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Our ref: HEM-10-46
Date: May 24, 2010

Subject: Additional Information and Clarifications Concerning 10 CFR 20.2002 Alternate Waste Disposal Authorization and Exemption for Specific Hematite Decommissioning Project Waste (License No. SNM-00033, Docket No. 070-00036)

Reference: 1) Westinghouse (E. K. Hackmann) letter to Document Control Desk (NRC), HEM-09-52, dated May 21, 2009, “Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste”

During a telephone conversation between Westinghouse Electric Company LLC (Westinghouse) and NRC staff personnel on April 19, 2010, the NRC requested additional information concerning the Westinghouse request for authorization of 10 CFR 20.2002 Alternate Waste Disposal Approval and Exemptions from licensing requirements 10 CFR 30 and 70 for Hematite Decommissioning Waste (i.e., mostly soils; hereinafter termed alternate waste disposal for soils). Attached are the responses for the requested information.

NRC also requested clarification on which documents submitted by Westinghouse apply to, and should be utilized by NRC in review of, the request for alternate waste disposal for soils for the Hematite Decommissioning Project (HDP). This letter also consolidates additional information previously submitted that specifically applies to this subject.

Attachment 1 summarizes applicable correspondence and provides further information requested by the NRC. Attachment 2 provides a RESRAD case in response to a request discussed in Attachment 2. Attachment 3 provides a description of the plan to sample waste prior to its transportation to the disposal site. The documentation provided with this submittal and that provided or referenced explicitly herein constitute the full and complete information necessary for NRC to review the request for alternate waste disposal for soils for the Hematite Decommissioning Project.

If you have questions or comments regarding this submittal, please contact Gerard Couture, Licensing Manager, at (803) 647-2045.

Sincerely,

E. Kurt Hackmann
Director, Hematite Decommissioning Project

Attachment:
1) Additional Information and Clarifications Concerning 10 CFR 20.2002 Alternate Waste Disposal Authorization and Exemption for Hematite Decommissioning Project Waste
2) RESRAD, Version 6.5 Case (Summary: EGL Vadose Zone Analysis, T ½ Limit = 180 days, 2/22/10, 17:11, File: USEI_EGL_FINAL_03_25_05.RAD)
3) Characterization Framework for Waste Destined for USEI

cc:
J. J. Hayes, NRC Project Manager, w/ attachments
C. Hyslop, US Ecology Idaho, Inc., w/ attachments
J. E. Kennedy, FSME/DWMEP/EPPAD, w/ attachments
C. A. Lipa, NRC Region III/DNMS/MCID, w/o attachments
K. I. McConnell, NRC/FSME/DWMEP/DURLD, w/o attachments
J. W. Smetanka, Westinghouse, w/o attachments
L. L. Spradley, FSME/DWMEP/EPPAD, w/ attachments

Attachment 1

Additional Information and Clarifications Concerning 10 CFR 20.2002 Alternate Waste Disposal Authorization and Exemption for Hematite Decommissioning Project Waste

References:
1) Westinghouse (E. K. Hackmann) letter to NRC Document Control Desk, HEM-09-52, dated May 21, 2009, "Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste" (ADAMS Accession No. ML091480071)
2) Westinghouse (E. K. Hackmann) letter to NRC Document Control Desk, HEM-09-146, dated December 29, 2009, "Response to Request for Additional Information – Alternate Waste Disposal" (ADAMS Accession No. ML100320540)
3) Westinghouse (E. K. Hackmann) letter to NRC Document Control Desk, HEM-10-6, dated January 20, 2010, "Additional Information Concerning Alternate Waste Disposal"
4) Westinghouse (E. K. Hackmann) letter to NRC Document Control Desk, HEM-10-9, dated January 21, 2010, "Corrected Compact Disks Concerning Alternate Waste Disposal"
5) Westinghouse (E. K. Hackmann) letter to NRC Document Control Desk, HEM-10-38, dated March 31, 2010, "Additional Information for Alternate Waste Disposal Authorization and Exemption" (ADAMS Accession No. ML100950386)
6) Westinghouse (E. K. Hackmann) letter to NRC Document Control Desk, HEM-09-94 dated August 12, 2009, "Decommissioning Plan and Revision to License Application" (ADAMS Accession No. ML092330123)

Synopsis of Correspondence

The following Synopsis of Correspondence is provided as a summary of documents submitted by Westinghouse that apply to, and should be utilized by the NRC in review of, the request for alternate waste disposal for soils.

Reference 1 originally requested an authorization for alternate waste disposal for soils. Reference 1 also requested an exemption from the licensing requirements of 10 CFR 30.3 and 10 CFR 70.3 for those wastes to allow their disposal at U.S. Ecology's facility in Idaho (USEI).

References 2 and 3 responded to NRC Requests for Additional Information (RAI) concerning Reference 1. Reference 2 included two Compact Disks (CD) which contained discrepancies. Replacement CDs were provided via Reference 4 to replace those of Reference 2.

Reference 5 submitted clarifications to several Reference 2 RAI responses as a result of a telephone conversation between Westinghouse and NRC staff personnel on March 3, 2010. Reference 6 submitted various documents; one of those documents, DO-08-008, "Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides," Revision 0 (ADAMS Accession No. ML092870492) is referred to herein. The information herein and that in References 1 through 6 constitute the full and complete information necessary for NRC to review the request for alternate waste disposal for soils.

Responses to NRC Telephone Request of April 19, 2010

The information below responds to additional information requested by NRC as a result of a telephone conversation between Westinghouse and NRC staff personnel on April 19, 2010. The questions are paraphrased from the telephone call.

1. **NRC Question:** Provide information regarding the detection capabilities for radiological surveys and field measurements of soil during excavation and waste packaging for transportation.

   Westinghouse Response: The instrumentation to be used will be a Ludlum Model 2221 coupled to a Ludlum 44-10 detector, or equivalent. The minimum detectable concentrations (MDC) for total uranium when performing surveys of surface soil at varying degrees of enrichment assuming a background count rate of 8,000 counts per minute are provided below in Table 1. In all cases, the MDC are less than the median concentration of total uranium expected in the waste, and only a small fraction of the USEI waste acceptance criteria.

   Table 1
   MDC for Total Uranium Based on Degree of Enrichment

Enrichment (wt% U-235)	Total U[a] (pCi/g)
3	65
20	77
50	95
75	109

   [a] MDC values assume a surveyor efficiency of 50%.

   In the event that elevated radioactivity in excess of the action levels established for nuclear criticality safety is identified during the radiological surveys of soil or waste materials during excavation, the material is transferred to a Waste Evaluation Area for further evaluation. The evaluation includes spreading the material to a nominal depth of two inches, performing a scan survey and visual inspection to identify discrete items. In the event that such an item is found, the item will be assayed using a High Purity Germanium (HPGe) detector and will either be placed into the material control and accounting system, or a waste disposition plan will be prepared that provides instruction for preparing the item for disposal.

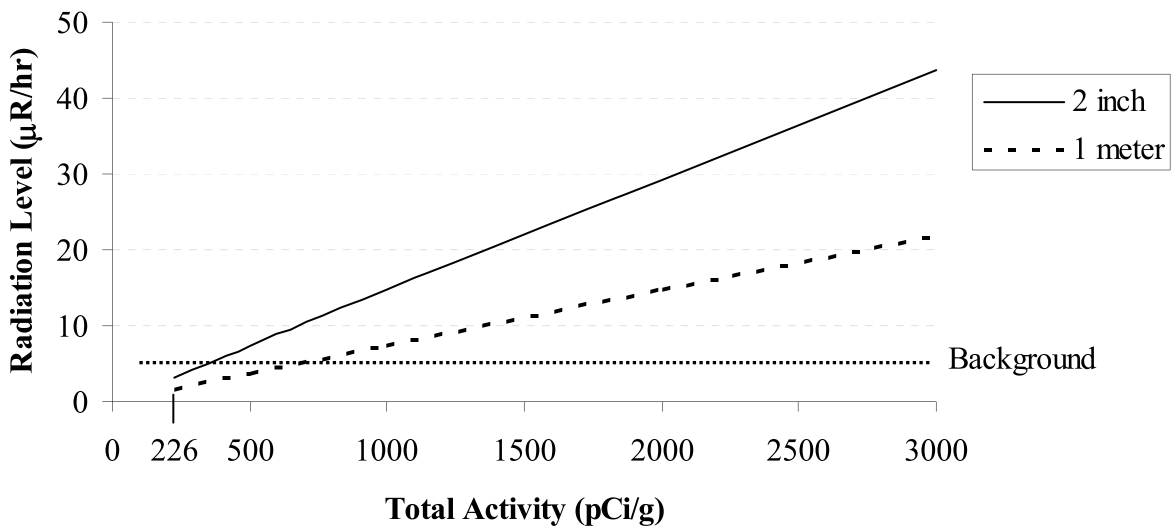
   During burial pit excavation, the bulk of the excavated material is expected to be transported through a box counting system, in addition to being subjected to scan surveys during excavation. This analysis will provide data regarding the suitability of the material for disposal, or for re-use of soil as backfill. The detection capability of this system is provided below in response to "*Further Clarifications of March 3, 2010 Telephone Conversation*", Question 3, Bullet item 4.

   The radiological surveys performed of loaded shipping containers will be used to confirm gamma spectroscopy results from either the box counter or composite samples collected from material not going through the box counter.. The surveys will be performed using a Ludlum

Model 19 Micro-R meter, or equivalent. The instrumentation used for these surveys will have a minimum detectable exposure rate of approximately 1 to 2 μR/hour, assuming a background exposure rate of 5 to 8 μR/hour.

Figure 1 illustrates the expected radiation levels on rail cars loaded with varying total activity concentrations in soil ranging from the expected median concentration value up to the USEI Waste Acceptance Criteria (WAC). As indicated in the figure, a significant departure from the expected median concentration (226 pCi/g) will be apparent through measurements of the radiation level. The radiation levels at a distance of two inches and at one meter for concentrations at the USEI waste acceptance criteria are 44 and 21 μR/hr, respectively.

Figure 1
Radiation Levels on Rail Cars With Varying Soil Concentration
(at distances of 2 inches and 1 meter)



The radiation levels in the figure above at a distance of 2 inches and at a distance of one meter were based on a MicroShield© model that assumed a soil density of 1.69 grams per cubic centimeter; a container wall thickness of ⅜ inch; the expected median concentration in the first case; and the median concentration scaled to the USEI WAC in the second case.

Additional detail on the conceptual characterization process is provided in the "Characterization Framework for Waste Destined for USEI, " provided in Attachment 3 to the accompanying transmittal letter

2. **NRC Question:** Provide an explanation of the differing post-closure doses calculated for building debris waste (i.e., 1.9 mrem) versus the original alternate disposal request (i.e., 2.931 mrem) and if this revised information should be considered in the soil waste alternate disposal action.

Westinghouse Response:
Hematite submitted a post-closure dose calculation as part of the May 21, 2009, alternate dose request for soil (Reference 1). Based on NRC comments received on December 9, 2009, this post-closure dose assessment was revised and resubmitted on December 29, 2009 (Reference 2). During the development of the Alternate Disposal Request for Building Debris, Hematite identified and corrected an inconsistency in the calculation methodology that had been used for waste.

As a result of this correction, the calculated post-closure dose decreases from 2.931 to 1.9 mrem. This correction results in only a slight decrease in dose. However it provides a more accurate estimate of the potential post-closure dose.

Please find enclosed as Attachment 2 of this letter a revised post-closure dose assessment to replace on previous submittals and to be used for the basis of the pose closure dose associated with this request for alternate waste disposal for soils.

The following provides an explanation of the corrections that has been made.

Summary of Changes

Contaminated Zone Height

Initially a contaminated zone height of 33.6 meter was assumed. The contaminated zone height was modified to 14.93 meter to reflect the actual height of the waste which would occupy the cell.

Radionuclide Concentrations

Initially the radionuclide concentration was based on a volume weighted average of the Hematite waste volume and total waste volumes. This calculation was corrected to account for the difference in density between the 'as-shipped' Hematite waste (1.69 g/cm^3) versus the 'as-placed' in the USEI waste cell (1.5 g/cm^3).

Detailed calculations of these parameters are presented below.

Calculation of RESRAD Model Contaminated Zone Height

Input Parameters

Contaminated Zone Surface Area = 80,937.2 m^2
Density of USEI Waste = 1.5 g/ cm^3 = 1.655 ton/m^3
Mass of USEI Waste Received = 2,000,000 ton

Equations Used

Contaminated Zone Height =
(Volume of USEI Waste Received) / (Contaminated Zone Surface Area)

Volume of USEI Waste Received=
(Mass of USEI Waste Received) / (Density of USEI Waste)

Calculation

Volume of USEI Waste Received= 2,000,000 ton /1.655 ton/m^3 = 1,208,662 m^3
Contaminated Zone Height = 1,208,662 m^3 / 80,937.2 m^2 = 14.93 m

Calculation of RESRAD Input Concentrations

Input Parameters

Contaminated Zone Surface Area = 80,937.2 m^2
Density of USEI Waste = 1.5 g/ cm^3 = 1.655 ton/m^3
Mass of USEI Waste Received = 2,000,000 ton
Volume of Hematite Waste Received = 22,809 m^3
Density of Hematite Waste (as shipped) = 1.69 g/cm^3 = 1.86 ton/m^3

Equations Used

Cell Concentration = Concentration Shipped Material × Dilution Factor
Dilution Factor = (Mass of Hematite Waste) / (Mass of USEI Waste Received)
Mass of Hematite Waste = Volume of Hematite Waste × Density of Hematite Waste

Calculations

Mass of Hematite Waste = 22,809 m^3 × 1.860 tons / m^3 = 42425 ton
Dilution Factor = 42425 ton / 2,000,000 ton = 0.0212

Table 2
Resulting Radionuclide Input Values for RESRAD Model

Radionuclide	Concentration (pCi/g)	
	Shipped	Modeled[a]
Ra-226	1	2.12E-02
Th-232	1.2	2.55E-02
Tc-99	27	5.73E-01
U-234	113	2.40E+00
U-235	5.5	1.17E-01
U-238	18	3.82E-01

[a] Modeled Concentration = Shipped Concentration × Dilution Factor

Further Clarifications of March 3, 2010 Telephone Conversation

Reference 5 provides the clarifications discussed in the March 3, 2010 telephone conversation. The following additional information is provided specific to the NRC Agenda for the meeting (numbering is consistent with the Agenda). The purpose of this call was to discuss a series of informal comments related to the December 29, 2009 Westinghouse response to the December 3, 2009 NRC request for additional information (RAI).

Health Physics RAIs 1 & 2

1. Westinghouse responded that "the protocols include scan surveys of gamma radiation and visual inspection over the surface of exposed soil during excavation to identify soil volumes and/or components that potentially contain an amount of radioactivity that exceeds an action level established for criticality safety."

    - **NRC Question:** What depth of exposed soil will be surveyed during this process?

      Westinghouse Response: Soil within areas where criticality safety controls are applied will be excavated in 12 inch layers. Each of these layers will be scanned using a Ludlum Model 2221 coupled to a Ludlum 44-10 detector, or equivalent.

      Soil outside of areas where criticality safety controls are applied will be excavated in the manner most efficient based on operational considerations. In the absence of the excavation scan, this soil will be scanned when placed in the waste holding area. Additionally, a composite sample will be obtained that is composed of aliquots collected at biased locations based on the scan survey at a minimum frequency of one aliquot per 15 - 20 cubic yards (e.g., each load), resulting in a composite sample that is representative of 100 cubic yards (volume is equivalent to slightly more than one railcar and is approximately 40,000 lbs).

    - **NRC Question:** What instrumentation will be used for the gamma scans?

      Westinghouse Response: The instrumentation to be used will be a Ludlum Model 2221 coupled to a Ludlum 44-10 detector, or equivalent.

    - **NRC Question:** How will non-gamma radionuclides be accounted for (e.g., Tc-99)?

      Westinghouse Response: The contribution to radioactivity in the waste from non-gamma emitting radionuclides will initially be determined by applying scaling factors established in Westinghouse Electric Company Document No. DO-08-008, "Derivation of Surrogates and Scaling Factors for Hard-To-Detect

Radionuclides," Revision 0 to either the bulk U-235 measurement made by the box counting system or gamma spectroscopy analysis of composite samples. Offsite laboratory Tc-99 analysis will be used to further refine these estimates. Additional detail on the characterization process is provided in Attachment 3 to the accompanying transmittal letter, "Characterization Framework for Waste Destined for USEI. .

As expected, the Tc-99/U-235 ratios present in the dataset used to derive the median concentrations for the alternate waste disposal for soils is slightly higher than that presented in DO-08-008, "Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides" (see Table 3, below).

Table 3
Tc-99/U-235 Ratios

Plant Soils Area[a] (pCi/g)	**Tc-99 Soils Area**[a]	**Burial Pit Soils Area**[a]	**Soil Contour Dataset**[b]
9.6	46	5.9	38

[a] Based on the DO-08-008, *Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides*, Revision 0.
[b] Based on weighted median Tc-99/U-235 concentration ratio within the dataset used to derive soils concentrations in the request for alternate disposal for soils (Reference 5, Attachment 2, "Soil_Contour_Data.xls").

This is due to the fact that the dataset used to calculate the soil concentrations targeted only high activity areas (> DCGL). While this dataset, as expected, over-estimates the average concentrations in materials at the time of shipment, and provides a conservative basis for the potential dose consequences from the shipment and disposal of those materials, this dataset also results in a ratio of Tc-99/U-235 larger than expected on average at the time of shipment. The reason for this difference is that the material shipped will be mixed with lower activity material during the process of excavation and preparation for shipment.

Therefore, the Tc-99 ratios presented in DO-08-008, "Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides," are a reasonable and prudent starting point to estimate the Tc-99 in the material that will be shipped. Laboratory analysis will be performed (as described in Attachment 3 to the accompanying transmittal letter, "Characterization Framework for Waste Destined for USEI) to refine the Tc-99 inventory assigned to material leaving for USEI. Attachment 3 also provides details on the characterization process.

- **NRC Question:** How will a "visual inspection" be used to determine that certain excavated material contains radioactivity exceeding the stated action levels?

  Westinghouse Response: The sole reliance on visual inspection cannot be expected to determine whether excavated material contains radioactivity. Rather, visual inspection provides the opportunity to identify materials that due to configuration may not be surveyed with adequate sensitivity by the gamma scan surveys using the Ludlum 44-10 detector, or equivalent and as such warrant additional investigation . The investigation may include disassembly to facilitate survey and/or sampling, or may include measurements using HPGe.

2. The Westinghouse response seems to indicate that action levels established for criticality safety and for the weighted Derived Concentration Guideline Level (DCGL) will be used with soil gamma scans for the purpose of segregation. It is also stated that "since the requirements for detection sensitivity imposed by criticality safety and by the need to measure concentrations at the DCGL are equivalent to a small fraction of the concentration limit specified in the WAC, the probability of failing to identify an average concentration in the waste stream that exceeds the WAC is very small."

   Clarification is needed on how the "average concentration in the waste stream" will be determined:

   - **NRC Question:** How much soil volume will be used for averaging purposes?

     Westinghouse Response: Excavated soil will be loaded into a truck having a capacity of 15 - 20 cubic yards. Each truck load of material will be either subjected to bulk gamma analysis (box counter), or evaluated by the composite sampling as the material is placed at the waste holding area. The composite sample will be analyzed for each 100 cubic yards of material (volume is equivalent to slightly more than one railcar and is approximately 40,000 lbs). These measurements will be used to establish the average radionuclide concentration in shipped material. From a more global project perspective and in the context of post-closure dose, the entire project waste volume is considered one population for the purpose of averaging.

   - **NRC Question:** Is there a potential for soil dilution that may allow hot-spots or higher activity components to be included in the averaged waste stream concentration?

     Westinghouse Response: Yes, however only contaminated soil will be intentionally blended as a part of the process for preparing the soil for transportation to disposal. Some amount of non-contaminated soil may be inadvertently combined with contaminated soil during excavation which will increase waste volume, however this cannot be avoided.

     Higher activity components that are identified from radiological surveys during excavation will be measured (e.g., HPGe or other gamma radiation detector) and either determined not to exceed the USEI WAC, decontaminated to a level that meets the USEI WAC, or disposed at an approved disposal facility.

3. The Westinghouse RAI response notes that after soil segregation takes place a second visual inspection and possible gamma scans may be performed. A bulk volume measurement will then be taken of the bulk container prior to shipment. It is stated that this measurement will be performed "using gamma spectroscopy, or will be measured through the collection of a composite sample obtained from each 100 cubic yards of soil (volume is equivalent to slightly more than one railcar and is approximately 40,000 lbs) that will be subsequently analyzed by gamma spectroscopy."

   Several items on bulk volume measurements need clarification:

   - **NRC Question:** What gamma spectroscopy instruments will be used if the bulk container itself is measured (e.g., ISOCS)?

     Westinghouse Response: The measurement system (e.g. box counter) that will be used for bulk assay will employ an array of HPGe detectors. The minimum detection levels are provided in Table 4 below as a portion of the response to the question regarding detection levels. The advantages of using an array of detectors include a lower level of detection given the same counting interval, and the capability to identify portions (e.g., a quadrant) of a particular container the show elevated concentrations relative to the balance of the container. In the event that an elevated portion is identified, an investigation of the container will be performed that may include additional measurements using HPGe or unloading the container for further inspection to ensure that the contents do not exceed the USEI WAC.

   - **NRC Question:** What will be the radionuclides of interest?

     Westinghouse Response: The primary radionuclides of interest are U-234, U-235, U-238, Th-232, Ra-226 and Tc-99.

   - **NRC Question:** How will non-gamma radionuclides be accounted for (e.g., Tc-99)?

     Westinghouse Response: This is a duplicate question. Please see the previous response to *Further Clarifications of March 3, 2010 Telephone Conversation,* RAIs 1 & 2, Question 1, bullet 3.

   - **NRC Question:** What are the lower limits of detection for the radionuclides of interest? Are they sufficient to demonstrate that the waste will be released at or below the expected concentration (226 pCi/g)?

     Westinghouse Response: To provide an estimate of the minimum detectable activity (MDA) that could be reached using a box counting system suitable for use at the Hematite site, the performance of the Energy Solutions GARDIAN-III system was modeled. This modeling was performed using the current characterization files for GARDIAN-III detectors and the ISOCS software. The modeled case assumed a dump truck whose load dimensions are 15 feet long, 7 feet 3 inches wide and 4 feet tall. The length and width are equivalent to a typical dump truck bed. The 4 foot height corresponds to a total volume of 15 cubic yards (the dump truck volume anticipated for use at Hematite).

The loaded soil was assumed to have a density of 1.5 g/cc, which results in a total net weight of 38,000 pounds of soil. The background level associated with the estimated MDAs for GARDIAN-III was approximately 5 μR/hr.

Table 4, below presents the estimated MDAs for the summed detector response for count times of 1 minute, 10 minutes, and 90 minutes based on this analysis. The projected MDA using the U-235 MDA values from Table 4 and the Tc-99/U-235 ratios from Table 3 are presented in Table 5.

Table 4
Estimated MDA for Box Counting System
(Based on GARDIAN-III Summed Detector Response)

Count Time (minutes)	Ra-226 MDA[a] (pCi/g)	Th-232 MDA (pCi/g)	U-235 MDA (pCi/g)	U-238 MDA (pCi/g)
1	21/0.67	0.67	1.3	29
10	6.9/0.21	0.21	0.42	9
90	2.3/0.07	0.07	0.14	3

[a] MDA values shown for both direct analysis using 186 keV peak (higher value) and indirect analysis using daughters (i.e., Bi-241/Pb-214).

Table 5
Estimated Inferred Tc-99 MDA for Box Counting System
(Based on GARDIAN-III Summed Detector Response)[a]

Count Time (minutes)	Plant Soils Area (pCi/g)	Tc-99 Soils Area (pCi/g)	Burial Pit Soils Area (pCi/g)	Soil Contour Dataset (pCi/g)
1	12.5	59.8	7.7	49.5
10	4.0	19.3	2.5	16.0
90	1.3	6.4	0.8	5.3

[a] Based on the U-235 MDA values from Table 4 and the Tc-99/U-235 ratios from Table 3.

The maximum Tc-99 MDA for a counting interval of 10 minutes (shown in Table 5, above) is 19.3 pCi/g. This is less than the value of 27 pCi/g (shown in Table 2, page 6) which was used in the post-closure dose assessment for Tc-99. Accordingly, this system will be adequate to measure the median concentrations that are expected to be present in the waste.

- **NRC Question:** What is the basis for averaging over 100 cubic yards if composite sampling of soil is performed?

  Westinghouse Response: 100 cubic yards is the approximate volume of a gondola car. Restricting the review of average concentrations to this relatively small volume of material will provide timely notification to waste management personnel in the event that concentrations are not within the expected range of variability as the stockpile is being created.

It is not clear what action levels or limits Westinghouse intends to use for these bulk container measurements, the USEI WAC value or the expected concentrations stated by Westinghouse. Westinghouse provided "expected concentrations for radionuclides following excavation and aggregation" in Table 1 of the "Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste (HEM-09-52)." These nuclides plus progeny (totaling 226 pCi/g or ~8% of USEI's 3000 pCi/g total activity concentration limit) were used as the basis of Westinghouse's dose estimates.

- **NRC Question:** How will Westinghouse document that each bulk container is within the limits of the expected concentrations used for Westinghouse's dose analysis in the "Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste (HEM-09-52)?"

  Westinghouse Response: The waste concentration for each container will be documented on the associated waste manifest. Hematite does not intend to use the concentration values contained in Table 1 of the "Request for Alternate Disposal Approval and Exemptions for Specific Hematite Decommissioning Project Waste (HEM-09-52)" as limiting concentrations for individual containers. Rather, Hematite will track waste shipments and associated material concentrations during the course of the project and will keep a running average concentration of the waste material. The average concentration of the total material shipped at the conclusion of the project is not expected to exceed the Table 1 concentrations.

  NRC Question: What action level will be used to indicate that additional investigation of a bulk container needs to be performed?

  Westinghouse Response: The primary methods to determine that waste is suitable for packaging for disposal are gamma spectroscopy analysis of waste samples that are collected as the waste is delivered to the waste holding area, or a gamma assay of bulk containers as the waste is transported to the waste holding area.

  The Tc-99 activity will be initially inferred based on the scaling factor for Tc-99/U-235 derived from previous characterization data that has been compiled in

Westinghouse Electric Company Document No. DO-08-008, "Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides," Revision 0, based on the area from which the material originated. The U-234 activity will be inferred based on the measured U-238/U-235 ratio and the associated degree of enrichment.

These measurements occur prior to packaging shipping containers, and are the basis for the decision to load the containers. Either type of measurement that indicates the waste exceeds the USEI waste acceptance criteria will serve as an action level for investigation through radiological surveys and/or sampling of the material, and may be followed by proper blending with other contaminated soil.

Additionally, radiological surveys of loaded packages will be performed to confirm that the measurement was correct. Survey measurements of loaded containers that significantly depart from typical measurements (e.g., contact measurement greater than 44 μR/hour, which is equivalent to the USEI WAC based on the Hematite source term) will be investigated through additional radiological surveys and/or sampling. The investigation will either confirm that the waste meets the USEI waste acceptance criteria; or will indicate that the waste must be disposed at another approved facility or be commingled with waste containing lesser concentrations and then re-sampled to confirm that the waste meets the USEI WAC. Information gathered from these types of investigation samples will also be used to confirm or refine radiation survey action levels to identify material concentrations that may be of concern from either a waste management or radiological safety perspective. Additional detail on the process for final characterization of waste sent to disposal is contained in Attachment 3 of the accompanying transmittal letter (*Characterization Framework for Waste Destined for USEI*).

Original HP RAI Number 2

The response to this RAI was essentially the same as the previous response. It is stated that visual inspections, gamma scans, and gamma spectroscopy may be used. It is noted that soil will be placed at an interim lay-down area after excavation, visual inspection/gamma scans may be performed, and that soil will be placed at a waste stockpile area prior to bulk container measurements. It is not clear from the description how homogeneity will be achieved and maintained.

- **NRC Question:** How will waste homogeneity be achieved? By performing measurements over an entire bulk container there are some inherent assumptions that each container is homogenously mixed. If this is not true, there is the potential for hot-spots or higher activity components to be released due to radioactivity dilution within a container.

Westinghouse Response: The material excavation and handling process within the excavation will necessarily result in some amount of mixing of the material. Further mixing will occur during loading of the material for transport to the waste holding area. Additional mixing will occur during unloading of the material at the waste holding area. Finally, mixing will occur during the process of loading the material into the conveyance for transport to disposal.

Prior to departure, radiological surveys of the waste container will be performed to ensure no portions of the container (hot spots) exceed the specified radiation levels in order to confirm the material meets the USEI waste acceptance criteria. Note that the radiation level associated with an individual container may exceed the radiation level associated with a container at the expected median concentration. However, the average radiation level for containers over the entire duration of the project, and the estimated dose to members of the public during transport and unloading, will be equivalent to that previously evaluated in Reference 1.

Although not a consideration for potential doses during transport and only a factor for post-closure dose, additional mixing will occur during offloading for trans-shipment, and when placing the material in the burial cell.

Further Clarifications of April 29, 2010 Telephone Conversation

In an April 29, 2010 telephone conversation the NRC requested several additional clarifications with respect to the request for alternate waste disposal of soils. The additional information is provided below.

NRC Question: Provide reasoning why an agricultural scenario is not a reasonable scenario for the Idaho facility.

Westinghouse Response: An inadvertent chronic intruder-agriculture scenario is not considered plausible for the USEI disposal site given the site's remote location, arid environmental conditions, waste placement practices and a landfill cap that is designed to prevent intrusion into radioactive materials disposed at the site. For these reasons the intruder construction scenarios that were previously supplied to NRC are bounding for the Hematite waste disposal.

The USEI site is located in a very arid climatic region and receives an average of 7 inches of rainfall per year (see Reference 8, Additional Information letter HEM-10-38 dated March 31, 2010, Attachment 1, Response 5 Page 13, item e). This low precipitation rate is not enough to sustain crop production. USEI's active disposal site is located on a topographic high with no natural surface water sources within the entirety of the active disposal area or its surrounding 1,000 acre buffer zone. In addition, the two saturated zones located below the site (called "aquifers" by convention in communication with the State of Idaho) are deep and have low yields. The 'upper aquifer' is approximately 225 to 265 below the surface of the closed landfill (165 to 200 feet below ground level) and yields less than 0.5 gpm at the southern extent of the site where USEI's active disposal cells are located (see Reference 4, Additional Information letter HEM-10-6 dated January 20, 2010, Attachment 1, Section 2.2.4 on Page 6). The 'lower aquifer' has an even lower yield, less than 0.01 gpm.

The site also employs a cap design and waste placement practices that are intended to preclude intrusion into radioactive material. USEI's landfill and cap are constructed to the uniform standards found in 40 CFR 264 Part N for mixed hazardous waste and low activity radioactive waste (LARW).

In summary, the final landfill cover is designed to minimize migration of liquids into and through the closed landfills, minimize necessary post-closure cover maintenance, promote surface drainage, minimize erosion or abrasion of the final cover, and accommodate settlement and subsidence without losing integrity. The final cover system also has a permeability less than or equal to that of the bottom liner system or natural sub-soils present and is designed to withstand freeze/thaw cycles. The cover system employs a 30-inch vegetated protective cover soil layer; surface water control and drainage channels designed to accommodate peak flood events; a series of concentric mid-slope interceptor ditches to divert sheet flow before it can reach erosive velocities or become concentrated flow on the steeper side slopes; a double-sided geocomposite drainage net lateral drainage layer; a 40-mil textured HDPE geomembrane liner primary barrier layer; a geosynthetic clay liner secondary barrier; a landfill gas collection/venting layer; and waste placement that precludes disposal of radioactive material within 3.6 to 6 meters of the surface of the final constructed cap which provides a suitable radon barrier and further reduces the potential for intrusion.

More specifically, USEI restricts the placement of any radioactive waste within 3.6 meters of the surface of the finished cap of the landfill. Other hazardous or non-radioactive soil and debris waste may be used to finish filling the landfill. This provides a suitable radon diffusion barrier and the soil, debris and other waste used for the radon barrier is visually distinguishable from site soils to any inadvertent intruder. In addition, the Exempt Radioactive Materials Procedure contains a specific limitation on placing any Radium-226 bearing waste in concentrations greater than 222 pCi/g within 6 meters of the surface of the finished cap. For operational ease, USEI is handling all radioactive waste the same and no radioactive material is placed within 6 meters of the outer surface of the finished cap.

Given USEI's site environmental conditions and landfill cap and design features, an inadvertent agriculture-intruder scenario is not realistic. The scenarios previously submitted are considered bounding for the Hematite wastes.

NRC Question: Explain the difference in soil volume between the request for alternate disposal for soils and the calculation spreadsheet used to determine radionuclide concentrations.

Westinghouse Response: The radionuclide concentrations associated with the request for alternate disposal for soils were determined from contours drawn from samples which exceeded the site DCGL (i.e., in the spreadsheet of Attachment 2 of Reference 5; Filename: Soil_Contour_Data.xls). This volume is less than the actual volume that will be excavated due to the fact that additional materials will be mixed during excavation. In order to allow for this fact and to conservatively allow for uncertainty in the volume of material that might be shipped to USEI, Hematite based the volume of soil to be shipped on the total amount of soil that is expected to be excavated from the site. The different volumes therefore result in the reasonable, yet conservatively high, estimation of radionuclide concentrations in the conservatively large estimation of total waste volume to be shipped.

NRC Question: Include an explanation of surrogates in response to the soil questions.

Westinghouse Response: An explanation of surrogates is provided in the response to the first question, fourth bullet above, under Further Clarifications of March 3, 2010 Telephone Conversation, Health Physics RAIs 1 & 2.

NRC Question: Provide a process plan for sampling, step-by-step, including When, Where, Why, How much to sample and analyze. Also, a validation of the surrogate ratios. HDP needs to show they meet the mean and maximum.

Westinghouse Response: See Attachment 3 to the accompanying transmittal letter for Hematites conceptual framework for characterization of waste prior to shipment to USEI..

NRC Question: Submit a corrected soil post-closure dose calculation.

Westinghouse Response: Attachment 2 of this letter contains a revised post-closure dose assessment to replace all previous submittals and to be used for the basis of this request for alternate disposal for soil.

Attachment 2

RESRAD, Version 6.5 Case

Summary: EGL Vadose Zone Analysis, $T_{1/2}$ Limit = 180 days, 2/22/10, 17:11,
File: USEI_EGL_FINAL_03_25_05.RAD
(27 pages)

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
A-1	DCF's for external ground radiation, (mrem/yr)/(pCi/g)			
A-1	Ac-227 (Source: FGR 12)	4.951E-04	4.951E-04	DCF1(1)
A-1	Ac-228 (Source: FGR 12)	5.978E+00	5.978E+00	DCF1(2)
A-1	At-218 (Source: FGR 12)	5.847E-03	5.847E-03	DCF1(3)
A-1	Bi-210 (Source: FGR 12)	3.606E-03	3.606E-03	DCF1(4)
A-1	Bi-211 (Source: FGR 12)	2.559E-01	2.559E-01	DCF1(5)
A-1	Bi-212 (Source: FGR 12)	1.171E+00	1.171E+00	DCF1(6)
A-1	Bi-214 (Source: FGR 12)	9.808E+00	9.808E+00	DCF1(7)
A-1	Fr-223 (Source: FGR 12)	1.980E-01	1.980E-01	DCF1(8)
A-1	Pa-231 (Source: FGR 12)	1.906E-01	1.906E-01	DCF1(9)
A-1	Pa-234 (Source: FGR 12)	1.155E+01	1.155E+01	DCF1(10)
A-1	Pa-234m (Source: FGR 12)	8.967E-02	8.967E-02	DCF1(11)
A-1	Pb-210 (Source: FGR 12)	2.447E-03	2.447E-03	DCF1(12)
A-1	Pb-211 (Source: FGR 12)	3.064E-01	3.064E-01	DCF1(13)
A-1	Pb-212 (Source: FGR 12)	7.043E-01	7.043E-01	DCF1(14)
A-1	Pb-214 (Source: FGR 12)	1.341E+00	1.341E+00	DCF1(15)
A-1	Po-210 (Source: FGR 12)	5.231E-05	5.231E-05	DCF1(16)
A-1	Po-211 (Source: FGR 12)	4.764E-02	4.764E-02	DCF1(17)
A-1	Po-212 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(18)
A-1	Po-214 (Source: FGR 12)	5.138E-04	5.138E-04	DCF1(19)
A-1	Po-215 (Source: FGR 12)	1.016E-03	1.016E-03	DCF1(20)
A-1	Po-216 (Source: FGR 12)	1.042E-04	1.042E-04	DCF1(21)
A-1	Po-218 (Source: FGR 12)	5.642E-05	5.642E-05	DCF1(22)
A-1	Ra-223 (Source: FGR 12)	6.034E-01	6.034E-01	DCF1(23)
A-1	Ra-224 (Source: FGR 12)	5.119E-02	5.119E-02	DCF1(24)
A-1	Ra-226 (Source: FGR 12)	3.176E-02	3.176E-02	DCF1(25)
A-1	Ra-228 (Source: FGR 12)	0.000E+00	0.000E+00	DCF1(26)
A-1	Rn-219 (Source: FGR 12)	3.083E-01	3.083E-01	DCF1(27)
A-1	Rn-220 (Source: FGR 12)	2.298E-03	2.298E-03	DCF1(28)
A-1	Rn-222 (Source: FGR 12)	2.354E-03	2.354E-03	DCF1(29)
A-1	Tc-99 (Source: FGR 12)	1.255E-04	1.255E-04	DCF1(30)
A-1	Th-227 (Source: FGR 12)	5.212E-01	5.212E-01	DCF1(31)
A-1	Th-228 (Source: FGR 12)	7.940E-03	7.940E-03	DCF1(32)
A-1	Th-230 (Source: FGR 12)	1.209E-03	1.209E-03	DCF1(33)
A-1	Th-231 (Source: FGR 12)	3.643E-02	3.643E-02	DCF1(34)
A-1	Th-232 (Source: FGR 12)	5.212E-04	5.212E-04	DCF1(35)
A-1	Th-234 (Source: FGR 12)	2.410E-02	2.410E-02	DCF1(36)
A-1	Tl-207 (Source: FGR 12)	1.980E-02	1.980E-02	DCF1(37)
A-1	Tl-208 (Source: FGR 12)	2.298E+01	2.298E+01	DCF1(38)
A-1	Tl-210 (Source: no data)	0.000E+00	-2.000E+00	DCF1(39)
A-1	U-234 (Source: FGR 12)	4.017E-04	4.017E-04	DCF1(40)
A-1	U-235 (Source: FGR 12)	7.211E-01	7.211E-01	DCF1(41)
A-1	U-238 (Source: FGR 12)	1.031E-04	1.031E-04	DCF1(42)
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.724E+00	6.700E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	2.320E-02	1.360E-02	DCF2(3)
B-1	Ra-226+D	8.594E-03	8.580E-03	DCF2(4)
B-1	Ra-228+D	5.078E-03	4.770E-03	DCF2(5)

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
B-1	Tc-99	8.320E-06	8.320E-06	DCF2(6)
B-1	Th-228+D	3.454E-01	3.420E-01	DCF2(7)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(8)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(9)
B-1	U-234	1.320E-01	1.320E-01	DCF2(10)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(11)
B-1	U-238	1.180E-01	1.180E-01	DCF2(12)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(13)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.410E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pb-210+D	7.276E-03	5.370E-03	DCF3(3)
D-1	Ra-226+D	1.321E-03	1.320E-03	DCF3(4)
D-1	Ra-228+D	1.442E-03	1.440E-03	DCF3(5)
D-1	Tc-99	1.460E-06	1.460E-06	DCF3(6)
D-1	Th-228+D	8.086E-04	3.960E-04	DCF3(7)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(8)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(9)
D-1	U-234	2.830E-04	2.830E-04	DCF3(10)
D-1	U-235+D	2.673E-04	2.660E-04	DCF3(11)
D-1	U-238	2.550E-04	2.550E-04	DCF3(12)
D-1	U-238+D	2.687E-04	2.550E-04	DCF3(13)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(2,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(2,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(2,3)
D-34				
D-34	Pb-210+D , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(3,1)
D-34	Pb-210+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-04	8.000E-04	RTF(3,2)
D-34	Pb-210+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	3.000E-04	3.000E-04	RTF(3,3)
D-34				
D-34	Ra-226+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(4,1)
D-34	Ra-226+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,2)
D-34	Ra-226+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(4,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(5,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(5,3)
D-34				
D-34	Tc-99 , plant/soil concentration ratio, dimensionless	5.000E+00	5.000E+00	RTF(6,1)
D-34	Tc-99 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Tc-99 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(6,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)

Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(7,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(7,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(7,3)
D-34				
D-34	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(8,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(8,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(8,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(9,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(9,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(9,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(10,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(10,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(10,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(11,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(11,3)
D-34				
D-34	U-238 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(12,1)
D-34	U-238 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(12,2)
D-34	U-238 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(12,3)
D-34				
D-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(13,1)
D-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(13,2)
D-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(13,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
D-5				
D-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
D-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
D-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(5,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(5,2)
D-5				
D-5	Tc-99 , fish	2.000E+01	2.000E+01	BIOFAC(6,1)
D-5	Tc-99 , crustacea and mollusks	5.000E+00	5.000E+00	BIOFAC(6,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(7,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(7,2)
D-5				

Dose Conversion Factor (and Related) Parameter Summary (continued)
Dose Library: FGR 12 & FGR 11

Menu	Parameter	Current Value#	Base Case*	Parameter Name
D-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(8,1)
D-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(8,2)
D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(9,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(9,2)
D-5				
D-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(10,1)
D-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(10,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(11,2)
D-5				
D-5	U-238 , fish	1.000E+01	1.000E+01	BIOFAC(12,1)
D-5	U-238 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(12,2)
D-5				
D-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(13,1)
D-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(13,2)

#For DCF1(xxx) only, factors are for infinite depth & area. See ETFG table in Ground Pathway of Detailed Report.
*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	8.094E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	1.493E+01	2.000E+00	---	THICK0
R011	Fraction of contamination that is submerged	0.000E+00	0.000E+00	---	SUBMFRACT
R011	Length parallel to aquifer flow (m)	5.820E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ra-226	2.120E-02	0.000E+00	---	S1(4)
R012	Initial principal radionuclide (pCi/g): Tc-99	5.730E-01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): Th-232	2.550E-02	0.000E+00	---	S1(9)
R012	Initial principal radionuclide (pCi/g): U-234	2.400E+00	0.000E+00	---	S1(10)
R012	Initial principal radionuclide (pCi/g): U-235	1.170E-01	0.000E+00	---	S1(11)
R012	Initial principal radionuclide (pCi/g): U-238	3.820E-01	0.000E+00	---	S1(12)
R012	Concentration in groundwater (pCi/L): Ra-226	not used	0.000E+00	---	W1(4)
R012	Concentration in groundwater (pCi/L): Tc-99	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---	W1(9)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(10)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(11)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(12)
R013	Cover depth (m)	3.600E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	1.780E+00	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	1.000E-04	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	5.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	7.500E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.840E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.300E-01	4.000E-01	---	TPSZ

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Saturated zone effective porosity	4.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	4.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	2.500E+01	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	1.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.000E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	5	1	---	NS
R015	Unsat. zone 1, thickness (m)	1.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.630E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	5.200E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	1.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	4.500E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	1.100E+01	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.500E-02	1.000E+01	---	HCUZ(1)
R015	Unsat. zone 2, thickness (m)	4.600E+00	0.000E+00	---	H(2)
R015	Unsat. zone 2, soil density (g/cm**3)	1.690E+00	1.500E+00	---	DENSUZ(2)
R015	Unsat. zone 2, total porosity	3.400E-01	4.000E-01	---	TPUZ(2)
R015	Unsat. zone 2, effective porosity	3.300E-01	2.000E-01	---	EPUZ(2)
R015	Unsat. zone 2, field capacity	7.000E-02	2.000E-01	---	FCUZ(2)
R015	Unsat. zone 2, soil-specific b parameter	2.000E+00	5.300E+00	---	BUZ(2)
R015	Unsat. zone 2, hydraulic conductivity (m/yr)	2.200E+03	1.000E+01	---	HCUZ(2)
R015	Unsat. zone 3, thickness (m)	2.130E+01	0.000E+00	---	H(3)
R015	Unsat. zone 3, soil density (g/cm**3)	1.300E+00	1.500E+00	---	DENSUZ(3)
R015	Unsat. zone 3, total porosity	5.200E-01	4.000E-01	---	TPUZ(3)
R015	Unsat. zone 3, effective porosity	4.000E-01	2.000E-01	---	EPUZ(3)
R015	Unsat. zone 3, field capacity	4.900E-01	2.000E-01	---	FCUZ(3)
R015	Unsat. zone 3, soil-specific b parameter	3.000E+00	5.300E+00	---	BUZ(3)
R015	Unsat. zone 3, hydraulic conductivity (m/yr)	9.000E+02	1.000E+01	---	HCUZ(3)
R015	Unsat. zone 4, thickness (m)	1.680E+01	0.000E+00	---	H(4)
R015	Unsat. zone 4, soil density (g/cm**3)	1.310E+00	1.500E+00	---	DENSUZ(4)
R015	Unsat. zone 4, total porosity	4.900E-01	4.000E-01	---	TPUZ(4)
R015	Unsat. zone 4, effective porosity	4.300E-01	2.000E-01	---	EPUZ(4)
R015	Unsat. zone 4, field capacity	4.800E-01	2.000E-01	---	FCUZ(4)
R015	Unsat. zone 4, soil-specific b parameter	5.000E+00	5.300E+00	---	BUZ(4)
R015	Unsat. zone 4, hydraulic conductivity (m/yr)	6.000E+01	1.000E+01	---	HCUZ(4)
R015	Unsat. zone 5, thickness (m)	1.220E+01	0.000E+00	---	H(5)
R015	Unsat. zone 5, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(5)
R015	Unsat. zone 5, total porosity	5.200E-01	4.000E-01	---	TPUZ(5)
R015	Unsat. zone 5, effective porosity	1.500E-01	2.000E-01	---	EPUZ(5)
R015	Unsat. zone 5, field capacity	3.200E-01	2.000E-01	---	FCUZ(5)
R015	Unsat. zone 5, soil-specific b parameter	8.000E+00	5.300E+00	---	BUZ(5)
R015	Unsat. zone 5, hydraulic conductivity (m/yr)	1.000E-01	1.000E+01	---	HCUZ(5)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for Ra-226				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1)
R016	Unsaturated zone 2 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,2)
R016	Unsaturated zone 3 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,3)
R016	Unsaturated zone 4 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,4)
R016	Unsaturated zone 5 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,5)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.524E-05	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for Tc-99				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(6,1)
R016	Unsaturated zone 2 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(6,2)
R016	Unsaturated zone 3 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(6,3)
R016	Unsaturated zone 4 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(6,4)
R016	Unsaturated zone 5 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(6,5)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.319E-02	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for Th-232				
R016	Contaminated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	5.800E+03	6.000E+04	---	DCNUCU(9,1)
R016	Unsaturated zone 2 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(9,2)
R016	Unsaturated zone 3 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(9,3)
R016	Unsaturated zone 4 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(9,4)
R016	Unsaturated zone 5 (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCU(9,5)
R016	Saturated zone (cm**3/g)	3.200E+03	6.000E+04	---	DCNUCS(9)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.211E-06	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	1.600E+03	5.000E+01	---	DCNUCU(10,1)
R016	Unsaturated zone 2 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(10,2)
R016	Unsaturated zone 3 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(10,3)
R016	Unsaturated zone 4 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(10,4)
R016	Unsaturated zone 5 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(10,5)
R016	Saturated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.102E-04	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	1.600E+03	5.000E+01	---	DCNUCU(11,1)
R016	Unsaturated zone 2 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(11,2)
R016	Unsaturated zone 3 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(11,3)
R016	Unsaturated zone 4 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(11,4)
R016	Unsaturated zone 5 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(11,5)
R016	Saturated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.102E-04	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	1.600E+03	5.000E+01	---	DCNUCU(12,1)
R016	Unsaturated zone 2 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(12,2)
R016	Unsaturated zone 3 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(12,3)
R016	Unsaturated zone 4 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(12,4)
R016	Unsaturated zone 5 (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCU(12,5)
R016	Saturated zone (cm**3/g)	3.500E+01	5.000E+01	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.102E-04	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Unsaturated zone 2 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,2)
R016	Unsaturated zone 3 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,3)
R016	Unsaturated zone 4 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,4)
R016	Unsaturated zone 5 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,5)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.922E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,1)
R016	Unsaturated zone 2 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,2)
R016	Unsaturated zone 3 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,3)
R016	Unsaturated zone 4 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,4)
R016	Unsaturated zone 5 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(2,5)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.726E-05	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Pb-210				
R016	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
R016	Unsaturated zone 2 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,2)
R016	Unsaturated zone 3 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,3)
R016	Unsaturated zone 4 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,4)
R016	Unsaturated zone 5 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,5)
R016	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.869E-05	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,1)
R016	Unsaturated zone 2 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,2)
R016	Unsaturated zone 3 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,3)
R016	Unsaturated zone 4 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,4)
R016	Unsaturated zone 5 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(5,5)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.524E-05	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,1)
R016	Unsaturated zone 2 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,2)
R016	Unsaturated zone 3 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,3)
R016	Unsaturated zone 4 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,4)
R016	Unsaturated zone 5 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(7,5)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.460E-08	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for daughter Th-230				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,1)
R016	Unsaturated zone 2 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,2)
R016	Unsaturated zone 3 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,3)
R016	Unsaturated zone 4 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,4)
R016	Unsaturated zone 5 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(8,5)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	6.460E-08	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	1.000E+00	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.100E+01	FMEAT
R018	Contamination fraction of milk	-1	-1	0.100E+01	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	1.000E+00	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	1.500E-01	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+00	---	DENSFL

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Total porosity of the cover material	4.130E-01	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	1.000E-01	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	2.650E-02	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	3.000E-02	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	7.233E-07	2.000E-06	---	DIFCV
R021	in foundation material	3.000E-07	3.000E-07	---	DIFFL
R021	in contaminated zone soil	3.000E-07	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	1.500E+00	5.000E-01	---	REXG
R021	Height of the building (room) (m)	2.500E+00	2.500E+00	---	HRM
R021	Building interior area factor	1.000E+00	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	0.000E+00	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	2.500E-01	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	1.500E-01	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	512	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	1	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	suppressed
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	active
Find peak pathway doses	active

Contaminated Zone Dimensions	
Area:	80937.20 square meters
Thickness:	14.93 meters
Cover Depth:	3.60 meters

Initial Soil Concentrations, pCi/g	
Ra-226	2.120E-02
Tc-99	5.730E-01
Th-232	2.550E-02
U-234	2.400E+00
U-235	1.170E-01
U-238	3.820E-01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	4.104E-04	4.103E-04	4.100E-04	4.091E-04	4.066E-04	3.985E-04	5.648E-01	3.872E-04
M(t):	1.642E-05	1.641E-05	1.640E-05	1.636E-05	1.626E-05	1.594E-05	2.259E-02	1.549E-05

Maximum TDOSE(t): 1.919E+00 mrem/yr at t = 246.7 ± 0.5 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.467E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.885E-22	0.0000	0.000E+00	0.0000	3.794E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	4.417E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	2.729E-24	0.0000	0.000E+00	0.0000	5.493E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	2.730E-31	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	5.097E-27	0.0000	0.000E+00	0.0000	2.054E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	4.419E-19	0.0000	0.000E+00	0.0000	3.849E-04	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.467E+02 years

Water Dependent Pathways

Radio-Nuclide Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.794E-04	0.0002
Tc-99	1.561E+00	0.8136	0.000E+00	0.0000	0.000E+00	0.0000	2.763E-01	0.1440	3.690E-03	0.0019	7.727E-02	0.0403	1.918E+00	0.9998
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.417E-19	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.493E-06	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.730E-31	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.054E-10	0.0000
Total	1.561E+00	0.8136	0.000E+00	0.0000	0.000E+00	0.0000	2.763E-01	0.1440	3.690E-03	0.0019	7.727E-02	0.0403	1.919E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.529E-22	0.0000	0.000E+00	0.0000	4.104E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	2.168E-21	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	1.126E-29	0.0000	0.000E+00	0.0000	3.020E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	3.476E-27	0.0000	0.000E+00	0.0000	3.407E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	2.321E-21	0.0000	0.000E+00	0.0000	4.104E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.104E-04	1.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.168E-21	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.020E-11	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.407E-18	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.104E-04	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.531E-22	0.0000	0.000E+00	0.0000	4.103E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.331E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	7.889E-29	0.0000	0.000E+00	0.0000	2.114E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	3.481E-27	0.0000	0.000E+00	0.0000	5.110E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.347E-20	0.0000	0.000E+00	0.0000	4.103E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.103E-04	1.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.331E-20	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.114E-10	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.110E-17	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.103E-04	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.533E-22	0.0000	0.000E+00	0.0000	4.100E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	5.303E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	4.179E-28	0.0000	0.000E+00	0.0000	1.117E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	3.491E-27	0.0000	0.000E+00	0.0000	5.962E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	5.318E-20	0.0000	0.000E+00	0.0000	4.100E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.100E-04	1.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.303E-20	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.117E-09	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.962E-16	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.100E-04	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.542E-22	0.0000	0.000E+00	0.0000	4.091E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.994E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	3.768E-27	0.0000	0.000E+00	0.0000	9.993E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	3.527E-27	0.0000	0.000E+00	0.0000	1.581E-14	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.995E-19	0.0000	0.000E+00	0.0000	4.091E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.091E-04	1.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.994E-19	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.993E-09	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.581E-14	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.091E-04	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.569E-22	0.0000	0.000E+00	0.0000	4.065E-04	0.9998	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.333E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	3.250E-26	0.0000	0.000E+00	0.0000	8.421E-08	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	3.633E-27	0.0000	0.000E+00	0.0000	3.866E-13	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.335E-19	0.0000	0.000E+00	0.0000	4.066E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.065E-04	0.9998
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.333E-19	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.421E-08	0.0002
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.866E-13	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.066E-04	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.665E-22	0.0000	0.000E+00	0.0000	3.976E-04	0.9977	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	3.747E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	3.819E-25	0.0000	0.000E+00	0.0000	9.122E-07	0.0023	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	4.032E-27	0.0000	0.000E+00	0.0000	1.382E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	3.749E-19	0.0000	0.000E+00	0.0000	3.985E-04	1.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.976E-04	0.9977
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.747E-19	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.122E-07	0.0023
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.382E-11	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.985E-04	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	1.972E-22	0.0000	0.000E+00	0.0000	3.730E-04	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	4.688E-19	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	4.283E-24	0.0000	0.000E+00	0.0000	8.103E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	3.708E-31	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	5.597E-27	0.0000	0.000E+00	0.0000	3.688E-10	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	4.690E-19	0.0000	0.000E+00	0.0000	3.811E-04	0.0007	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.730E-04	0.0007
Tc-99	4.592E-01	0.8131	0.000E+00	0.0000	0.000E+00	0.0000	8.134E-02	0.1440	1.090E-03	0.0019	2.276E-02	0.0403	5.644E-01	0.9993
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.688E-19	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.103E-06	0.0000
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.708E-31	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.688E-10	0.0000
Total	4.592E-01	0.8131	0.000E+00	0.0000	0.000E+00	0.0000	8.134E-02	0.1440	1.090E-03	0.0019	2.276E-02	0.0403	5.648E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	3.566E-22	0.0000	0.000E+00	0.0000	2.988E-04	0.7718	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Tc-99	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	1.027E-18	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-234	1.053E-22	0.0000	0.000E+00	0.0000	8.827E-05	0.2280	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-235	4.101E-30	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
U-238	3.131E-26	0.0000	0.000E+00	0.0000	1.357E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	1.027E-18	0.0000	0.000E+00	0.0000	3.871E-04	0.9999	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ra-226	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.988E-04	0.7718
Tc-99	4.367E-08	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	7.734E-09	0.0000	1.036E-10	0.0000	2.164E-09	0.0000	5.367E-08	0.0001
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.027E-18	0.0000
U-234	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.827E-05	0.2280
U-235	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.101E-30	0.0000
U-238	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.357E-08	0.0000
Total	4.367E-08	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	7.734E-09	0.0000	1.036E-10	0.0000	2.164E-09	0.0000	3.872E-04	1.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226+D	Ra-226+D	1.000E+00	1.936E-02	1.935E-02	1.934E-02	1.930E-02	1.918E-02	1.875E-02	1.759E-02	1.410E-02
Ra-226+D	Pb-210+D	1.000E+00	4.023E-32	1.192E-31	2.706E-31	7.378E-31	1.666E-30	2.829E-30	3.705E-30	8.079E-30
Ra-226+D	∑DSR(j)		1.936E-02	1.935E-02	1.934E-02	1.930E-02	1.918E-02	1.875E-02	1.759E-02	1.410E-02
Tc-99	Tc-99	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.850E-01	9.366E-08
Th-232	Th-232	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-232	Ra-228+D	1.000E+00	1.508E-24	4.299E-24	8.989E-24	1.896E-23	2.651E-23	3.016E-23	4.052E-23	1.139E-22
Th-232	Th-228+D	1.000E+00	8.501E-20	5.220E-19	2.080E-18	7.818E-18	1.307E-17	1.470E-17	1.839E-17	4.027E-17
Th-232	∑DSR(j)		8.501E-20	5.220E-19	2.080E-18	7.818E-18	1.307E-17	1.470E-17	1.839E-17	4.027E-17
U-234	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	Th-230	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	Ra-226+D	1.000E+00	1.258E-11	8.809E-11	4.656E-10	4.164E-09	3.509E-08	3.801E-07	3.376E-06	3.678E-05
U-234	Pb-210+D	1.000E+00	1.313E-41	1.959E-40	2.259E-39	5.742E-38	1.255E-36	3.301E-35	5.692E-34	1.957E-32
U-234	∑DSR(j)		1.258E-11	8.809E-11	4.656E-10	4.164E-09	3.509E-08	3.801E-07	3.376E-06	3.678E-05
U-235+D	U-235+D	1.000E+00	1.591E-39	1.595E-39	1.602E-39	1.629E-39	1.707E-39	2.012E-39	3.217E-39	1.662E-38
U-235+D	Pa-231	1.000E+00	5.881E-39	1.767E-38	4.140E-38	1.259E-37	3.804E-37	1.438E-36	6.362E-36	8.356E-35
U-235+D	Ac-227+D	1.000E+00	3.844E-35	2.670E-34	1.387E-33	1.168E-32	8.407E-32	6.019E-31	3.169E-30	3.505E-29
U-235+D	∑DSR(j)		3.844E-35	2.670E-34	1.387E-33	1.168E-32	8.407E-32	6.019E-31	3.169E-30	3.505E-29
U-238	U-238	5.400E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238+D	U-238+D	9.999E-01	9.099E-27	9.112E-27	9.139E-27	9.234E-27	9.509E-27	1.054E-26	1.414E-26	3.958E-26
U-238+D	U-234	9.999E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238+D	Th-230	9.999E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238+D	Ra-226+D	9.999E-01	8.918E-18	1.338E-16	1.561E-15	4.138E-14	1.012E-12	3.618E-11	9.653E-10	3.552E-08
U-238+D	Pb-210+D	9.999E-01	0.000E+00	0.000E+00	5.605E-45	4.358E-43	2.833E-41	2.635E-39	1.488E-37	1.832E-35
U-238+D	∑DSR(j)		8.918E-18	1.338E-16	1.561E-15	4.138E-14	1.012E-12	3.618E-11	9.653E-10	3.552E-08

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	1.291E+03	1.292E+03	1.293E+03	1.296E+03	1.304E+03	1.333E+03	1.421E+03	1.774E+03
Tc-99	*1.697E+10	*1.697E+10	*1.697E+10	*1.697E+10	*1.697E+10	*1.697E+10	2.538E+01	2.669E+08
Th-232	*1.097E+05	*1.097E+05	*1.097E+05	*1.097E+05	*1.097E+05	*1.097E+05	*1.097E+05	*1.097E+05
U-234	*6.247E+09	*6.247E+09	*6.247E+09	6.004E+09	7.125E+08	6.577E+07	7.404E+06	6.798E+05
U-235	*2.161E+06	*2.161E+06	*2.161E+06	*2.161E+06	*2.161E+06	*2.161E+06	*2.161E+06	*2.161E+06
U-238	*3.361E+05	*3.361E+05	*3.361E+05	*3.361E+05	*3.361E+05	*3.361E+05	*3.361E+05	*3.361E+05

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 246.7 ± 0.5 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ra-226	2.120E-02	0.000E+00	1.936E-02	1.291E+03	1.790E-02	1.397E+03
Tc-99	5.730E-01	246.7 ± 0.5	3.348E+00	7.468E+00	3.348E+00	7.468E+00
Th-232	2.550E-02	1.000E+03	4.027E-17	*1.097E+05	1.732E-17	*1.097E+05
U-234	2.400E+00	1.000E+03	3.678E-05	6.798E+05	2.289E-06	1.092E+07
U-235	1.170E-01	1.000E+03	3.505E-29	*2.161E+06	2.334E-30	*2.161E+06
U-238	3.820E-01	1.000E+03	3.552E-08	*3.361E+05	5.376E-10	*3.361E+05

*At specific activity limit

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	Ra-226	1.000E+00	4.104E-04	4.103E-04	4.100E-04	4.091E-04	4.065E-04	3.976E-04	3.730E-04	2.988E-04
Ra-226	U-234	1.000E+00	3.020E-11	2.114E-10	1.117E-09	9.993E-09	8.421E-08	9.122E-07	8.103E-06	8.827E-05
Ra-226	U-238	9.999E-01	3.407E-18	5.110E-17	5.962E-16	1.581E-14	3.866E-13	1.382E-11	3.688E-10	1.357E-08
Ra-226	∑DOSE(j)		4.104E-04	4.103E-04	4.100E-04	4.091E-04	4.066E-04	3.985E-04	3.811E-04	3.871E-04
Pb-210	Ra-226	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.531E-32	5.998E-32	7.855E-32	1.713E-31
Pb-210	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	U-238	9.999E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pb-210	∑DOSE(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.531E-32	5.998E-32	7.855E-32	1.713E-31
Tc-99	Tc-99	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.644E-01	5.367E-08
Th-232	Th-232	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ra-228	Th-232	1.000E+00	3.846E-26	1.096E-25	2.292E-25	4.835E-25	6.760E-25	7.691E-25	1.033E-24	2.904E-24
Th-228	Th-232	1.000E+00	2.168E-21	1.331E-20	5.303E-20	1.994E-19	3.333E-19	3.747E-19	4.688E-19	1.027E-18
U-234	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	U-238	9.999E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-234	∑DOSE(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	U-234	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	U-238	9.999E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-230	∑DOSE(j)		0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-235	U-235	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pa-231	U-235	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ac-227	U-235	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.708E-31	4.101E-30
U-238	U-238	5.400E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U-238	U-238	9.999E-01	3.476E-27	3.481E-27	3.491E-27	3.527E-27	3.633E-27	4.026E-27	5.402E-27	1.512E-26
U-238	∑DOSE(j)		3.476E-27	3.481E-27	3.491E-27	3.527E-27	3.633E-27	4.026E-27	5.402E-27	1.512E-26

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ra-226	Ra-226	1.000E+00	2.120E-02	2.119E-02	2.117E-02	2.110E-02	2.089E-02	2.019E-02	1.831E-02	1.301E-02
Ra-226	U-234	1.000E+00	0.000E+00	4.679E-09	4.209E-08	4.670E-07	4.186E-06	4.586E-05	3.964E-04	3.838E-03
Ra-226	U-238	9.999E-01	0.000E+00	7.037E-16	1.899E-14	7.026E-13	1.890E-11	6.913E-10	1.801E-08	5.897E-07
Ra-226	∑S(j):		2.120E-02	2.119E-02	2.117E-02	2.110E-02	2.090E-02	2.024E-02	1.871E-02	1.685E-02
Pb-210	Ra-226	1.000E+00	0.000E+00	6.486E-04	1.886E-03	5.648E-03	1.274E-02	1.953E-02	1.858E-02	1.320E-02
Pb-210	U-234	1.000E+00	0.000E+00	4.810E-11	1.279E-09	4.487E-08	1.048E-06	2.549E-05	3.218E-04	3.616E-03
Pb-210	U-238	9.999E-01	0.000E+00	5.435E-18	4.347E-16	5.138E-14	3.700E-12	3.221E-10	1.337E-08	5.385E-07
Pb-210	∑S(j):		0.000E+00	6.486E-04	1.886E-03	5.648E-03	1.274E-02	1.955E-02	1.890E-02	1.682E-02
Tc-99	Tc-99	1.000E+00	5.730E-01	5.599E-01	5.345E-01	4.544E-01	2.857E-01	5.633E-02	5.443E-04	4.828E-11
Th-232	Th-232	1.000E+00	2.550E-02	2.550E-02	2.550E-02	2.550E-02	2.550E-02	2.550E-02	2.549E-02	2.547E-02
Ra-228	Th-232	1.000E+00	0.000E+00	2.896E-03	7.738E-03	1.786E-02	2.480E-02	2.549E-02	2.548E-02	2.546E-02
Th-228	Th-232	1.000E+00	0.000E+00	4.754E-04	3.170E-03	1.439E-02	2.446E-02	2.549E-02	2.548E-02	2.546E-02
U-234	U-234	1.000E+00	2.400E+00	2.400E+00	2.399E+00	2.397E+00	2.392E+00	2.373E+00	2.320E+00	2.143E+00
U-234	U-238	9.999E-01	0.000E+00	1.083E-06	3.248E-06	1.082E-05	3.238E-05	1.071E-04	3.142E-04	9.685E-04
U-234	∑S(j):		2.400E+00	2.400E+00	2.399E+00	2.397E+00	2.392E+00	2.373E+00	2.320E+00	2.144E+00
Th-230	U-234	1.000E+00	0.000E+00	2.160E-05	6.480E-05	2.159E-04	6.470E-04	2.147E-03	6.364E-03	2.033E-02
Th-230	U-238	9.999E-01	0.000E+00	4.874E-12	4.386E-11	4.870E-10	4.376E-09	4.836E-08	4.286E-07	4.512E-06
Th-230	∑S(j):		0.000E+00	2.160E-05	6.480E-05	2.159E-04	6.470E-04	2.147E-03	6.364E-03	2.034E-02
U-235	U-235	1.000E+00	1.170E-01	1.170E-01	1.170E-01	1.169E-01	1.166E-01	1.157E-01	1.132E-01	1.048E-01
Pa-231	U-235	1.000E+00	0.000E+00	2.475E-06	7.424E-06	2.473E-05	7.403E-05	2.450E-04	7.198E-04	2.230E-03
Ac-227	U-235	1.000E+00	0.000E+00	3.898E-08	3.435E-07	3.549E-06	2.632E-05	1.709E-04	6.429E-04	2.155E-03
U-238	U-238	5.400E-05	2.063E-05	2.063E-05	2.062E-05	2.061E-05	2.056E-05	2.040E-05	1.996E-05	1.848E-05
U-238	U-238	9.999E-01	3.820E-01	3.819E-01	3.819E-01	3.816E-01	3.807E-01	3.778E-01	3.696E-01	3.421E-01
U-238	∑S(j):		3.820E-01	3.820E-01	3.819E-01	3.816E-01	3.807E-01	3.778E-01	3.696E-01	3.421E-01

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 15.82 seconds

Attachment 3

Conceptual Characterization Framework for Waste Destined for USEI

1 Overview of Waste Characterization Activities

1.1 Material to be loaded for shipment to USEI will be staged at the waste holding area.

1.2 Two types of stockpiles will generally be present; one that is accepting material from the excavation areas, and one that is being actively loaded into railcars.

1.3 The activity concentration in the stockpile accepting material will be based on a weighted average. As material is added to the stockpile, the weight of each load and the activity concentration within each load (as measured either by the box counter or from subsequent gamma spectral analysis of composite samples collected at a frequency of one sample per 100 cubic yards (volume is equivalent to slightly more than one railcar and is approximately 40,000 lbs) will be used to define the weighted average concentration within the stockpile.

1.4 A final weighted average concentration will be determined for the stockpile based on the information described above prior to being approved for loading, and will be considered representative of the concentration to be placed into a series of railcars.

1.5 Coincident with the process of creating and characterizing the stockpile as summarized above, the stockpile created and characterized on the previous day will be loaded into railcars for transport to disposal.

1.6 As documentation of disposal, a running inventory of the average radionuclide concentrations (i.e., total activity and total mass shipped) of each radionuclide will be maintained.

1.7 If the Tc-99 inventory was initially based on inferred data (i.e., gamma spectroscopy and application of scaling factors), the Tc-99 inventory data will be updated upon receipt of laboratory data.

1.8 Additionally gamma spectroscopy analysis will be performed along with Tc-99 on composite samples of shipped material to gather information on the Tc-99/U-235 ratio. This information will be evaluated to assess the suitability of the continued use of the surrogate values published in DO-08-008, *Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides*, Revision 0, for waste shipping purposes.

1.9 The three major streams of waste material coming into the waste holding area are anticipated to be a result of the following material handling processes:

- Material Originating From Areas Requiring Nuclear Criticality Safety (NCS) Controls, With The Material Assayed By The Box Counter,
- Material Originating From Areas Requiring NCS Controls, With Material Assayed By Composite Sampling, And

- Material Originating From Areas **Not** Requiring NCS Controls, With Material Assayed By Composite Sampling.

The waste characterization techniques that apply to each of these three material handling processes are detailed below. Note that the first two techniques are to be implemented within areas that require controls for nuclear criticality safety, and therefore excavation and radiological surveys will progress in discrete lifts with radiological scanning performed between each lift.

2 Material Originating From Areas Requiring NCS Controls – Box Counter Assay

2.1 The surface of the material will be scanned within the excavation prior to each successive lift. Scanning will be performed using sodium iodide detector with approximate scanning sensitivity for total uranium as indicated in Table 1.

Table 1
MDC for Total Uranium Based on Degree of Enrichment

Enrichment (wt% U-235)	Total U[a] (pCi/g)
3	65
20	77
50	95
75	109

[a] MDC values assume a surveyor efficiency of 50%.

2.2 In addition to the radiological scanning, a visual examination will be performed to identify materials which due to their specific material characteristics warrant removal and additional investigation.

2.3 Discrete sources of elevated activity or other items that cannot be adequately characterized to meet the requirements for NCS based on the results of radiological scanning will be removed from the material stream and taken to a waste evaluation area for characterization. This will also provide information regarding suitability for disposal at USEI.

2.4 Once scanning of each lift has been completed and any sources of elevated activity or other items have been characterized, the material will be loaded into a 15 - 20 cubic yard container and taken to the box counter for weighing and assay by gamma spectroscopy.

2.5 This measurement will be used as the basis for the concentrations of Ra-226, Th-232, U-235, and U-238 within that load of material, and to provide an initial estimate of the concentration of Tc-99 through application of the scaling factors from DO-08-008, *Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides*, Revision 0, and the U-234/U-235 ratio based on the calculated enrichment, as described in steps 2.7 and 2.9 below.

2.6 The estimated Minimum Detectable Activity (MDA) for radionuclides that are measured directly using the box counter are provided in Table 2. These values are larger than the calculated values from Table 5 in Attachment 1 of the accompanying transmittal letter in consideration of the potential for conditions that differ from those assumed for the calculated values.

Table 2
Estimated MDA Values for Box Counter System – Gamma Emitters

Count Time (minutes)	Ra-226 MDA[a] (pCi/g)	Th-232 MDA (pCi/g)	U-235 MDA (pCi/g)	U-238 MDA (pCi/g)
10	10/1	1	1	10

[a] MDA values shown for both direct analysis using 186 keV peak (higher value) and indirect analysis using daughters (i.e., Bi-241/Pb-214).

2.7 The Tc-99 activity will be initially inferred based on the scaling factor for Tc-99/U-235 derived from previous characterization data that has been compiled in Westinghouse Electric Company Document No. DO-08-008, *"Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides,"* Revision 0, based on the area from which the material originated.

2.8 The effective estimated minimum detectable activity for Tc-99 (inferred) based on the detection levels indicated in Table 2 through application of the scaling factors are provided in the Table 3.

Table 3
Estimated Inferred MDA Values for Box Counter System – Tc-99

Count Time (minutes)	Plant Soils Area[a] (pCi/g)	Tc-99 Soils Area[a] (pCi/g)	Burial Pit Soils Area[a] (pCi/g)	Soil Contour Dataset[b] (pCi/g)
10	10	46	6	38

[a] Based on the U-235 MDA value from Table 2 and the Tc-99/U-235 ratios from Westinghouse Electric Company Document No. DO-08-008, *"Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides,"* Revision 0.

b Based on the U-235 MDA value from Table 2 and the Tc-99/U-235 ratios from the dataset used to derive soils concentrations in the request for alternate waste disposal for soils (Reference 5, Attachment 2, "Soil_Contour_Data.xls").

2.9 The U-234 activity will be inferred based on the measured U-238/U-235 ratio and the associated degree of enrichment.

2.10 The effective estimated minimum detectable activity for U-234 (inferred) based on the detection levels indicated in Table 2 and a calculation based on the degree of enrichment defined by the ratio of U-235/U-238. The results for varying degree of enrichment are provided in 4 Table.

Table 4
Estimated Inferred MDA Values for Box Counter System – U-234

Count Time (minutes)	**Natural U** (pCi/g)	**5 wt% U-235** (pCi/g)	**20 wt% U-235** (pCi/g)	**95 wt% U-235** (pCi/g)
10	21	18	20	32

3 Material Originating From Areas Requiring NCS Controls – With Material Assayed By Composite Sampling

3.1 Repeat Steps 2.1 – 2.3

3.2 Once scanning of each lift has been completed and any sources of elevated activity or other items have been characterized, the material will be loaded into a 15 - 20 cubic yard container and transported to the waste holding area.

3.3 One sample aliquot will be obtained at random from each 15 – 20 cubic yards of material as the material is placed onto the stockpile

3.4 One composite sample will be created from the aliquots at a frequency of approximately one sample per approximately 100 cubic yards (volume is equivalent to slightly more than one railcar and approximately 40,000 lbs), and submitted for gamma spectroscopy analysis.

3.5 This measurement will be used as the basis for the concentrations of Ra-226, Th-232, U-235, and U-238 within that volume of material, and to provide an estimate of the concentration of Tc-99 and U-234 through application of the scaling factors from DO-08-008, *Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides*, Revision 0, and the U-234/U-235 ratio based on the calculated enrichment, as described in steps 3.7 and 3.9.

3.6 The estimated minimum detectable activity for radionuclides that are measured directly using gamma spectroscopy are provided in Table 5.

Table 5[a]
Estimated MDA Values for Gamma Spectroscopy System – Gamma Emitters

Count Time (minutes)	**Ra-226 MDA (pCi/g)**	**Th-232 MDA (pCi/g)**	**U-235 MDA (pCi/g)**	**U-238 MDA (pCi/g)**
Variable	3	3	5	20

[a] Estimated MDA values shown based on expected system performance with samples analyzed without drying and homogenization.

3.7 The Tc-99 activity will initially be inferred based the U-235 concentration value obtained from gamma spectroscopy and the application of a Tc-99/U-235 scaling factor from DO-08-008, *Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides*, Revision 0, based on the area from which the material originated.

3.8 The estimated minimum detectable activity for Tc-99 (inferred) based on the detection levels indicated in Table 5 through application of the scaling factors are provided in Table 6.

Table 6
Estimated Inferred MDA Values for Gamma Spectroscopy System – Tc-99

Count Time (minutes)	**Plant Soils Area[a]** (pCi/g)	**Tc-99 Soils Area[a]** (pCi/g)	**Burial Pit Soils Area[a]** (pCi/g)	**Soil Contour Dataset[b]** (pCi/g)
variable	48	230	30	190

a Based on the U-235 MDA value from Table 5 and the Tc-99/U-235 ratios from Westinghouse Electric Company Document No. DO-08-008, *"Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides,"* Revision 0.

b Based on the U-235 MDA value from Table 5 and the Tc-99/U-235 ratios from the dataset used to derive soils concentrations in the request for alternate waste disposal for soils (Reference 5, Attachment 2, "Soil_Contour_Data.xls").

3.9 The U-234 activity will be inferred based on the measured U-238/U-235 ratio and the associated degree of enrichment.

3.10 The estimated minimum detectable activity for U-234 (inferred) based on the detection levels indicated in Table 5 and a calculation based on the degree of enrichment defined by the ratio of U-235/U-238. The results for varying degree of enrichment are provided in Table 7.

Table 7
Estimated Inferred MDA Values for Gamma Spectroscopy System – U-234

Count Time (minutes)	**Natural U** (pCi/g)	**5 wt% U-235** (pCi/g)	**20 wt% U-235** (pCi/g)	**95 wt% U-235** (pCi/g)
Variable	105	91	100	159

4 Material Originating From Areas Not Requiring NCS Controls – With Material Assayed By Composite Sampling

4.1 Material will be loaded into a 15 - 20 cubic yard container and taken to the waste holding area.

4.2 The material will be unloaded at the waste holding area and the exposed surface of the pile will be scanned.

4.3 Scanning will be performed using a sodium iodide detector with approximate scanning sensitivity for total uranium as indicated in Table 8.

Table 8
MDC for Total Uranium Based on Degree of Enrichment

Enrichment (wt% U-235)	Total U[a] (pCi/g)
3	65
20	77
50	95
75	109

[a] MDC values assume a surveyor efficiency of 50%.

4.4 In addition to the radiological scanning, a visual examination will be performed to identify materials which due to their specific material characteristics warrant removal and additional investigation. Examples include intact containers, or bulky objects with sufficient mass to impede characterization through the scan survey.

4.5 Discrete sources of elevated activity or other items that cannot be adequately characterized by radiological scanning will be removed from the material stream and taken to the waste evaluation area for detailed characterization. This will also provide information regarding suitability for disposal at USEI.

4.6 A composite sample will be obtained that is composed of aliquots collected at biased locations from each 15 – 20 cubic yard of material as the material is unloaded at the waste holding area.

4.7 Repeat Steps 3.4 – 3.10

5 Summary of Sampling Data to Characterize Stockpile Concentrations

5.1 Material Originating From Areas Requiring NCS Controls – Box Counter Assay

- Each 15 – 20 yard load of material will be analyzed using the box counter.

5.2 Material Originating From Areas Requiring NCS Controls – With Material Assay By Composite Sampling

- One composite sample per 100 yd^3 (approximately 40,000 lbs) will be analyzed by onsite gamma spectroscopy.

5.3 Material Originating From Areas Not Requiring NCS Controls – With Material Assay By Composite Sampling

- One composite sample per 100 yd^3 (approximately 40,000 lbs) will be analyzed by onsite gamma spectroscopy.

5.4 A composite sample will be created for each stockpile of material (approximately 500 yd^3), This sample will be dried and homogenized, and submitted for gamma spectroscopy and Tc-99 analysis.

5.5 The stockpile concentration will be calculated based on the weighted average of the primary radionuclide (from gamma spectroscopy) concentrations from the individual input material stream concentrations along with the associated Tc-99 and U-234 concentrations based on their respective inferred values.

5.6 If determined suitable to shipment to USEI (based on initial characterization data and the ongoing characterization of waste material), the material will be authorized for shipment.

5.7 The concentration determined in the process summarized above will be assigned to all rail cars loaded from the stockpile.

6 Final Characterization of Waste Sent to Disposal

6.1 One composite sample from the stockpile will be dried, homogenized and submitted for gamma spectroscopy and Tc-99 analysis.

6.2 The results of this analysis will be used to refine or update the Tc-99 inventory estimates for railcars represented by the volume of material sent for disposal.

6.3 This information will also be evaluated to assess the suitability of the continued use of the surrogate values published in Westinghouse Document DO-08-008, Derivation of Surrogates and Scaling Factors for Hard-To-Detect Radionuclides, Revision 0, for waste shipping purposes.

6.4 The running total Tc-99 inventory will be updated based on this data and maintained less than the projected project total (i.e. average of 27 pCi/g shipped over 424,425 tons of soil).

7 Summary of Detection Capabilities

A summary of the detection capability for key nuclides which were sensitive in the performance assessment evaluation is presented below. The requisite capabilities of detection of 16 and 13 pCi/g for Th-232 and Ra-226, respectively and the ability to reliably determine a mean activity of 27 pCi/g of Tc-99 are clearly demonstrated through the use of onsite gamma spectroscopy coupled with subsequent laboratory analysis for Tc-99.

7.1 <u>Ra-226</u>

Material going through the box counter will be assayed with an estimated minimum detection sensitivity of 1 pCi/g through the indirect analysis of Ra-226 progeny (Bi-241/Pb-214). Direct measurement of Ra-226 yields an estimated minimum detection sensitivity of 10 pCi/g.

Composite samples submitted for gamma spectroscopy will be counted on a HPGe system with an estimated minimum detection sensitivity of 3 pCi/g.

Confirmation samples submitted for offsite analysis will have an estimated minimum detection sensitivity of 1 pCi/g.

7.2 Th-232

Material going through the box counter will be assayed with an estimated minimum detection sensitivity of 1 pCi/g.

Composite samples submitted for gamma spectroscopy will be counted on a HPGe system with an estimated minimum detection sensitivity of 3 pCi/g.

Confirmation samples submitted for offsite analysis will have an estimated minimum detection sensitivity of 1 pCi/g.

7.3 Tc-99

Material going through the box counter will be assayed with an estimated minimum detection sensitivity (based on scaling factors) of between 6 and 50 pCi/g, depending on the origin of the material.

Composite samples submitted for gamma spectroscopy will be counted on a HPGe system with an estimated (based on scaling factors) minimum detection sensitivity of between 30 and 230 pCi/g.

Confirmation samples submitted for offsite analysis will have an estimated minimum detection sensitivity of 1 pCi/g.