E-07	2.58E-07	1.29E-10	2.00E-01	5.15E-08	2.58E-11	0.000%	0.000%
134Cs	7.99E-06	4.00E-14	2.22E-07	2.22E-07	1.11E-10	1.00E-01	2.22E-08	1.11E-11	0.000%	0.000%
137Cs	1.00E+00	5.00E-09	2.77E-02	2.77E-02	1.39E-05	2.70E-02	7.49E-04	3.74E-07	1.077%	1.077%
151Sm	1.01E-01	5.04E-10	2.79E-03	2.79E-03	1.40E-06	7.50E-04	2.10E-06	1.05E-09	0.003%	0.003%
152Eu	2.23E-04	1.12E-12	6.19E-06	6.19E-06	3.09E-09	2.40E-01	1.48E-06	7.42E-10	0.002%	0.002%
154Eu	4.69E-03	2.34E-11	1.30E-04	1.30E-04	6.50E-08	2.00E-01	2.60E-05	1.30E-08	0.037%	0.037%
155Eu	1.41E-02	7.05E-11	3.91E-04	3.91E-04	1.96E-07	8.00E-03	3.13E-06	1.56E-09	0.005%	0.005%
226Ra	1.99E-08	9.96E-17	5.53E-10	5.53E-10	2.76E-13	4.60E-01	2.54E-10	1.27E-13	0.000%	0.000%
228Ra	1.04E-06	5.18E-15	2.87E-08	2.87E-08	1.44E-11	1.90E-01	5.46E-09	2.73E-12	0.000%	0.000%
227Ac	2.46E-07	1.23E-15	6.82E-09	6.82E-09	3.41E-12	1.50E+01	1.02E-07	5.11E-11	0.000%	0.000%
229Th	4.19E-08	2.10E-16	1.16E-09	1.16E-09	5.82E-13	1.60E+01	1.86E-08	9.31E-12	0.000%	0.000%
232Th	4.10E-08	2.05E-16	1.14E-09	1.14E-09	5.69E-13	8.00E+00	9.11E-09	4.55E-12	0.000%	0.000%
231Pa	2.55E-07	1.28E-15	7.08E-09	7.08E-09	3.54E-12	1.20E+01	8.50E-08	4.25E-11	0.000%	0.000%
232U	3.17E-06	1.59E-14	8.79E-08	8.79E-08	4.40E-11	1.10E+01	9.67E-07	4.84E-10	0.001%	0.001%

ISOTOPE	AVERAGE TANK Cs-137 RATIO	AVERAGE CURIES PER GRAM OF SOIL	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
233U	1.22E-05	6.09E-14	3.38E-07	3.38E-07	1.69E-10	3.10E+00	1.05E-06	5.23E-10	0.002%	0.002%
234U	2.41E-04	1.20E-12	6.67E-06	6.67E-06	3.34E-09	3.10E+00	2.07E-05	1.03E-08	0.030%	0.030%
235U	1.06E-05	5.32E-14	2.95E-07	2.95E-07	1.48E-10	3.00E+00	8.85E-07	4.43E-10	0.001%	0.001%
236U	2.46E-06	1.23E-14	6.82E-08	6.82E-08	3.41E-11	2.90E+00	1.98E-07	9.89E-11	0.000%	0.000%
238U	2.42E-04	1.21E-12	6.72E-06	6.72E-06	3.36E-09	2.80E+00	1.88E-05	9.41E-09	0.027%	0.027%
237Np	1.92E-06	9.58E-15	5.32E-08	5.32E-08	2.66E-11	1.20E+01	6.38E-07	3.19E-10	0.001%	0.001%
238Pu	1.19E-03	5.93E-12	3.29E-05	3.29E-05	1.65E-08	7.60E+00	2.50E-04	1.25E-07	0.360%	0.360%
239Pu	1.08E-01	5.41E-10	3.00E-03	3.00E-03	1.50E-06	8.20E+00	2.46E-02	1.23E-05	35.430%	35.424%
240Pu	1.14E-02	5.71E-11	3.17E-04	3.17E-04	1.58E-07	8.20E+00	2.60E-03	1.30E-06	3.737%	3.736%
241Pu	6.76E-02	3.38E-10	1.87E-03	1.87E-03	9.37E-07	1.30E-01	2.44E-04	1.22E-07	0.350%	0.350%
242Pu	3.23E-07	1.62E-15	8.97E-09	8.97E-09	4.49E-12	7.80E+00	7.00E-08	3.50E-11	0.000%	0.000%
241Am	1.88E-02	9.41E-11	5.22E-04	5.22E-04	2.61E-07	1.30E+01	6.78E-03	3.39E-06	9.759%	9.758%
243Am	4.19E-07	2.09E-15	1.16E-08	1.16E-08	5.81E-12	1.30E+01	1.51E-07	7.55E-11	0.000%	0.000%
242Cm	1.47E-04	7.36E-13	4.08E-06	4.08E-06	2.04E-09	4.10E-01	1.67E-06	8.37E-10	0.002%	0.002%
243Cm	5.12E-06	2.56E-14	1.42E-07	1.42E-07	7.10E-11	8.50E+00	1.21E-06	6.04E-10	0.002%	0.002%
244Cm	4.77E-05	2.39E-13	1.32E-06	1.32E-06	6.62E-10	6.70E+00	8.87E-06	4.44E-09	0.013%	0.013%
TOTAL			6.57E-01	6.57E-01	3.43E-04		6.95E-02	3.48E-05	100%	100%

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SOURCE TERM FOR CABLE TOOL AND SONIC DRILLING BASED ON SCALING TO TANK ISOTOPE/Cs-137 RATIOS TO FIELD DATA BNWL-CC-701

NUMBER OF BOREHOLES PER YEAR	10	
LENGTH OF 10-INCH NOMINAL DIAMETER CASING PER BOREHOLE	50	FEET
LENGTH OF 8-INCH NOMINAL DIAMETER CASING PER BOREHOLE	200	FEET
RELEASE FRACTION	1.00E-03	
VOLUME OF SOIL REMOVED PER BOREHOLE PLUS 15% EXPANSION	111.65	FEET^3
AVERAGE DEPTH OF CONTAMINATED SOIL PER BOREHOLE (OCCURS AT 10-INCH BOREHOLE DIAMETER)	20	FEET
VOLUME OF CONTAMINATED SOIL (20 FEET LAYER IN 10-INCH BOREHOLE)	10.91	FEET^3
MAXIMUM VOLUME OF CONTAMINATED SOIL PER BOREHOLE + 15% EXPANSION	12.54	FEET^3
MAXIMUM VOLUME OF CONTAMINATED SOIL PER YEAR + 15% EXPANSION	125.45	FEET^3
DENSITY OF SOIL	97.5	POUNDS/FEET^3 (AVERAGE FOR LOOSE, DRY SAND & GRAVEL - MARKS STANDARD HANDBOOK FOR MECHANICAL ENGINEERS)
TOTAL WEIGHT OF CONTAMINATED SOIL AVAILABLE TO CHALLENGE HEPA FILTER PER YEAR	1.22E+04	POUNDS/YEAR
TOTAL WEIGHT OF CONTAMINATED SOIL AVAILABLE TO CHALLENGE HEPA FILTER PER YEAR	5.55E+06	GRAMS/YEAR
MAXIMUM AVERAGE Cs-137 CONCENTRATION SOIL IN CONTAMINATED LAYER	5.00E-06	CURIES PER GRAM OF SOIL
NUMBER OF HEPA FILTERS	0	
HEPA FILTER EFFICIENCY	99.95%	

ISOTOPE	AVERAGE TANK Cs-137 RATIO	AVERAGE CURIES PER GRAM OF SOIL	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	4.15E-04	2.08E-09	1.15E-02	1.15E-05	1.15E-05	2.50E-05	2.88E-10	2.88E-10	0.000%	0.000%
14C	1.15E-04	5.75E-10	3.19E-03	3.19E-06	3.19E-06	1.90E-03	6.06E-09	6.06E-09	0.000%	0.000%
59Ni	2.77E-04	1.39E-09	7.69E-03	7.69E-06	7.69E-06	3.10E-04	2.38E-09	2.38E-09	0.000%	0.000%
63Ni	2.70E-02	1.35E-07	7.48E-01	7.48E-04	7.48E-04	2.60E-04	1.94E-07	1.94E-07	0.000%	0.000%
60Co	5.22E-04	2.61E-09	1.45E-02	1.45E-05	1.45E-05	2.50E-01	3.62E-06	3.62E-06	0.005%	0.005%
90Sr	1.12E+01	5.58E-05	3.10E+02	3.10E-01	3.10E-01	1.10E-01	3.41E-02	3.41E-02	49.000%	49.000%
90Y	1.12E+01	5.58E-05	3.10E+02	3.10E-01	3.10E-01	3.40E-04	1.05E-04	1.05E-04	0.151%	0.151%
93Zr	1.30E-04	6.51E-10	3.61E-03	3.61E-06	3.61E-06	1.30E-03	4.69E-09	4.69E-09	0.000%	0.000%
99Tc	1.92E-03	9.60E-09	5.33E-02	5.33E-05	5.33E-05	2.30E-02	1.23E-06	1.23E-06	0.002%	0.002%
106Ru	9.23E-07	4.61E-12	2.56E-05	2.56E-08	2.56E-08	1.60E-02	4.10E-10	4.10E-10	0.000%	0.000%
125Sb	3.92E-04	1.96E-09	1.09E-02	1.09E-05	1.09E-05	2.40E-03	2.61E-08	2.61E-08	0.000%	0.000%
126Sn	4.31E-05	2.15E-10	1.19E-03	1.19E-06	1.19E-06	4.70E-02	5.61E-08	5.61E-08	0.000%	0.000%
129I	9.28E-06	4.64E-11	2.58E-04	2.58E-07	2.58E-07	2.00E-01	5.15E-08	5.15E-08	0.000%	0.000%
134Cs	7.99E-06	4.00E-11	2.22E-04	2.22E-07	2.22E-07	1.00E-01	2.22E-08	2.22E-08	0.000%	0.000%
137Cs	1.00E+00	5.00E-06	2.77E+01	2.77E-02	2.77E-02	2.70E-02	7.49E-04	7.49E-04	1.077%	1.077%
151Sm	1.01E-01	5.04E-07	2.79E+00	2.79E-03	2.79E-03	7.50E-04	2.10E-06	2.10E-06	0.003%	0.003%
152Eu	2.23E-04	1.12E-09	6.19E-03	6.19E-06	6.19E-06	2.40E-01	1.48E-06	1.48E-06	0.002%	0.002%
154Eu	4.69E-03	2.34E-08	1.30E-01	1.30E-04	1.30E-04	2.00E-01	2.60E-05	2.60E-05	0.037%	0.037%
155Eu	1.41E-02	7.05E-08	3.91E-01	3.91E-04	3.91E-04	8.00E-03	3.13E-06	3.13E-06	0.005%	0.005%
226Ra	1.99E-08	9.96E-14	5.53E-07	5.53E-10	5.53E-10	4.60E-01	2.54E-10	2.54E-10	0.000%	0.000%
228Ra	1.04E-06	5.18E-12	2.87E-05	2.87E-08	2.87E-08	1.90E-01	5.46E-09	5.46E-09	0.000%	0.000%
227Ac	2.46E-07	1.23E-12	6.82E-06	6.82E-09	6.82E-09	1.50E+01	1.02E-07	1.02E-07	0.000%	0.000%
229Th	4.19E-08	2.10E-13	1.16E-06	1.16E-09	1.16E-09	1.60E+01	1.86E-08	1.86E-08	0.000%	0.000%
232Th	4.10E-08	2.05E-13	1.14E-06	1.14E-09	1.14E-09	8.00E+00	9.11E-09	9.11E-09	0.000%	0.000%
231Pa	2.55E-07	1.28E-12	7.08E-06	7.08E-09	7.08E-09	1.20E+01	8.50E-08	8.50E-08	0.000%	0.000%
232U	3.17E-06	1.59E-11	8.79E-05	8.79E-08	8.79E-08	1.10E+01	9.67E-07	9.67E-07	0.001%	0.001%

233U	1.22E-05	6.09E-11	3.38E-04	3.38E-07	3.38E-07	3.10E+00	1.05E-06	1.05E-06	0.002%	0.002%
234U	2.41E-04	1.20E-09	6.67E-03	6.67E-06	6.67E-06	3.10E+00	2.07E-05	2.07E-05	0.030%	0.030%
235U	1.06E-05	5.32E-11	2.95E-04	2.95E-07	2.95E-07	3.00E+00	8.85E-07	8.85E-07	0.001%	0.001%
236U	2.46E-06	1.23E-11	6.82E-05	6.82E-08	6.82E-08	2.90E+00	1.98E-07	1.98E-07	0.000%	0.000%
238U	2.42E-04	1.21E-09	6.72E-03	6.72E-06	6.72E-06	2.80E+00	1.88E-05	1.88E-05	0.027%	0.027%
237Np	1.92E-06	9.58E-12	5.32E-05	5.32E-08	5.32E-08	1.20E+01	6.38E-07	6.38E-07	0.001%	0.001%
238Pu	1.19E-03	5.93E-09	3.29E-02	3.29E-05	3.29E-05	7.60E+00	2.50E-04	2.50E-04	0.360%	0.360%
239Pu	1.08E-01	5.41E-07	3.00E+00	3.00E-03	3.00E-03	8.20E+00	2.46E-02	2.46E-02	35.430%	35.430%
240Pu	1.14E-02	5.71E-08	3.17E-01	3.17E-04	3.17E-04	8.20E+00	2.60E-03	2.60E-03	3.737%	3.737%
241Pu	6.76E-02	3.38E-07	1.87E+00	1.87E-03	1.87E-03	1.30E-01	2.44E-04	2.44E-04	0.350%	0.350%
242Pu	3.23E-07	1.62E-12	8.97E-06	8.97E-09	8.97E-09	7.80E+00	7.00E-08	7.00E-08	0.000%	0.000%
241Am	1.88E-02	9.41E-08	5.22E-01	5.22E-04	5.22E-04	1.30E+01	6.78E-03	6.78E-03	9.759%	9.759%
243Am	4.19E-07	2.09E-12	1.16E-05	1.16E-08	1.16E-08	1.30E+01	1.51E-07	1.51E-07	0.000%	0.000%
242Cm	1.47E-04	7.36E-10	4.08E-03	4.08E-06	4.08E-06	4.10E-01	1.67E-06	1.67E-06	0.002%	0.002%
243Cm	5.12E-06	2.56E-11	1.42E-04	1.42E-07	1.42E-07	8.50E+00	1.21E-06	1.21E-06	0.002%	0.002%
244Cm	4.77E-05	2.39E-10	1.32E-03	1.32E-06	1.32E-06	6.70E+00	8.87E-06	8.87E-06	0.013%	0.013%
TOTAL			**6.57E+02**	**6.57E-01**	**6.57E-01**		**6.95E-02**	**6.95E-02**	**100%**	**100%**

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SOURCE TERM FOR CLOSED END PROBE AND CONE PENETROMETER BASED ON SCALING TO TANK ISOTOPE/Cs-137 RATIOS

NUMBER OF BOREHOLES PER YEAR	10		
VOLUME OF 75, 2-INCH DIAMETER X 10 INCH LONG SAMPLE PER BOREHOLE	1.3635	FEET^3	
VOLUME OF 10, 4-INCH DIAMETER X 2 FEET LONG SAMPLES	1.7453	FEET^3	
TOTAL SAMPLE VOLUME PER BOREHOLE	1.75	FEET^3	(MAXIMUM SOIL SAMPLE VOLUME PER BOREHOLE)
VOLUME FRACTION OF SOIL SAMPLES FROM HIGHLY CONTAMINATED ZONE	0.25		
TOTAL VOLUME OF CONTAMINATED SOIL EXTRACTED PER BOREHOLE BASED ON MAXIMUM SAMPLE VOLUME PER BOREHOLE	0.44	FEET^3	
TOTAL VOLUME OF CONTAMINATED SOIL EXTRACTED PER YEAR	4.36	FEET^3	
DENSITY OF SOIL	110	POUNDS/FEET^3	(AVERAGE FOR LOOSE, DRY SAND & GRAVEL - MARKS STANDARD HANDBOOK FOR MECHANICAL ENGINEERS)
TOTAL WEIGHT OF CONTAMINATED SOIL	2.18E+05	GRAMS	
Cs-137 CONCENTRATION SOIL (ASSUMES 100% SATURATION OF VOID SPACE)	3.30E-04	CURIES PER GRAM OF SOIL	
FRACTION OF SAMPLE AVAILABLE FOR RELEASE TO ATMOSPHERE	0.10		
RELEASE FRACTION	1.00E-03		
NUMBER OF HEPA FILTERS	0		
HEPA FILTER EFFICIENCY	99.95%		

ISOTOPE	AVERAGE TANK Cs-137 RATIO	AVERAGE CURIES PER GRAM OF SOIL	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	4.15E-04	1.37E-07	2.98E-02	2.98E-06	2.98E-06	2.50E-05	7.46E-11	7.46E-11	0.000%	0.000%
14C	1.15E-04	3.79E-08	8.26E-03	8.26E-07	8.26E-07	1.90E-03	1.57E-09	1.57E-09	0.000%	0.000%
59Ni	2.77E-04	9.15E-08	1.99E-02	1.99E-06	1.99E-06	3.10E-04	6.17E-10	6.17E-10	0.000%	0.000%
63Ni	2.70E-02	8.90E-06	1.94E+00	1.94E-04	1.94E-04	2.60E-04	5.04E-08	5.04E-08	0.000%	0.000%
60Co	5.22E-04	1.72E-07	3.75E-02	3.75E-06	3.75E-06	2.50E-01	9.37E-07	9.37E-07	0.005%	0.005%
90Sr	1.12E+01	3.68E-03	8.02E+02	8.02E-02	8.02E-02	1.10E-01	8.82E-03	8.82E-03	49.000%	49.000%
90Y	1.12E+01	3.68E-03	8.02E+02	8.02E-02	8.02E-02	3.40E-04	2.73E-05	2.73E-05	0.151%	0.151%
93Zr	1.30E-04	4.29E-08	9.35E-03	9.35E-07	9.35E-07	1.30E-03	1.22E-09	1.22E-09	0.000%	0.000%
99Tc	1.92E-03	6.34E-07	1.38E-01	1.38E-05	1.38E-05	2.30E-02	3.17E-07	3.17E-07	0.002%	0.002%
106Ru	9.23E-07	3.05E-10	6.63E-05	6.63E-09	6.63E-09	1.60E-02	1.06E-10	1.06E-10	0.000%	0.000%
125Sb	3.92E-04	1.29E-07	2.82E-02	2.82E-06	2.82E-06	2.40E-03	6.76E-09	6.76E-09	0.000%	0.000%
126Sn	4.31E-05	1.42E-08	3.09E-03	3.09E-07	3.09E-07	4.70E-02	1.45E-08	1.45E-08	0.000%	0.000%
129I	9.28E-06	3.06E-09	6.67E-04	6.67E-08	6.67E-08	2.00E-01	1.33E-08	1.33E-08	0.000%	0.000%
134Cs	7.99E-06	2.64E-09	5.74E-04	5.74E-08	5.74E-08	1.00E-01	5.74E-09	5.74E-09	0.000%	0.000%
137Cs	1.00E+00	3.30E-04	7.18E+01	7.18E-03	7.18E-03	2.70E-02	1.94E-04	1.94E-04	1.077%	1.077%
151Sm	1.01E-01	3.32E-05	7.24E+00	7.24E-04	7.24E-04	7.50E-04	5.43E-07	5.43E-07	0.003%	0.003%
152Eu	2.23E-04	7.36E-08	1.60E-02	1.60E-06	1.60E-06	2.40E-01	3.85E-07	3.85E-07	0.002%	0.002%
154Eu	4.69E-03	1.55E-06	3.37E-01	3.37E-05	3.37E-05	2.00E-01	6.73E-06	6.73E-06	0.037%	0.037%
155Eu	1.41E-02	4.65E-06	1.01E+00	1.01E-04	1.01E-04	8.00E-03	8.11E-07	8.11E-07	0.005%	0.005%
226Ra	1.99E-08	6.58E-12	1.43E-06	1.43E-10	1.43E-10	4.60E-01	6.59E-11	6.59E-11	0.000%	0.000%
228Ra	1.04E-06	3.42E-10	7.44E-05	7.44E-09	7.44E-09	1.90E-01	1.41E-09	1.41E-09	0.000%	0.000%
227Ac	2.46E-07	8.11E-11	1.77E-05	1.77E-09	1.77E-09	1.50E+01	2.65E-08	2.65E-08	0.000%	0.000%
229Th	4.19E-08	1.38E-11	3.01E-06	3.01E-10	3.01E-10	1.60E+01	4.82E-09	4.82E-09	0.000%	0.000%
232Th	4.10E-08	1.35E-11	2.95E-06	2.95E-10	2.95E-10	8.00E+00	2.36E-09	2.36E-09	0.000%	0.000%
231Pa	2.55E-07	8.43E-11	1.83E-05	1.83E-09	1.83E-09	1.20E+01	2.20E-08	2.20E-08	0.000%	0.000%
232U	3.17E-06	1.05E-09	2.28E-04	2.28E-08	2.28E-08	1.10E+01	2.51E-07	2.51E-07	0.001%	0.001%
233U	1.22E-05	4.02E-09	8.74E-04	8.74E-08	8.74E-08	3.10E+00	2.71E-07	2.71E-07	0.002%	0.002%
234U	2.41E-04	7.94E-08	1.73E-02	1.73E-06	1.73E-06	3.10E+00	5.36E-06	5.36E-06	0.030%	0.030%
235U	1.06E-05	3.51E-09	7.64E-04	7.64E-08	7.64E-08	3.00E+00	2.29E-07	2.29E-07	0.001%	0.001%
236U	2.46E-06	8.11E-10	1.77E-04	1.77E-08	1.77E-08	2.90E+00	5.12E-08	5.12E-08	0.000%	0.000%
238U	2.42E-04	8.00E-08	1.74E-02	1.74E-06	1.74E-06	2.80E+00	4.88E-06	4.88E-06	0.027%	0.027%

ISOTOPE	AVERAGE TANK Cs-137 RATIO	AVERAGE CURIES PER GRAM OF SOIL	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
237Np	1.92E-06	6.32E-10	1.38E-04	1.38E-08	1.38E-08	1.20E+01	1.65E-07	1.65E-07	0.001%	0.001%
238Pu	1.19E-03	3.92E-07	8.53E-02	8.53E-06	8.53E-06	7.60E+00	6.48E-05	6.48E-05	0.360%	0.360%
239Pu	1.08E-01	3.57E-05	7.78E+00	7.78E-04	7.78E-04	8.20E+00	6.38E-03	6.38E-03	35.430%	35.430%
240Pu	1.14E-02	3.77E-06	8.20E-01	8.20E-05	8.20E-05	8.20E+00	6.73E-04	6.73E-04	3.737%	3.737%
241Pu	6.76E-02	2.23E-05	4.85E+00	4.85E-04	4.85E-04	1.30E-01	6.31E-05	6.31E-05	0.350%	0.350%
242Pu	3.23E-07	1.07E-10	2.32E-05	2.32E-09	2.32E-09	7.80E+00	1.81E-08	1.81E-08	0.000%	0.000%
241Am	1.88E-02	6.21E-06	1.35E+00	1.35E-04	1.35E-04	1.30E+01	1.76E-03	1.76E-03	9.759%	9.759%
243Am	4.19E-07	1.38E-10	3.01E-05	3.01E-09	3.01E-09	1.30E+01	3.91E-08	3.91E-08	0.000%	0.000%
242Cm	1.47E-04	4.85E-08	1.06E-02	1.06E-06	1.06E-06	4.10E-01	4.33E-07	4.33E-07	0.002%	0.002%
243Cm	5.12E-06	1.69E-09	3.68E-04	3.68E-08	3.68E-08	8.50E+00	3.13E-07	3.13E-07	0.002%	0.002%
244Cm	4.77E-05	1.58E-08	3.43E-03	3.43E-07	3.43E-07	6.70E+00	2.30E-06	2.30E-06	0.013%	0.013%
TOTAL			1.70E+03	1.70E-01	1.70E-01		1.80E-02	1.80E-02	100%	100%

ATTACHMENT F

POTENTIAL-TO-EMIT ASSUMPTIONS AND CALCULATIONS CLOSING BOREHOLES AND REMOVING CASING

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SOURCE TERM FOR CLOSING BOREHOLES - AIR DRILLING METHOD

NUMBER OF BOREHOLES DECOMMISIONED PER YEAR	10	
LENGTH OF 10-INCH NOMINAL DIAMETER CASING PER BOREHOLE	50	FEET
LENGTH OF 8-INCH NOMINAL DIAMETER CASING PER BOREHOLE	200	FEET
TOTAL SURFACE AREA OF EQUIVALENT BOREHOLE	97.08	FEET^2
ASSUMED CONTAMINATED SOIL THICKNESS	1/64	INCH
OUTSIDE UNIFORM SOIL COVERAGE VOLUME PER BOREHOLE	0.72	FEET^3
OUTSIDE UNIFORM SOIL COVERAGE VOLUME PER YEAR	7.17	FEET^3
OUTSIDE FRACTION OF SURFACE CONTAMINATED	0.15	
INSIDE FRACTION OF SURFACE CONTAMINATED	0.015	
ESTIMATED SOIL COVERAGE VOLUME	1.183	FEET^3
DENSITY OF SOIL	110	POUNDS/FEET^3 (AVERAGE FOR LOOSE, DRY SAND & GRAVEL - MARKS STANDARD HANDBOOK FOR MECHANICAL ENGINEERS)
WEIGHT OF SOIL	130.17	POUNDS
WEIGHT OF SOIL	59,044.05	GRAMS
RELEASE FRACTION	1.00E-03	

ISOTOPE	AVERAGE CURIES PER GRAM OF SOIL	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	2.08E-12	1.23E-07	1.23E-10	1.23E-10	2.50E-05	3.06E-15	3.06E-15	0.00%	0.00%
14C	5.75E-13	3.39E-08	3.39E-11	3.39E-11	1.90E-03	6.45E-14	6.45E-14	0.00%	0.00%
59Ni	1.39E-12	8.18E-08	8.18E-11	8.18E-11	3.10E-04	2.54E-14	2.54E-14	0.00%	0.00%
63Ni	1.35E-10	7.96E-06	7.96E-09	7.96E-09	2.60E-04	2.07E-12	2.07E-12	0.00%	0.00%
60Co	2.61E-12	1.54E-07	1.54E-10	1.54E-10	2.50E-01	3.85E-11	3.85E-11	0.01%	0.01%
90Sr	5.58E-08	3.30E-03	3.30E-06	3.30E-06	1.10E-01	3.63E-07	3.63E-07	49.00%	49.00%
90Y	5.58E-08	3.30E-03	3.30E-06	3.30E-06	3.40E-04	1.12E-09	1.12E-09	0.15%	0.15%
93Zr	6.51E-13	3.84E-08	3.84E-11	3.84E-11	1.30E-03	4.99E-14	4.99E-14	0.00%	0.00%
99Tc	9.60E-12	5.67E-07	5.67E-10	5.67E-10	2.30E-02	1.30E-11	1.30E-11	0.00%	0.00%
106Ru	4.61E-15	2.72E-10	2.72E-13	2.72E-13	1.60E-02	4.36E-15	4.36E-15	0.00%	0.00%
125Sb	1.96E-12	1.16E-07	1.16E-10	1.16E-10	2.40E-03	2.78E-13	2.78E-13	0.00%	0.00%
126Sn	2.15E-13	1.27E-08	1.27E-11	1.27E-11	4.70E-02	5.97E-13	5.97E-13	0.00%	0.00%
129I	4.64E-14	2.74E-09	2.74E-12	2.74E-12	2.00E-01	5.48E-13	5.48E-13	0.00%	0.00%
134Cs	4.00E-14	2.36E-09	2.36E-12	2.36E-12	1.00E-01	2.36E-13	2.36E-13	0.00%	0.00%
137Cs	5.00E-09	2.95E-04	2.95E-07	2.95E-07	2.70E-02	7.97E-09	7.97E-09	1.08%	1.08%
151Sm	5.04E-10	2.97E-05	2.97E-08	2.97E-08	7.50E-04	2.23E-11	2.23E-11	0.00%	0.00%
152Eu	1.12E-12	6.58E-08	6.58E-11	6.58E-11	2.40E-01	1.58E-11	1.58E-11	0.00%	0.00%
154Eu	2.34E-11	1.38E-06	1.38E-09	1.38E-09	2.00E-01	2.77E-10	2.77E-10	0.04%	0.04%
155Eu	7.05E-11	4.16E-06	4.16E-09	4.16E-09	8.00E-03	3.33E-11	3.33E-11	0.00%	0.00%
226Ra	9.96E-17	5.88E-12	5.88E-15	5.88E-15	4.60E-01	2.71E-15	2.71E-15	0.00%	0.00%
228Ra	5.18E-15	3.06E-10	3.06E-13	3.06E-13	1.90E-01	5.81E-14	5.81E-14	0.00%	0.00%
227Ac	1.23E-15	7.26E-11	7.26E-14	7.26E-14	1.50E+01	1.09E-12	1.09E-12	0.00%	0.00%
229Th	2.10E-16	1.24E-11	1.24E-14	1.24E-14	1.60E+01	1.98E-13	1.98E-13	0.00%	0.00%
232Th	2.05E-16	1.21E-11	1.21E-14	1.21E-14	8.00E+00	9.69E-14	9.69E-14	0.00%	0.00%
231Pa	1.28E-15	7.54E-11	7.54E-14	7.54E-14	1.20E+01	9.05E-13	9.05E-13	0.00%	0.00%
232U	1.59E-14	9.36E-10	9.36E-13	9.36E-13	1.10E+01	1.03E-11	1.03E-11	0.00%	0.00%
233U	6.09E-14	3.59E-09	3.59E-12	3.59E-12	3.10E+00	1.11E-11	1.11E-11	0.00%	0.00%
234U	1.20E-12	7.10E-08	7.10E-11	7.10E-11	3.10E+00	2.20E-10	2.20E-10	0.03%	0.03%
235U	5.32E-14	3.14E-09	3.14E-12	3.14E-12	3.00E+00	9.42E-12	9.42E-12	0.00%	0.00%
236U	1.23E-14	7.26E-10	7.26E-13	7.26E-13	2.90E+00	2.10E-12	2.10E-12	0.00%	0.00%

238U	1.21E-12	7.16E-08	7.16E-11	7.16E-11	2.80E+00	2.00E-10	2.00E-10	0.03%	0.03%
237Np	9.58E-15	5.66E-10	5.66E-13	5.66E-13	1.20E+01	6.79E-12	6.79E-12	0.00%	0.00%
238Pu	5.93E-12	3.50E-07	3.50E-10	3.50E-10	7.60E+00	2.66E-09	2.66E-09	0.36%	0.36%
239Pu	5.41E-10	3.20E-05	3.20E-08	3.20E-08	8.20E+00	2.62E-07	2.62E-07	35.43%	35.43%
240Pu	5.71E-11	3.37E-06	3.37E-09	3.37E-09	8.20E+00	2.76E-08	2.76E-08	3.74%	3.74%
241Pu	3.38E-10	1.99E-05	1.99E-08	1.99E-08	1.30E-01	2.59E-09	2.59E-09	0.35%	0.35%
242Pu	1.62E-15	9.55E-11	9.55E-14	9.55E-14	7.80E+00	7.45E-13	7.45E-13	0.00%	0.00%
241Am	9.41E-11	5.55E-06	5.55E-09	5.55E-09	1.30E+01	7.22E-08	7.22E-08	9.76%	9.76%
243Am	2.09E-15	1.24E-10	1.24E-13	1.24E-13	1.30E+01	1.61E-12	1.61E-12	0.00%	0.00%
242Cm	7.36E-13	4.34E-08	4.34E-11	4.34E-11	4.10E-01	1.78E-11	1.78E-11	0.00%	0.00%
243Cm	2.56E-14	1.51E-09	1.51E-12	1.51E-12	8.50E+00	1.28E-11	1.28E-11	0.00%	0.00%
244Cm	2.39E-13	1.41E-08	1.41E-11	1.41E-11	6.70E+00	9.44E-11	9.44E-11	0.01%	0.01%
TOTAL		6.99E-03	6.99E-06	6.99E-06		7.40E-07	7.40E-07	100.00%	100.00%

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SOURCE TERM FOR CLOSING BOREHOLES USING CABLE OR SONIC DRILLING									
NUMBER OF BOREHOLES DECOMMISIONED PER YEAR	10								
LENGTH OF 10-INCH NOMINAL DIAMETER CASING PER BOREHOLE	50	FEET							
LENGTH OF 8-INCH NOMINAL DIAMETER CASING PER BOREHOLE	200	FEET							
TOTAL SURFACE AREA OF EQUIVALENT BOREHOLE	97.08	FEET^2							
ASSUMED CONTAMINATED SOIL THICKNESS	1/64	INCH							
OUTSIDE UNIFORM SOIL COVERAGE VOLUME PER BOREHOLE	0.72	FEET^3							
OUTSIDE UNIFORM SOIL COVERAGE VOLUME PER YEAR	7.17	FEET^3							
OUTSIDE FRACTION OF SURFACE CONTAMINATED	0.15								
INSIDE FRACTION OF SURFACE CONTAMINATED	0.015								
ESTIMATED SOIL COVERAGE VOLUME	1.183	FEET^3							
DENSITY OF SOIL	110	POUNDS/FEET^3	(AVERAGE FOR LOOSE, DRY SAND & GRAVEL - MARKS STANDARD HANDBOOK FOR MECHANICAL ENGINEERS)						
WEIGHT OF SOIL	130.17	POUNDS							
WEIGHT OF SOIL	59,044.05	GRAMS							
RELEASE FRACTION	1.00E-03								
ISOTOPE	AVERAGE CURIES PER GRAM OF SOIL	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	2.08E-09	1.23E-04	1.23E-07	1.23E-07	2.50E-05	3.06E-12	3.06E-12	0.00%	0.00%
14C	5.75E-10	3.39E-05	3.39E-08	3.39E-08	1.90E-03	6.45E-11	6.45E-11	0.00%	0.00%
59Ni	1.39E-09	8.18E-05	8.18E-08	8.18E-08	3.10E-04	2.54E-11	2.54E-11	0.00%	0.00%
63Ni	1.35E-07	7.96E-03	7.96E-06	7.96E-06	2.60E-04	2.07E-09	2.07E-09	0.00%	0.00%
60Co	2.61E-09	1.54E-04	1.54E-07	1.54E-07	2.50E-01	3.85E-08	3.85E-08	0.01%	0.01%
90Sr	5.58E-05	3.30E+00	3.30E-03	3.30E-03	1.10E-01	3.63E-04	3.63E-04	49.00%	49.00%
90Y	5.58E-05	3.30E+00	3.30E-03	3.30E-03	3.40E-04	1.12E-06	1.12E-06	0.15%	0.15%
93Zr	6.51E-10	3.84E-05	3.84E-08	3.84E-08	1.30E-03	4.99E-11	4.99E-11	0.00%	0.00%
99Tc	9.60E-09	5.67E-04	5.67E-07	5.67E-07	2.30E-02	1.30E-06	1.30E-06	0.00%	0.00%
106Ru	4.61E-12	2.72E-07	2.72E-10	2.72E-10	1.60E-02	4.36E-12	4.36E-12	0.00%	0.00%
125Sb	1.96E-09	1.16E-04	1.16E-07	1.16E-07	2.40E-03	2.78E-10	2.78E-10	0.00%	0.00%
126Sn	2.15E-10	1.27E-05	1.27E-08	1.27E-08	4.70E-02	5.97E-10	5.97E-10	0.00%	0.00%
129I	4.64E-11	2.74E-06	2.74E-09	2.74E-09	2.00E-01	5.48E-10	5.48E-10	0.00%	0.00%
134Cs	4.00E-11	2.36E-06	2.36E-09	2.36E-09	1.00E-01	2.36E-10	2.36E-10	0.00%	0.00%
137Cs	5.00E-06	2.95E-01	2.95E-04	2.95E-04	2.70E-02	7.97E-06	7.97E-06	1.08%	1.08%
151Sm	5.04E-07	2.97E-02	2.97E-05	2.97E-05	7.50E-04	2.23E-08	2.23E-08	0.00%	0.00%
152Eu	1.12E-09	6.58E-05	6.58E-08	6.58E-08	2.40E-01	1.58E-08	1.58E-08	0.00%	0.00%
154Eu	2.34E-08	1.38E-03	1.38E-06	1.38E-06	2.00E-01	2.77E-07	2.77E-07	0.04%	0.04%
155Eu	7.05E-08	4.16E-03	4.16E-06	4.16E-06	8.00E-03	3.33E-08	3.33E-08	0.00%	0.00%
226Ra	9.96E-14	5.88E-09	5.88E-12	5.88E-12	4.60E-01	2.71E-12	2.71E-12	0.00%	0.00%
228Ra	5.18E-12	3.06E-07	3.06E-10	3.06E-10	1.90E-01	5.81E-11	5.81E-11	0.00%	0.00%
227Ac	1.23E-12	7.26E-08	7.26E-11	7.26E-11	1.50E+01	1.09E-09	1.09E-09	0.00%	0.00%
229Th	2.10E-13	1.24E-08	1.24E-11	1.24E-11	1.60E+01	1.98E-10	1.98E-10	0.00%	0.00%
232Th	2.05E-13	1.21E-08	1.21E-11	1.21E-11	8.00E+00	9.69E-11	9.69E-11	0.00%	0.00%
231Pa	1.28E-12	7.54E-08	7.54E-11	7.54E-11	1.20E+01	9.05E-10	9.05E-10	0.00%	0.00%
232U	1.59E-11	9.36E-07	9.36E-10	9.36E-10	1.10E+01	1.03E-08	1.03E-08	0.00%	0.00%
233U	6.09E-11	3.59E-06	3.59E-09	3.59E-09	3.10E+00	1.11E-08	1.11E-08	0.00%	0.00%
234U	1.20E-09	7.10E-05	7.10E-08	7.10E-08	3.10E+00	2.20E-07	2.20E-07	0.03%	0.03%
235U	5.32E-11	3.14E-06	3.14E-09	3.14E-09	3.00E+00	9.42E-09	9.42E-09	0.00%	0.00%
236U	1.23E-11	7.26E-07	7.26E-10	7.26E-10	2.90E+00	2.10E-09	2.10E-09	0.00%	0.00%

238U	1.21E-09	7.16E-05	7.16E-08	7.16E-08	2.80E+00	2.00E-07	2.00E-07	0.03%	0.03%
237Np	9.58E-12	5.66E-07	5.66E-10	5.66E-10	1.20E+01	6.79E-09	6.79E-09	0.00%	0.00%
238Pu	5.93E-09	3.50E-04	3.50E-07	3.50E-07	7.60E+00	2.66E-06	2.66E-06	0.36%	0.36%
239Pu	5.41E-07	3.20E-02	3.20E-05	3.20E-05	8.20E+00	2.62E-04	2.62E-04	35.43%	35.43%
240Pu	5.71E-08	3.37E-03	3.37E-06	3.37E-06	8.20E+00	2.76E-05	2.76E-05	3.74%	3.74%
241Pu	3.38E-07	1.99E-02	1.99E-05	1.99E-05	1.30E-01	2.59E-06	2.59E-06	0.35%	0.35%
242Pu	1.62E-12	9.55E-08	9.55E-11	9.55E-11	7.80E+00	7.45E-10	7.45E-10	0.00%	0.00%
241Am	9.41E-08	5.55E-03	5.55E-06	5.55E-06	1.30E+01	7.22E-05	7.22E-05	9.76%	9.76%
243Am	2.09E-12	1.24E-07	1.24E-10	1.24E-10	1.30E+01	1.61E-09	1.61E-09	0.00%	0.00%
242Cm	7.36E-10	4.34E-05	4.34E-08	4.34E-08	4.10E-01	1.78E-08	1.78E-08	0.00%	0.00%
243Cm	2.56E-11	1.51E-06	1.51E-09	1.51E-09	8.50E+00	1.28E-08	1.28E-08	0.00%	0.00%
244Cm	2.39E-10	1.41E-05	1.41E-08	1.41E-08	6.70E+00	9.44E-08	9.44E-08	0.01%	0.01%
TOTAL		6.99E+00	6.99E-03	6.99E-03		7.40E-04	7.40E-04	100.00%	100.00%

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SOURCE TERM FOR CLOSING BOREHOLES BASED ON CLOSED END PROBE AND CONE PENETROMETER

NUMBER OF BOREHOLES DECOMMISIONED PER YEAR	10								
LENGTH OF 10-INCH NOMINAL DIAMETER CASING PER BOREHOLE	50	FEET							
LENGTH OF 8-INCH NOMINAL DIAMETER CASING PER BOREHOLE	200	FEET							
TOTAL SURFACE AREA OF EQUIVALENT BOREHOLE	97.08	FEET^2							
ASSUMED CONTAMINATED SOIL THICKNESS	1/64	INCH							
OUTSIDE UNIFORM SOIL COVERAGE VOLUME PER BOREHOLE	0.72	FEET^3							
OUTSIDE UNIFORM SOIL COVERAGE VOLUME PER YEAR	7.17	FEET^3							
OUTSIDE FRACTION OF SURFACE CONTAMINATED	0.15								
INSIDE FRACTION OF SURFACE CONTAMINATED	0.015								
ESTIMATED SOIL COVERAGE VOLUME	1.183	FEET^3							
DENSITY OF SOIL	110	POUNDS/FEET^3	(AVERAGE FOR LOOSE, DRY SAND & GRAVEL - MARKS STANDARD HANDBOOK FOR MECHANICAL ENGINEERS)						
WEIGHT OF SOIL	130.17	POUNDS							
WEIGHT OF SOIL	59,044.05	GRAMS							
RELEASE FRACTION	1.00E-03								
ISOTOPE	AVERAGE CURIES PER GRAM OF SOIL	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	1.37E-07	8.09E-03	8.09E-06	8.09E-06	2.50E-05	2.02E-10	2.02E-10	0.00%	0.00%
14C	3.79E-08	2.24E-03	2.24E-06	2.24E-06	1.90E-03	4.26E-09	4.26E-09	0.00%	0.00%
59Ni	9.15E-08	5.40E-03	5.40E-06	5.40E-06	3.10E-04	1.67E-09	1.67E-09	0.00%	0.00%
63Ni	8.90E-06	5.25E-01	5.25E-04	5.25E-04	2.60E-04	1.37E-07	1.37E-07	0.00%	0.00%
60Co	1.72E-07	1.02E-02	1.02E-05	1.02E-05	2.50E-01	2.54E-06	2.54E-06	0.01%	0.01%
90Sr	3.68E-03	2.18E+02	2.18E-01	2.18E-01	1.10E-01	2.39E-02	2.39E-02	49.00%	49.00%
90Y	3.68E-03	2.18E+02	2.18E-01	2.18E-01	3.40E-04	7.40E-05	7.40E-05	0.15%	0.15%
93Zr	4.29E-08	2.54E-03	2.54E-06	2.54E-06	1.30E-03	3.30E-09	3.30E-09	0.00%	0.00%
99Tc	6.34E-07	3.74E-02	3.74E-05	3.74E-05	2.30E-02	8.61E-07	8.61E-07	0.00%	0.00%
106Ru	3.05E-10	1.80E-05	1.80E-08	1.80E-08	1.60E-02	2.88E-10	2.88E-10	0.00%	0.00%
125Sb	1.29E-07	7.64E-03	7.64E-06	7.64E-06	2.40E-03	1.83E-08	1.83E-08	0.00%	0.00%
126Sn	1.42E-08	8.39E-04	8.39E-07	8.39E-07	4.70E-02	3.94E-08	3.94E-08	0.00%	0.00%
129I	3.06E-09	1.81E-04	1.81E-07	1.81E-07	2.00E-01	3.62E-08	3.62E-08	0.00%	0.00%
134Cs	2.64E-09	1.56E-04	1.56E-07	1.56E-07	1.00E-01	1.56E-08	1.56E-08	0.00%	0.00%
137Cs	3.30E-04	1.95E+01	1.95E-02	1.95E-02	2.70E-02	5.26E-04	5.26E-04	1.08%	1.08%
151Sm	3.32E-05	1.96E+00	1.96E-03	1.96E-03	7.50E-04	1.47E-06	1.47E-06	0.00%	0.00%
152Eu	7.36E-08	4.35E-03	4.35E-06	4.35E-06	2.40E-01	1.04E-06	1.04E-06	0.00%	0.00%
154Eu	1.55E-06	9.13E-02	9.13E-05	9.13E-05	2.00E-01	1.83E-05	1.83E-05	0.04%	0.04%
155Eu	4.65E-06	2.75E-01	2.75E-04	2.75E-04	8.00E-03	2.20E-06	2.20E-06	0.00%	0.00%
226Ra	6.58E-12	3.88E-07	3.88E-10	3.88E-10	4.60E-01	1.79E-10	1.79E-10	0.00%	0.00%
228Ra	3.42E-10	2.02E-05	2.02E-08	2.02E-08	1.90E-01	3.83E-09	3.83E-09	0.00%	0.00%
227Ac	8.11E-11	4.79E-06	4.79E-09	4.79E-09	1.50E+01	7.18E-08	7.18E-08	0.00%	0.00%
229Th	1.38E-11	8.17E-07	8.17E-10	8.17E-10	1.60E+01	1.31E-08	1.31E-08	0.00%	0.00%
232Th	1.35E-11	8.00E-07	8.00E-10	8.00E-10	8.00E+00	6.40E-09	6.40E-09	0.00%	0.00%
231Pa	8.43E-11	4.97E-06	4.97E-09	4.97E-09	1.20E+01	5.97E-08	5.97E-08	0.00%	0.00%
232U	1.05E-09	6.18E-05	6.18E-08	6.18E-08	1.10E+01	6.79E-07	6.79E-07	0.00%	0.00%
233U	4.02E-09	2.37E-04	2.37E-07	2.37E-07	3.10E+00	7.35E-07	7.35E-07	0.00%	0.00%
234U	7.94E-08	4.69E-03	4.69E-06	4.69E-06	3.10E+00	1.45E-05	1.45E-05	0.03%	0.03%
235U	3.51E-09	2.07E-04	2.07E-07	2.07E-07	3.00E+00	6.22E-07	6.22E-07	0.00%	0.00%
236U	8.11E-10	4.79E-05	4.79E-08	4.79E-08	2.90E+00	1.39E-07	1.39E-07	0.00%	0.00%

ISOTOPE	AVERAGE CURIES PER GRAM OF SOIL	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
238U	8.00E-08	4.72E-03	4.72E-06	4.72E-06	2.80E+00	1.32E-05	1.32E-05	0.03%	0.03%
237Np	6.32E-10	3.73E-05	3.73E-08	3.73E-08	1.20E+01	4.48E-07	4.48E-07	0.00%	0.00%
238Pu	3.92E-07	2.31E-02	2.31E-05	2.31E-05	7.60E+00	1.76E-04	1.76E-04	0.36%	0.36%
239Pu	3.57E-05	2.11E+00	2.11E-03	2.11E-03	8.20E+00	1.73E-02	1.73E-02	35.43%	35.43%
240Pu	3.77E-06	2.23E-01	2.23E-04	2.23E-04	8.20E+00	1.82E-03	1.82E-03	3.74%	3.74%
241Pu	2.23E-05	1.32E+00	1.32E-03	1.32E-03	1.30E-01	1.71E-04	1.71E-04	0.35%	0.35%
242Pu	1.07E-10	6.30E-06	6.30E-09	6.30E-09	7.80E+00	4.92E-08	4.92E-08	0.00%	0.00%
241Am	6.21E-06	3.67E-01	3.67E-04	3.67E-04	1.30E+01	4.77E-03	4.77E-03	9.76%	9.76%
243Am	1.38E-10	8.16E-06	8.16E-09	8.16E-09	1.30E+01	1.06E-07	1.06E-07	0.00%	0.00%
242Cm	4.85E-08	2.87E-03	2.87E-06	2.87E-06	4.10E-01	1.18E-06	1.18E-06	0.00%	0.00%
243Cm	1.69E-09	9.98E-05	9.98E-08	9.98E-08	8.50E+00	8.48E-07	8.48E-07	0.00%	0.00%
244Cm	1.58E-08	9.30E-04	9.30E-07	9.30E-07	6.70E+00	6.23E-06	6.23E-06	0.01%	0.01%
TOTAL		4.61E+02	4.61E-01	4.61E-01		4.88E-02	4.88E-02	100.00%	100.00%

ATTACHMENT G

SUMMARY OF POTENTIAL-TO-EMIT ASSUMPTIONS DRILLING BOREHOLES/CLOSING BOREHOLES AND REMOVING CASING

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SUMMARY OF OVERALL EMISSIONS USING AIR DRILLING METHOD ONLY

ISOTOPE	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	1.16E-05	1.15E-05	1.15E-05	2.50E-05	2.88E-10	2.88E-10	0.00%	0.00%
14C	3.22E-06	3.19E-06	3.19E-06	1.90E-03	6.06E-09	6.06E-09	0.00%	0.02%
59Ni	7.77E-06	7.69E-06	3.93E-09	3.10E-04	2.38E-09	1.22E-12	0.00%	0.00%
63Ni	7.56E-04	7.48E-04	3.82E-07	2.60E-04	1.94E-07	9.93E-11	0.00%	0.00%
60Co	1.46E-05	1.45E-05	7.39E-09	2.50E-01	3.62E-06	1.85E-09	0.01%	0.01%
90Sr	3.13E-01	3.10E-01	1.58E-04	1.10E-01	3.41E-02	1.74E-05	49.00%	48.99%
90Y	3.13E-01	3.10E-01	1.58E-04	3.40E-04	1.05E-04	5.38E-08	0.15%	0.15%
93Zr	3.65E-06	3.61E-06	1.84E-09	1.30E-03	4.69E-09	2.40E-12	0.00%	0.00%
99Tc	5.38E-05	5.33E-05	2.72E-08	2.30E-02	1.23E-06	6.26E-10	0.00%	0.00%
106Ru	2.59E-08	2.56E-08	1.31E-11	1.60E-02	4.10E-10	2.09E-13	0.00%	0.00%
125Sb	1.10E-05	1.09E-05	5.55E-09	2.40E-03	2.61E-08	1.33E-11	0.00%	0.00%
126Sn	1.21E-06	1.19E-06	6.10E-10	4.70E-02	5.61E-08	2.87E-11	0.00%	0.00%
129I	2.60E-07	2.58E-07	1.32E-10	2.00E-01	5.15E-08	2.63E-11	0.00%	0.00%
134Cs	2.24E-07	2.22E-07	1.13E-10	1.00E-01	2.22E-08	1.13E-11	0.00%	0.00%
137Cs	2.80E-02	2.77E-02	1.42E-05	2.70E-02	7.49E-04	3.82E-07	1.08%	1.08%
151Sm	2.82E-03	2.79E-03	1.43E-06	7.50E-04	2.10E-06	1.07E-09	0.00%	0.00%
152Eu	6.25E-06	6.19E-06	3.16E-09	2.40E-01	1.48E-06	7.58E-10	0.00%	0.00%
154Eu	1.31E-04	1.30E-04	6.64E-08	2.00E-01	2.60E-05	1.33E-08	0.04%	0.04%
155Eu	3.95E-04	3.91E-04	2.00E-07	8.00E-03	3.13E-06	1.60E-09	0.00%	0.00%
226Ra	5.59E-10	5.53E-10	2.82E-13	4.60E-01	2.54E-10	1.30E-13	0.00%	0.00%
228Ra	2.90E-08	2.87E-08	1.47E-11	1.90E-01	5.46E-09	2.79E-12	0.00%	0.00%
227Ac	6.89E-09	6.82E-09	3.48E-12	1.50E+01	1.02E-07	5.22E-11	0.00%	0.00%
229Th	1.18E-09	1.16E-09	5.94E-13	1.60E+01	1.86E-08	9.51E-12	0.00%	0.00%
232Th	1.15E-09	1.14E-09	5.81E-13	8.00E+00	9.11E-09	4.65E-12	0.00%	0.00%
231Pa	7.16E-09	7.08E-09	3.62E-12	1.20E+01	8.50E-08	4.34E-11	0.00%	0.00%
232U	8.89E-08	8.79E-08	4.49E-11	1.10E+01	9.67E-07	4.94E-10	0.00%	0.00%
233U	3.41E-07	3.38E-07	1.72E-10	3.10E+00	1.05E-06	5.34E-10	0.00%	0.00%
234U	6.74E-06	6.67E-06	3.41E-09	3.10E+00	2.07E-05	1.06E-08	0.03%	0.03%
235U	2.98E-07	2.95E-07	1.51E-10	3.00E+00	8.85E-07	4.52E-10	0.00%	0.00%
236U	6.89E-08	6.82E-08	3.48E-11	2.90E+00	1.98E-07	1.01E-10	0.00%	0.00%
238U	6.79E-06	6.72E-06	3.43E-09	2.80E+00	1.88E-05	9.61E-09	0.03%	0.03%
237Np	5.37E-08	5.32E-08	2.71E-11	1.20E+01	6.38E-07	3.26E-10	0.00%	0.00%
238Pu	3.33E-05	3.29E-05	1.68E-08	7.60E+00	2.50E-04	1.28E-07	0.36%	0.36%
239Pu	3.04E-03	3.00E-03	1.53E-06	8.20E+00	2.46E-02	1.26E-05	35.43%	35.42%
240Pu	3.20E-04	3.17E-04	1.62E-07	8.20E+00	2.60E-03	1.33E-06	3.74%	3.74%
241Pu	1.89E-03	1.87E-03	9.57E-07	1.30E-01	2.44E-04	1.24E-07	0.35%	0.35%
242Pu	9.07E-09	8.97E-09	4.58E-12	7.80E+00	7.00E-08	3.57E-11	0.00%	0.00%
241Am	5.27E-04	5.22E-04	2.66E-07	1.30E+01	6.78E-03	3.46E-06	9.76%	9.76%
243Am	1.17E-08	1.16E-08	5.93E-12	1.30E+01	1.51E-07	7.71E-11	0.00%	0.00%
242Cm	4.12E-06	4.08E-06	2.08E-09	4.10E-01	1.67E-06	8.54E-10	0.00%	0.00%
243Cm	1.44E-07	1.42E-07	7.25E-11	8.50E+00	1.21E-06	6.16E-10	0.00%	0.00%
244Cm	1.34E-06	1.32E-06	6.76E-10	6.70E+00	8.87E-06	4.53E-09	0.01%	0.01%
TOTAL	6.64E-01	6.57E-01	3.50E-04		6.95E-02	3.55E-05	100.00%	100.00%

SUMMARY OF OVERALL EMISSIONS USING TRADITIONAL CABLE TOOL AND SONIC DRILLING

ISOTOPE	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	1.16E-02	1.16E-05	1.16E-05	2.50E-05	2.91E-10	2.91E-10	0.00%	0.00%
14C	3.22E-03	3.22E-06	3.22E-06	1.90E-03	6.13E-09	6.13E-09	0.00%	0.00%
59Ni	7.77E-03	7.77E-06	7.77E-06	3.10E-04	2.41E-09	2.41E-09	0.00%	0.00%
63Ni	7.56E-01	7.56E-04	7.56E-04	2.60E-04	1.96E-07	1.96E-07	0.00%	0.00%
60Co	1.46E-02	1.46E-05	1.46E-05	2.50E-01	3.66E-06	3.66E-06	0.01%	0.01%
90Sr	3.13E+02	3.13E-01	3.13E-01	1.10E-01	3.44E-02	3.44E-02	49.00%	49.00%
90Y	3.13E+02	3.13E-01	3.13E-01	3.40E-04	1.06E-04	1.06E-04	0.15%	0.15%
93Zr	3.65E-03	3.65E-06	3.65E-06	1.30E-03	4.74E-09	4.74E-09	0.00%	0.00%
99Tc	5.38E-02	5.38E-05	5.38E-05	2.30E-02	1.24E-06	1.24E-06	0.00%	0.00%
106Ru	2.59E-05	2.59E-08	2.59E-08	1.60E-02	4.14E-10	4.14E-10	0.00%	0.00%
125Sb	1.10E-02	1.10E-05	1.10E-05	2.40E-03	2.64E-08	2.64E-08	0.00%	0.00%
126Sn	1.21E-03	1.21E-06	1.21E-06	4.70E-02	5.67E-08	5.67E-08	0.00%	0.00%
129I	2.60E-04	2.60E-07	2.60E-07	2.00E-01	5.21E-08	5.21E-08	0.00%	0.00%
134Cs	2.24E-04	2.24E-07	2.24E-07	1.00E-01	2.24E-08	2.24E-08	0.00%	0.00%
137Cs	2.80E+01	2.80E-02	2.80E-02	2.70E-02	7.57E-04	7.57E-04	1.08%	1.08%
151Sm	2.82E+00	2.82E-03	2.82E-03	7.50E-04	2.12E-06	2.12E-06	0.00%	0.00%
152Eu	6.25E-03	6.25E-06	6.25E-06	2.40E-01	1.50E-06	1.50E-06	0.00%	0.00%
154Eu	1.31E-01	1.31E-04	1.31E-04	2.00E-01	2.63E-05	2.63E-05	0.04%	0.04%
155Eu	3.95E-01	3.95E-04	3.95E-04	8.00E-03	3.16E-06	3.16E-06	0.00%	0.00%
226Ra	5.59E-07	5.59E-10	5.59E-10	4.60E-01	2.57E-10	2.57E-10	0.00%	0.00%
228Ra	2.90E-05	2.90E-08	2.90E-08	1.90E-01	5.51E-09	5.51E-09	0.00%	0.00%
227Ac	6.89E-06	6.89E-09	6.89E-09	1.50E+01	1.03E-07	1.03E-07	0.00%	0.00%
229Th	1.18E-06	1.18E-09	1.18E-09	1.60E+01	1.88E-08	1.88E-08	0.00%	0.00%
232Th	1.15E-06	1.15E-09	1.15E-09	8.00E+00	9.21E-09	9.21E-09	0.00%	0.00%
231Pa	7.16E-06	7.16E-09	7.16E-09	1.20E+01	8.59E-08	8.59E-08	0.00%	0.00%
232U	8.89E-05	8.89E-08	8.89E-08	1.10E+01	9.78E-07	9.78E-07	0.00%	0.00%
233U	3.41E-04	3.41E-07	3.41E-07	3.10E+00	1.06E-06	1.06E-06	0.00%	0.00%
234U	6.74E-03	6.74E-06	6.74E-06	3.10E+00	2.09E-05	2.09E-05	0.03%	0.03%
235U	2.98E-04	2.98E-07	2.98E-07	3.00E+00	8.95E-07	8.95E-07	0.00%	0.00%
236U	6.89E-05	6.89E-08	6.89E-08	2.90E+00	2.00E-07	2.00E-07	0.00%	0.00%
238U	6.79E-03	6.79E-06	6.79E-06	2.80E+00	1.90E-05	1.90E-05	0.03%	0.03%
237Np	5.37E-05	5.37E-08	5.37E-08	1.20E+01	6.45E-07	6.45E-07	0.00%	0.00%
238Pu	3.33E-02	3.33E-05	3.33E-05	7.60E+00	2.53E-04	2.53E-04	0.36%	0.36%
239Pu	3.04E+00	3.04E-03	3.04E-03	8.20E+00	2.49E-02	2.49E-02	35.43%	35.43%
240Pu	3.20E-01	3.20E-04	3.20E-04	8.20E+00	2.63E-03	2.63E-03	3.74%	3.74%
241Pu	1.89E+00	1.89E-03	1.89E-03	1.30E-01	2.46E-04	2.46E-04	0.35%	0.35%
242Pu	9.07E-06	9.07E-09	9.07E-09	7.80E+00	7.07E-08	7.07E-08	0.00%	0.00%
241Am	5.27E-01	5.27E-04	5.27E-04	1.30E+01	6.86E-03	6.86E-03	9.76%	9.76%
243Am	1.17E-05	1.17E-08	1.17E-08	1.30E+01	1.53E-07	1.53E-07	0.00%	0.00%
242Cm	4.12E-03	4.12E-06	4.12E-06	4.10E-01	1.69E-06	1.69E-06	0.00%	0.00%
243Cm	1.44E-04	1.44E-07	1.44E-07	8.50E+00	1.22E-06	1.22E-06	0.00%	0.00%
244Cm	1.34E-03	1.34E-06	1.34E-06	6.70E+00	8.97E-06	8.97E-06	0.01%	0.01%
TOTAL	6.64E+02	6.64E-01	6.64E-01		7.03E-02	7.03E-02	100.00%	100.00%

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SUMMARY OF OVERALL EMISSIONS USING CLOSED END PROBE AND CONE PENETROMETER								
ISOTOPE	ANNUAL HANDLING LIMIT CURIES PER YEAR	TOTAL UNABATED RELEASE CURIES PER YEAR	TOTAL ABATED RELEASE CURIES PER YEAR	200-EAST AREA CAP88PC OFFSITE DOSE CONVERSION FACTOR MREM/CURIE	UNABATED OFFSITE DOSE MREM PER YEAR	ABATED OFFSITE DOSE MREM PER YEAR	PERCENT OF UNABATED DOSE	PERCENT OF ABATED DOSE
3H	3.79E-02	1.11E-05	1.11E-05	2.50E-05	2.77E-10	2.77E-10	0.00%	0.00%
14C	1.05E-02	3.07E-06	3.07E-06	1.90E-03	5.83E-09	5.83E-09	0.00%	0.00%
59Ni	2.53E-02	7.39E-06	7.39E-06	3.10E-04	2.29E-09	2.29E-09	0.00%	0.00%
63Ni	2.46E+00	7.19E-04	7.19E-04	2.60E-04	1.87E-07	1.87E-07	0.00%	0.00%
60Co	4.77E-02	1.39E-05	1.39E-05	2.50E-01	3.48E-06	3.48E-06	0.01%	0.01%
90Sr	1.02E+03	2.98E-01	2.98E-01	1.10E-01	3.27E-02	3.27E-02	49.00%	49.00%
90Y	1.02E+03	2.98E-01	2.98E-01	3.40E-04	1.01E-04	1.01E-04	0.15%	0.15%
93Zr	1.19E-02	3.47E-06	3.47E-06	1.30E-03	4.51E-09	4.51E-09	0.00%	0.00%
99Tc	1.75E-01	5.12E-05	5.12E-05	2.30E-02	1.18E-06	1.18E-06	0.00%	0.00%
106Ru	8.43E-05	2.46E-08	2.46E-08	1.60E-02	3.94E-10	3.94E-10	0.00%	0.00%
125Sb	3.58E-02	1.05E-05	1.05E-05	2.40E-03	2.51E-08	2.51E-08	0.00%	0.00%
126Sn	3.93E-03	1.15E-06	1.15E-06	4.70E-02	5.40E-08	5.40E-08	0.00%	0.00%
129I	8.48E-04	2.48E-07	2.48E-07	2.00E-01	4.95E-08	4.95E-08	0.00%	0.00%
134Cs	7.30E-04	2.13E-07	2.13E-07	1.00E-01	2.13E-08	2.13E-08	0.00%	0.00%
137Cs	9.13E+01	2.67E-02	2.67E-02	2.70E-02	7.20E-04	7.20E-04	1.08%	1.08%
151Sm	9.20E+00	2.69E-03	2.69E-03	7.50E-04	2.01E-06	2.01E-06	0.00%	0.00%
152Eu	2.04E-02	5.95E-06	5.95E-06	2.40E-01	1.43E-06	1.43E-06	0.00%	0.00%
154Eu	4.28E-01	1.25E-04	1.25E-04	2.00E-01	2.50E-05	2.50E-05	0.04%	0.04%
155Eu	1.29E+00	3.76E-04	3.76E-04	8.00E-03	3.01E-06	3.01E-06	0.00%	0.00%
226Ra	1.82E-06	5.31E-10	5.31E-10	4.60E-01	2.44E-10	2.44E-10	0.00%	0.00%
228Ra	9.46E-05	2.76E-08	2.76E-08	1.90E-01	5.25E-09	5.25E-09	0.00%	0.00%
227Ac	2.24E-05	6.55E-09	6.55E-09	1.50E+01	9.83E-08	9.83E-08	0.00%	0.00%
229Th	3.83E-06	1.12E-09	1.12E-09	1.60E+01	1.79E-08	1.79E-08	0.00%	0.00%
232Th	3.75E-06	1.09E-09	1.09E-09	8.00E+00	8.76E-09	8.76E-09	0.00%	0.00%
231Pa	2.33E-05	6.81E-09	6.81E-09	1.20E+01	8.17E-08	8.17E-08	0.00%	0.00%
232U	2.90E-04	8.45E-08	8.45E-08	1.10E+01	9.30E-07	9.30E-07	0.00%	0.00%
233U	1.11E-03	3.25E-07	3.25E-07	3.10E+00	1.01E-06	1.01E-06	0.00%	0.00%
234U	2.20E-02	6.41E-06	6.41E-06	3.10E+00	1.99E-05	1.99E-05	0.03%	0.03%
235U	9.72E-04	2.84E-07	2.84E-07	3.00E+00	8.51E-07	8.51E-07	0.00%	0.00%
236U	2.25E-04	6.56E-08	6.56E-08	2.90E+00	1.90E-07	1.90E-07	0.00%	0.00%
238U	2.21E-02	6.46E-06	6.46E-06	2.80E+00	1.81E-05	1.81E-05	0.03%	0.03%
237Np	1.75E-04	5.11E-08	5.11E-08	1.20E+01	6.13E-07	6.13E-07	0.00%	0.00%
238Pu	1.08E-01	3.17E-05	3.17E-05	7.60E+00	2.41E-04	2.41E-04	0.36%	0.36%
239Pu	9.89E+00	2.89E-03	2.89E-03	8.20E+00	2.37E-02	2.37E-02	35.43%	35.43%
240Pu	1.04E+00	3.05E-04	3.05E-04	8.20E+00	2.50E-03	2.50E-03	3.74%	3.74%
241Pu	6.17E+00	1.80E-03	1.80E-03	1.30E-01	2.34E-04	2.34E-04	0.35%	0.35%
242Pu	2.95E-05	8.63E-09	8.63E-09	7.80E+00	6.73E-08	6.73E-08	0.00%	0.00%
241Am	1.72E+00	5.02E-04	5.02E-04	1.30E+01	6.52E-03	6.52E-03	9.76%	9.76%
243Am	3.82E-05	1.12E-08	1.12E-08	1.30E+01	1.45E-07	1.45E-07	0.00%	0.00%
242Cm	1.34E-02	3.92E-06	3.92E-06	4.10E-01	1.61E-06	1.61E-06	0.00%	0.00%
243Cm	4.68E-04	1.37E-07	1.37E-07	8.50E+00	1.16E-06	1.16E-06	0.00%	0.00%
244Cm	4.36E-03	1.27E-06	1.27E-06	6.70E+00	8.53E-06	8.53E-06	0.01%	0.01%
TOTAL	2.16E+03	6.32E-01	6.32E-01		6.68E-02	6.68E-02	100.00%	100.00%

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ATTACHMENT H

POTENTIAL-TO-EMIT EXAMPLE CALCULATION

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Vadose Zone Sampling Example Calculation

$disintegration := 1 \quad curie := 3.7 \cdot 10^{10} \cdot \frac{disintegration}{sec} \quad rem := 1 \quad millirem := .001 \cdot rem$

The first step is to determine the annual handling limit which corresponds to the actual volume of soil to be removed. Based on field experience, the volume of soil that has been removed is observed to expand approximately 15% because the soil is no longer compacted.

$Diameter_{10_inch} := 10 \cdot in \qquad Length_{10_inch} := 50 \cdot ft$

$Diameter_{8_inch} := 8 \cdot in \qquad Length_{8_inch} := 200 \cdot ft$

$Borehole := \frac{10}{yr}$

$$Volume_{10_inch} := \pi \cdot \left[\frac{\frac{Diameter_{10_inch}}{2}}{12 \cdot \frac{in}{ft}} \right]^2 \cdot Length_{10_inch} \qquad Volume_{10_inch} = 27.271 \cdot ft$$

$$Volume_{8_inch} := \pi \cdot \left[\frac{\frac{Diameter_{8_inch}}{2}}{12 \cdot \frac{in}{ft}} \right]^2 \cdot Length_{8_inch} \qquad Volume_{8_inch} = 69.813 \cdot ft^3$$

$$Volume_{Actual} := 1.15 \cdot \left(Volume_{10_inch} + Volume_{8_inch} \right) \qquad Volume_{Actual} = 111.647 \cdot ft^3$$

The average verticle span of soil contamination is assumed to be 20 feet. This 20 feet can be anywhere along the depth of the borehole. For conservatism assume that the 20 feet of soil contamination corresponds to the 10 inch diameter.

$$Length_{contamination} := 20 \cdot ft$$

$$Volume_{contamination} := 1.15 \cdot \pi \cdot \left[\frac{\frac{Diameter_{10_inch}}{2}}{12 \cdot \frac{in}{ft}} \right]^2 \cdot Length_{contamination}$$

$$Volume_{contamination} = 12.545 \cdot ft^3$$

The average density of loose soil is 97.5 pounds per cubic feet (Marks' Standardard Handbook for Mechanical Engineers, 9th Edition)

$$\rho_{soil} := 97.5 \cdot \frac{lb}{ft^3}$$

$$Soil_{contamination} := Volume_{contamination} \cdot \rho_{soil} \qquad Soil_{contamination} = 1.223 \cdot 10^3 \cdot lb$$

The amount of contaminated soil that reaches the HEPA filter in one year is as follows:

$$HEPA_{contamination} := Soil_{contamination} \cdot Borehole$$

$$HEPA_{contamination} = 1.223 \cdot 10^4 \cdot \frac{lb}{yr} \qquad HEPA_{contamination} = 5.548 \cdot 10^6 \cdot \frac{gm}{yr}$$

Air Rotary Drilling Annual Handling Limit Calculation for Pu-239:

$$\eta_{HEPA} := .9995 \qquad Cs_{contamination} := 5.0 \cdot 10^{-9} \cdot \frac{curie}{gm}$$

$$Pu239_Cs_137_{ratio} := 1.08 \cdot 10^{-1}$$

$$Pu239_{PQ} := Soil_{contamination} \cdot Cs_{contamination} \cdot Pu239_Cs_137_{ratio} \cdot Borehole$$

$$Pu239_{PQ} = 2.996 \cdot 10^{-3} \cdot \frac{curie}{yr}$$

Air Rotary Drilling Unabated and Abated Release/Dose Calculation for Pu-239 using a conservative 40 CFR 61 Appendix D release fraction of 1.00 for particulates and liquids:

$RF := 1.00$

$Pu239_{unabated} := Pu239_{PQ} \cdot RF$ $\quad Pu239_{unabated} = 2.996 \cdot 10^{-3} \cdot \frac{curie}{yr}$

$Pu239_{abated} := Pu239_{unabated} \cdot (1 - \eta_{HEPA})$

$Pu239_{abated} = 1.498 \cdot 10^{-6} \cdot \frac{curie}{yr}$

$DoseFactor_{Pu_239} := 8.20 \cdot \frac{millirem}{curie}$

$Pu239_{unabated_dose} := Pu239_{unabated} \cdot DoseFactor_{Pu_239}$

$Pu239_{unabated_dose} = 0.025 \cdot \frac{millirem}{yr}$

$Pu239_{abated_dose} := Pu239_{abated} \cdot DoseFactor_{Pu_239}$

$Pu239_{abated_dose} = 1.228 \cdot 10^{-5} \cdot \frac{millirem}{yr}$

For the other drilling techniques (e.g., closed end probe and cone penetrometer) the source of airborne emissions is expected to come from the volume of soil extracted during sampling activities. The maximum soil sample volume from each borehole is based on obtaining up to 10, 4-inch diameter by 2 feet long samples.

$Sample_{volume} := 10 \cdot 2 \cdot ft \cdot \pi \cdot \left(\frac{4 \cdot in}{2 \cdot 12 \cdot \frac{in}{ft}}\right)^2$ $\quad Sample_{volume} = 1.745 \cdot ft^3$

The total fraction of samples from the contaminated zone is expected to be 0.25. Since the samples are being extracted from the well, the samples are compacted; therefore, an average density for compacted soil was used.The average density of loose soil is 97.5 pounds per cubic feet (Marks' Standard Handbook for Mechanical Engineers, 9th Edition) The maximum volume of contaminated soil per year is calculated below.

$$fraction_{contaminated_zone} := .25$$

$$\rho_{soil_compacted} := 110 \cdot \frac{lb}{ft^3}$$

$$Soil_{contaminated} := Sample_{volume} \cdot fraction_{contaminated_zone} \cdot \rho_{soil_compacted} \cdot Borehole$$

$$Soil_{contaminated} = 479.966 \cdot \frac{lb}{yr} \qquad Soil_{contaminated} = 2.177 \cdot 10^5 \cdot \frac{gm}{yr}$$

Other Drilling Techniques Annual Possession Quantity Calculation for Pu-239:

$$Cs_{contamination} := 3.30 \cdot 10^{-4} \cdot \frac{curie}{gm}$$

$$Pu239_Cs_137_{ratio} := 1.08 \cdot 10^{-1}$$

$$Pu239_{PQ} := Soil_{contaminated} \cdot Cs_{contamination} \cdot Pu239_Cs_137_{ratio}$$

$$Pu239_{PQ} = 7.759 \cdot \frac{curie}{yr}$$

Other Drilling Techniques Unabated and Abated Release/Dose Calculation for Pu-239 using a conservative 40 CFR 61 Appendix D release fraction of 1E-03 for particulates and liquids and that only 10% of the contaminated soil is exposed to atmosphere:

$RF := 1 \cdot 10^{-3}$ $\quad$ $Fraction_{exposed} := .1$

$Pu239_{unabated} := Pu239_{PQ} \cdot RF \cdot Fraction_{exposed}$

$Pu239_{unabated} = 7.759 \cdot 10^{-4} \cdot \frac{curie}{yr}$

$Pu239_{abated} := Pu239_{unabated}$

$Pu239_{abated} = 7.759 \cdot 10^{-4} \cdot \frac{curie}{yr}$ $\quad$ $DoseFactor_{Pu_239} := 8.20 \cdot \frac{millirem}{curie}$

$Pu239_{unabated_dose} := Pu239_{unabated} \cdot DoseFactor_{Pu_239}$

$Pu239_{unabated_dose} = 6.362 \cdot 10^{-3} \cdot \frac{millirem}{yr}$

$Pu239_{abated_dose} := Pu239_{abated} \cdot DoseFactor_{Pu_239}$

$Pu239_{abated_dose} = 6.362 \cdot 10^{-3} \cdot \frac{millirem}{yr}$

For Casing Removal:

Assumed contaminated soil thickness on casing:

$$soil_{\Delta} := \frac{1}{64} \cdot in$$

For 10-inch casing, the estimated soil volume is:

$$Volume_{10} := .25\ Length_{10_inch} \cdot \pi \cdot \left[\left[\frac{\left(Diameter_{10_inch} + 2 \cdot soil_{\Delta}\right)}{12 \cdot \frac{in}{ft}} \right]^2 - \left(\frac{Diameter_{10_inch}}{12 \cdot \frac{in}{ft}} \right)^2 \right]$$

$$Volume_{10} = 0.171 \cdot ft^3$$

For 8-inch casing, the estimated soil volume is:

$$Volume_{8} := .25\ Length_{8_inch} \cdot \pi \cdot \left[\left[\frac{\left(Diameter_{8_inch} + 2 \cdot soil_{\Delta}\right)}{12 \cdot \frac{in}{ft}} \right]^2 - \left(\frac{Diameter_{8_inch}}{12 \cdot \frac{in}{ft}} \right)^2 \right]$$

$$Volume_{8} = 0.546 \cdot ft^3$$

The total soil volume on the casing if uniformly coated is:

$$Volume_{uniform} := Borehole \cdot \left(Volume_{10} + Volume_{8}\right)$$

$$Volume_{uniform} = 7.172 \cdot \frac{ft^3}{yr}$$

Based on previous experience, approximately 15% of the exterior surface of the casing is contaminated. For conservatism, an extra 10% of the exterior surface contamination is added to account for any potential contamination that may be within the interior of the casing. Therefore, the adjusted soil volume is:

$fraction_{exterior} := .15$

$fraction_{interior} := .1 \cdot fraction_{exterior}$ $\qquad fraction_{interior} = 0.015$

$fraction_{total} := fraction_{exterior} + fraction_{interior}$ $\qquad fraction_{total} = 0.165$

$Volume_{adjusted} := fraction_{total} \cdot Volume_{uniform}$

$Volume_{adjusted} = 1.183 \cdot \frac{ft^3}{yr}$

The average density of compacted soil is 110 pounds per cubic feet (Marks' Standard Handbook for Mechanical Engineers, 9th Edition)

$\rho_{soil_compacted} := 110 \cdot \frac{lb}{ft^3}$

The total weight of soil on the casing is:

$Weight_{soil_casing} := Volume_{adjusted} \cdot \rho_{soil_compacted}$

$Weight_{soil_casing} = 59044.1 \cdot \frac{gm}{yr}$

Annual handling limit calculation for Pu-239 associated with casing removal:

$Cs_{contamination} := 3.30 \cdot 10^{-4} \cdot \frac{curie}{gm}$ (Based on other drilling methods)

$Pu239_Cs_137_{ratio} := 1.08 \cdot 10^{-1}$

$Pu239_{PQ} := Weight_{soil_casing} \cdot Cs_{contamination} \cdot Pu239_Cs_137_{ratio}$

$Pu239_{PQ} = 2.104 \cdot \frac{curie}{yr}$

$RF := .001$

Casing Removal Unabated Release/Dose Calculation for Pu-239:

$Pu239_{unabated} := Pu239_{PQ} \cdot RF$

$Pu239_{unabated} = 2.104 \cdot 10^{-3} \cdot \frac{curie}{yr}$

$DoseFactor_{Pu_239} := 8.20 \cdot \frac{millirem}{curie}$

$Pu239_{unabated_dose} := Pu239_{unabated} \cdot DoseFactor_{Pu_239}$

$Pu239_{unabated_dose} = 0.017 \cdot \frac{millirem}{yr}$

$Pu239_{unabated_dose} = 1.73 \cdot 10^{-2} \cdot \frac{millirem}{yr}$

ATTACHMENT I

TWRS ALARACT DEMONSTRATION FOR PACKAGING AND TRANSPORTATION OF EQUIPMENT AND VEHICLES

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ALARACT 12

TWRS ALARACT DEMONSTRATION FOR
PACKAGING AND TRANSPORTATION OF EQUIPMENT AND VEHICLES

P John Martell FOR AWC Washington State Department of Health	1-5-99 Date
for U.S. Department of Energy - Richland Operations	12/29/98 Date
for Fluor Daniel Hanford	12/18/98 Date
DJB Lockheed Martin Hanford Corporation	12/10/98 Date

Rev. 0
11/19/98

TWRS ALARACT DEMONSTRATION FOR PACKAGING AND TRANSPORTATION OF EQUIPMENT & VEHICLES

1. Description of Activity:

Equipment and vehicles that become contaminated during work activities are reused when possible. If the equipment or vehicle is to be reused or stored in a contamination area, the removable activity levels on the surface of the item, or the outer-most container, must be in accordance with HSRCM-1, Table 2-4 (or latest revision). If the equipment or vehicle is to be transported to another facility, the surface of the item, or the outermost container, must meet the requirements under the Radiological Controls section listed below.

- Emission pathway - Fugitive/diffuse sources
- TWRS Facility Description - All TWRS facilities

2. Radiological Controls:

Removable contamination on the surface of the item, or the outer-most container, must be <1,000 dpm/100cm^2 beta/gamma and/or <20 dpm/100cm^2 alpha if the equipment or vehicle is leaving the contamination area

3. Monitoring:

- Radiological surveys (swipes for removable contamination) of work area
- Post job survey

4. Records/Documentation:

- Radiological work permit
- Radiological survey report(s)

ATTACHMENT J

DISCUSSION OF BEST AVAILABLE RADIONUCLIDE CONTROL TECHNOLOGY

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DISCUSSION OF BEST AVAILABLE RADIONUCLIDE CONTROL TECHNOLOGY
(REQUIREMENT 16)

Providing cost factors for construction, operation, and maintenance of the proposed control technology components is not required because the following BARCT discussion is provided. The BARCT is defined by WAC 246-247-030 as follows:

> "Technology that will result in a radionuclide emission limitation based on the maximum degree of reduction for radionuclides from any proposed newly constructed or significantly modified emission units that the licensing authority determines is achievable on a case-by-case basis. A BARCT compliance demonstration must consider energy, environmental, and economic impacts, and other costs through examination of production processes, and available methods, systems and techniques for control of radionuclide emissions. A BARCT compliance demonstration is the conclusion of an evaluative process that results in the selection of the most effective control technology from all know feasible alternatives. In no event shall application of BARCT result in emissions of radionuclides that could exceed the applicable standards of WAC 246-247-040. Control technology that meets BARCT requirements also meets ALARCT requirements."

As stated in WAC 246-247-120, only those radionuclides comprising more than 10 percent of the unabated dose need to be evaluated. All of the dose is due to particulate radionuclides. The Washington State Department of Health has provided guidance that HEPA filters generally are considered BARCT for particulate emissions (WDOH 1992).

It is proposed, pursuant to the quoted citation, that the ventilation system described in Section 8.0 and the controls (engineering and administrative) (described in Section 9.0) be approved as BARCT for the proposed activities.

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