DEPARTMENT OF THE ARMY
U. S. ARMY ABERDEEN TEST CENTER
400 COLLERAN ROAD
ABERDEEN PROVING GROUND, MARYLAND 21005-5059

REPLY TO
ATTENTION OF

Office of the Commander

Q-5

13 SEP 2005

Mr. James P. Dwyer
Nuclear Regulatory Commission, Region I
Division of Nuclear Materials Safety
475 Allendale Road
King of Prussia, Pennsylvania 19406

NMSO 2

SUB-834
04007354

Dear Mr. Dwyer:

Reference Nuclear Regulatory Commission License Number: SUB 834, Docket Number: 040-07354.

Aberdeen Test Center (ATC) proposes to transfer and dispose of unimportant quantities of licensed material, (10 CFR 40.13, less than 0.05% source material by weight, of the total vehicle weight) specifically depleted uranium (DU), present in battle damaged Bradley M2A2 Fighting Vehicles. ATC, through the Aberdeen Proving Ground Environmental Compliance Division, proposes to dispose of vehicle debris at the US Ecology Idaho Facility, located 10.5 miles NW on Highway 78, Lamely Road, Grand View, Idaho 83624. The purpose of this letter is to submit a request for NRC approval of proposed procedures for disposal of the above vehicle debris in accordance with the provisions of 10 CFR 20.2002.

A description of the waste material for disposal that contains small amounts of licensed materials, including the physical and chemical properties important to risk evaluation and the proposed manner and conditions of waste disposal, is provided in enclosure 1. In addition, ATC has performed a radiological assessment of the debris and determined that the potential dose to members of the public, as a consequence of the proposed waste disposal, will be very low and significantly less than 25 millirem per year.

ATC hereby requests an expedited review and approval of this request to support disposal of the remaining debris from two Bradley M2A2 Fighting Vehicles at the US Ecology Idaho Facility. Regulated license quantities of radioactive waste generated under this license normally is transported to a licensed commercial low-level radioactive waste disposal facility.

There are no regulatory commitments contained in this letter.

137815

If you have any questions regarding this submittal, please contact Mr. John C. Beckman, ATC Radiation Safety Officer, at (410) 278- 9618. A copy of this letter will be forwarded to Mr. Matthew G. Wiherle, Aberdeen Proving Grounds Radiation Safety Officer.

Sincerely,

John P. Rooney
Colonel, U. S. Army
Commanding

Enclosure

Attachment 1

Aberdeen Proving Ground
Request for Approval of Proposed Procedures
in accordance with 10 CFR 20.2002

August 2005

Aberdeen Proving Ground
Request for Approval of Proposed Procedures
in accordance with 10 CFR 20.2002

1. INTRODUCTION

This request is for approval of proposed disposal procedures in accordance with the provisions of 10 CFR 20.2002. This will allow Aberdeen Proving Ground (APG) to dispose of Bradley M2A2 Fighting Vehicle waste debris containing unimportant quantities of source material received from Iraq at the US Ecology Idaho Facility, Grand View, Idaho. This attachment documents an assessment of the radiological impacts of the proposed disposal. The following sections describe disposal site characteristics, the waste material, the radiological assessment and conclusions. This request and subsequent conclusion is that potential radiation doses to members of the public would not exceed 25 millirem per year from the proposed disposal. The following conservative calculations indicate that potential doses to members of the public after closure of the site and to workers involved in the transportation to and placement of the Bradley Vehicle waste debris at the US Ecology facility would receive a small fraction of this limit.

2. DISPOSAL SITE CHARACTERISTICS

This section describes the features of the disposal facility of importance in radiological assessment. It describes in turn the geographical and physical environment of the facility, including the engineered features, the permits under which the site operates, including radioactive material disposal limits, site operations, including radiation monitoring, and post-closure plans. A complete description of the site is provided in documents submitted to the State of Idaho in support of permit applications (Envirosafe, 2000, Ref. 2; CH2M Hill, 1993, Ref. 3). Only a summary description of the key features in detail sufficient to support radiological analysis is provided by this request.

2.1. ENVIRONMENT AND FACILITY DESIGN

The US Ecology Idaho site is located near Grand View, Idaho in the Owyhee County. Grand View is approximately 40 miles south-southeast of Boise, Idaho. The disposal site is located at 10.5 miles NW on Highway 78, Lemley Road, Grand View, Idaho, 83624

The natural site features most important from the standpoint of radioactive material confinement are the low precipitation rate and the long vertical distance to groundwater. The precipitation rate in this arid location is 0.184 meters per

year (Envirosafe, 2000, Ref. 2). The depth to groundwater accommodates a 3.6-meter thick cover, a 33.6-meter thick disposal zone, and a 61-meter thick unsaturated zone between the base of the disposal cell and groundwater (Envirosafe, 2000, Ref. 2; CH2M Hill, 1993, Ref. 3).

The US Ecology Idaho disposal site has various engineered features designed to enhance confinement performance that have been incorporated into the facility. At cell closure a radioactive material confinement cover that is 3.6-meter thick, has low permeability, and an erosion resistant cover is constructed. This final cover is to be constructed of compacted soil in conjunction with a 40-mil HDPE liner. The HDPE cover liner is to be integrated with a similar liner along the sides and bottom of the cell. The HDPE liner is ignored in this analysis to assure that projections of potential radiation dose are conservatively calculated.

Other facility design features and operating procedures provide shorter term confinement of radioactive materials and limit the potential for radiation exposure during receipt of material and emplacement of materials in the cell. These include a closed facility with filtered ventilation exhaust for transfer of incoming waste material from the shipping conveyance to US Ecology Idaho waste transfer vehicles, mechanized equipment for disposition of waste material in the cell, and daily interim cover of several inches of soil emplaced over newly deposited material at the end of each day's operations.

2.2. PERMITS

The US Ecology Idaho site is a Subtitle C RCRA hazardous waste disposal facility permitted under the authority of the Idaho Hazardous Waste Management Act, Chapter 44, Title 39, of the Idaho Code. The site operates under permit IDD073 114654. A Class I Permit Modification was approved in 1999, and a Class II Permit Modification was approved in 2001. The latter permit modification also accommodates recent changes to Idaho law and regulations regarding the disposal of radioactive material, as described below. In accordance with its regulations and permit conditions, the site has received certain radioactive materials exempt from Nuclear Regulatory Commissioning licensing requirements, including U.S. Army Corps of Engineers FUSRAP program materials, for a number of years.

Disposal of radioactive materials at the US Ecology Idaho site is regulated under the Rules of the Department of Environmental Quality, IDAPA 58.01.10, "Rules Regulating the Disposal of Radioactive Materials Not Regulated Under the Atomic Energy Act of 1954, As Amended." These regulations establish radiation protection standards and permit conditions for disposal of these materials at a permitted disposal facility under the authority of the Idaho Hazardous Waste Management Act, Chapter44, Title 39, Idaho Code.

Under the Idaho Department of Environmental Quality general protection standards, all owners and operators disposing of radioactive materials are required to conduct operations in a manner consistent with radiation protection standards contained in 10 CFR Part 20. In addition, no owner or operator may operate in a manner such that any member of the public would receive an annual Total Effective Dose Equivalent (TEDE) in excess of 100 millirem per year. In addition, no person may release radioactive material for unrestricted use in such a manner that the reasonably maximally expose individual would receive an annual TEDE greater than 15 millirem per year, excluding natural background.

The facility owner or operator is also required to comply with each of the following permit conditions:

• Department-approved waste acceptance criteria for radioactive material;

• A Department-approved closure program that provides reasonable assurance that the radon emanation rate from the closed disposal unit will not exceed twenty (20) picocuries per square meter per second averaged across the entire area of the closed disposal unit and meets the general radiation protection standard for the public (TEDE of 100 millirem per year); and

• A Department-approved environmental monitoring program that monitors air, ground water, surface water and soil for radionuclides and ambient radiation levels in the environs of the facility, and which demonstrates that no member of the general public is likely to exceed a radiation dose of 100 millirem per year from operations conducted at the site.

2.3. OPERATIONS

US Ecology Idaho accepts only wastes that conform to waste acceptance criteria approved by the Idaho Department of Environmental Quality, as required in DAPA 58.01.10. This is implemented in the form of a two-step pre-acceptance protocol. For the first step, the generator prepares a chemical and physical characterization of the waste stream on a US Ecology Idaho standard form. The second step is an evaluation performed by US Ecology Idaho to determine the acceptability of the waste. Waste will not be shipped until it is determined to be acceptable by US Ecology Idaho and appropriate Aberdeen Proving Ground radioactive waste transport and disposal procedures.

US Ecology Idaho is required by condition of its Department of Environmental Quality permit to operate in such a manner to assure that the highest potential dose to a worker handling radioactive material is 400 millirem TEDE per year, and that assures that the highest potential dose to a member of the public is 100 millirem TEDE per year from operations or 15 millirem TEDE per year from release of radioactive materials for unrestricted use.

To meet these requirements, US Ecology Idaho conducts operations in accordance with its Radioactive Material Health and Safety Manual and other operating procedures. These procedures include measures for minimizing release of material in receipt and handling. Transfers of as-received materials from shipping conveyances to USEI vehicles are performed in a closed structure with bag-filtered ventilation exhaust. Workers use mechanized equipment to transfer and deposit material in the disposal cell. Materials placed in the cell are covered each day with a stabilizing layer of soil and/or asphalt at least several inches thick to minimize the potential for release of radioactive materials to the atmosphere.

2.4. POST-CLOSURE PLAN

As required by the Idaho Department of Environmental Quality in IDAPA 58.01.10, US Ecology Idaho maintains an approved closure plan, submitted as part of its permit application (Envirosafe, 1998, Ref. 1). The plan conforms to all standard closure and post-closure requirements applicable to RCRA disposal facilities, including post-closure monitoring and financial assurance.

The plan provides reasonable assurance that the radon emanation rate from the closed disposal unit will not exceed twenty (20) picocuries per square meter per second averaged across the entire area of the closed disposal unit and reasonable assurance that the general radiation protection standard for the public (TEDE of 100 millirem per year) will not be exceeded.

3. DESCRIPTION OF BRADLEY VEHICLE WASTE DEBRIS

3.1 Physical Properties

APG requested a vendor evaluation of the radioactive content for two (2) Bradley Fighting Vehicles (M2A2). The vehicles were damaged under battle conditions in Iraq and returned to APG for removal of hazardous and radioactive materials.

The subject vehicles include a near intact Bradley Vehicle with a burnt out interior and a fully destroyed, and partially melted Bradley Vehicle. The fully destroyed vehicle has been reduced to a melted aluminum hull containing burnt residue on the interior floor and chassis of the vehicle. Both vehicles had depleted uranium (DU) munitions on board. Optical sighting lenses containing thorium were also present. APG has removed all remaining optical sighting lenses, munitions boxes containing residual deactivated rounds, and RCRA materials.

Only relatively small residual amounts of DU contamination from fragments of DU containing munitions remain onboard the Bradley Vehicles. The material is present in a dispersed and spotty fashion throughout the Bradley Vehicles.

The weights of the near intact and the fully destroyed vehicles are 42,000 pounds and 16,000 pounds, respectively. These weights are reduced from undamaged vehicle weights due to removal of engines, internal and external components, and various Resource Conservation and Recovery Act (RCRA) containing materials.

The Bradley Vehicle and contents are dry solid waste containing no absorbents or chelating agents. Details of the Bradley Vehicle size, weights, and radioactive content are provided by Ref. 5. This reference is provided as enclosure 1 to this submittal.

3.2 Estimated Waste Volume

It is estimated that the mass of the combined vehicles is 58,000 pounds. Utilizing an assumed density of aluminum for the entire vehicle (168 pounds per cubic feet), will result in a conservative volume of metal material contaminated with DU of 345 cubic feet. This volume of space taken up by the containerized vehicle debris as shipped to the disposal facility is expected to be approximately 3300 cubic feet. These volumes represent a small fraction of the annual volume of waste that the US Ecology Idaho facility expects to receive in any one year.

The disposal of the material is expected to take place as a single shipment and be completed by the end of calendar year 2005. The material will likely be placed in a single burial cell at the US Ecology Idaho facility.

3.3 Radiological Characterization of Waste

3.3.1 Background:

The subject Bradley Vehicles contained Depleted Uranium (DU) munitions as part of their combat load. The DU is present in munitions as a solid metal form. Damage including fire in the vehicle may result in the discharge of these DU munitions, resulting in solid DU metal or DU oxide contamination to the interior structures of the vehicle. In certain instances, the DU contamination may have become completely entrained in the melted aluminum matrix of the vehicle as the result of a high temperature engine fuel-fed fire. No other radioactive materials are involved.

Visual and radiological inspection was performed on the intact Bradley Vehicle on March 15, 2005. The radiological inspection indicated the presence of residual DU deposits on the debris present on the interior floor of the intact vehicle. Much of the residual material has since been removed. Low levels of spotty contamination, however, remain.

Visual and radiological inspection was also performed on the severely damaged and partially melted vehicle on March 15, 2005. The radiological inspection indicated the presence of residual DU deposits in the burnt/melted debris and melted aluminum matrix present on the floor area of the vehicle. Lesser amounts of contamination were found in other areas of the burnt hulk.

The highest count rates were detected in areas where spent munitions and/or shell casings were observed as well as an area where a munitions ammo box surrounded by the melted aluminum metal matrix was observed. No live munitions exist due to the intensity of the fire that engulfed the vehicle. Munitions ammo boxes and loose material contaminated with DU has since been removed. Residual contamination from DU-containing rounds is evident and remains within the melted metal matrix of the vehicle.

3.3.2 Characterization Results

- *Bradley Vehicle 2ADR3313R*

This vehicle is a relatively complete vehicle with an external shipping volume estimated at approximately 2700 cubic feet. The DU contamination associated with this vehicle is primarily surficial in nature and ranges from 20 to 500 cpm per direct frisk (beta/gamma probe area approximately 15 cm^2). The total DU activity is 5.9 microcuries. Based on the remaining mass of the vehicle (42,000 pounds) the DU concentration is less than 0.0001% by weight. This is less than 10 CFR 40.13 "Unimportant Quantities of Source Material" and below the allowed concentration of DU permitted by the US Ecology permit.

- *Bradley Vehicle 2AD21078*

This vehicle is a fully destroyed, and partially melted Bradley Vehicle with an estimated external shipping volume of approximately 600 cubic feet. The DU contamination associated with this vehicle is incorporated into the melted aluminum metal matrix and ranges from 40 to 60,000 cpm per direct frisk (beta/gamma probe area approximately 15 cm^2). The total DU activity is 384 - 756 microcuries. Based on the remaining mass of the vehicle (15,700 pounds) the DU concentration is less than 0.029% by weight. This is less than 10 CFR 40.13 "Unimportant Quantities of Source Material" and below the allowed concentration of DU permitted by the US Ecology permit.

4. RADIOLOGICAL ASSESSMENTS

4.1 Transport Worker Dose Assessment

The Transportation Scenario Maximally Exposed Individual (MEI) dose equivalent will not exceed a small fraction of 1 mrem. Evaluations of both

internal and external dose hazards to the transportation worker are discussed below.

Each conveyance will be strong-tight and will be verified to be in compliance with DOT external loose surface contamination limits prior to shipment. Therefore, there are no internal dose hazards associated with the Transportation Scenario.

The sum of the total DU activity from both Bradley Vehicles discussed in Section 3.3 of this submittal was used to calculate the penetrating gamma dose rate external to the conveyance used to transport the material. The geometry modeled assumes that all the DU activity from both vehicles is contained within a 1 square meter area with the receptor centered directly over the contaminated area. The activity is on the surface of the 1 square meter area. No dose reduction due shielding provided by the transport cab or truck trailer was applied. The MicroShield output file is attached to this submittal as enclosure 2 The following dose receptor points were modeled.

- a one (1) meter receptor point adjacent to the center of the 1 meter square contaminated surface, and
- a hypothetical "driver" receptor point two (2) meters from the center of the 1 meter square.

The resultant dose rates to each of these receptor points are 7.3×10^{-3}, and 2.0×10^{-3} mR per hour, respectively. Therefore, a transportation worker would need to spend in excess of 137 and 500 hours, respectively, at these locations to exceed a dose equivalent of one (1) mrem. It is qualitatively judged to be non-credible that the Transportation Scenario Maximum Exposed Individual (MEI) (e.g., transportation worker, or any other member of public interacting with the transportation activity) would exceed these occupancy times during the transport of the vehicles from APG to the US Ecology Idaho disposal facility.

Integrated total doses to members of the general public are expected to be less than 1×10^{-4} manrem based on 10 individuals being positioned at a distance of 1 meter from the transportation vehicle each for a period of 1 hour.

Integrated total doses to the hypothetical transportation worker is expected to be 2×10^{-4} manrem based on a 5 day long transportation haul with continuous occupancy in the cab and positioned at a distance of 2 meter from the transportation load.

4.2 Disposal Facility Worker Dose Assessment

Placement of material into the US Ecology waste disposal cell will not exceed one (1) mrem dose. Evaluations of both internal and external dose hazards to the transportation worker are discussed below.

Each Bradley Vehicle is expected to remain in a tarp or other shipping container when it is buried. Additionally, the amount of DU on the intact vehicle is small

and contained within the vehicle while the vehicle with more significant DU contamination is contained within the melted metal matrix. Therefore, there are no or little internal dose hazards associated with the Disposal Facility Worker Dose Scenario.

The total DU activity discussed in Sections 3.3 and 4.1 of this submittal was used as the source term for the penetrating gamma dose rates to a hypothetical disposal facility worker. The geometry modeled assumes a dose receptor point centered 1 meter above the 1 square meter surface assumed to contain all the DU activity from both Bradley Vehicles. The MicroShield output file used for the Transport Worker Dose assessment was utilized for the Disposal Facility Worker Dose assessment.

The resultant dose rate to this receptor point is 7.3×10^{-3} mR per hour. Therefore, a the Disposal Facility Worker would need to spend in excess of 137 at a location directly above the Bradley Vehicles to exceed a dose equivalent of one (1) mrem. It is qualitatively judged to be non-credible that the Disposal Facility Worker Maximum Exposed Individual (MEI) would exceed this occupancy times during the transport vehicle offloading and subsequent disposal activities associated with the Bradley Vehicles.

Integrated total doses to the hypothetical disposal facility workers are expected to be 1×10^{-4} manrem based on a 4 hour long offloading and burial cell positioning evolution with 3 workers continually positioned at a distance of 1 meter from the Bradley Vehicles.

4.3 Resident Farmer Dose Assessment

The RESRAD computer code was used to calculate the projected effect of the proposed disposal activity on future residents at the disposal site. The DU is assumed to be composed of the following activity based upon the routine uranium radionuclide contributions of depleted uranium (reference 4). Other input parameters are based upon US Ecology Idaho site specific information as provided in references 1, 2, and 3.

Uranium Percent U-235	*Mass Percentage*			*Activity Percentage* [a]			
	U-234	*U-235*	*U-238*	*U-234*	*U-235*	*U-236*	*U-238*
Depleted Uranium[b]	0.00100%	0.20000%	99.79900%	15.55%	1.07%		83.38%

[a] Data from HPS N13.22-1995
see also Health Physics and Radiological Health Handbook (third edition) Tables 12.23 - 12.25

[b] Data from Health and Environmental Consequences of Depleted Uranium Use in the Army: Technical Report June 1995 (U.S. Army Environmental Policy Institute)

The DU concentration in the soil was assumed at a level of 100 pCi/g, such that the resultant calculated dose equivalent to the maximum exposed individual (Resident Farmer) could be evaluated in terms of mrem/year per 100 pCi/g activity concentration of DU in the soil. The RESRAD summary report including the input parameter selection, and calculation results is included as enclosure 3 to this submittal.

The RESRAD results show that the maximum dose to a member of the public from the disposal of the Bradley Vehicle is expected to be extremely low. The maximum dose is expected to be less than 7E-24 mrem in year 1,000. The expected dose to a member of the public post closure is insignificant.

4.4 Dose Assessment Conclusions

The dose assessments provided demonstrate that the disposal of the APG Bradley Vehicle waste materials at the US Ecology Idaho facility will result in an insignificant dose (7E-24 mrem/yr) post closure to a member of the public. This dose is a very small fraction of the 25 mrem/yr allowable dose to member of the public. Integrated doses to transport workers, members of the general public exposed to the transportation vehicle, and disposal facility workers are less than 4×10^{-4} manrem. No internal dose is expected.

5. Conclusions

Based on the above assessment, it can be concluded that the calculated potential dose to members of the public (workers involved in the transportation to and placement of the waste and after closure of the site) as a consequence of the proposed waste disposal from the disposal of Bradley Vehicles contaminated with DU at the US Ecology Idaho Facility will be an insignificant fraction of the 25 millirem per year limit. Likewise, doses for transportation workers, members of the general public, and disposal facility workers exposed to the Bradley Vehicles could receive integrated doses of less than 4×10^{-4} manrem. Therefore, APG concludes that the proposed request for approval in accordance with 10 CFR 20.2002 will not have a significant impact on the workers, public, or the environment and that it is, therefore, acceptable.

References

1 US Ecology Idaho Inc. "Report on Analytical Basis for Waste Acceptance Criteria Revisions to Accept Naturally Occurring and Certain Other Low Activity Radioactive Material", 2001

2 Envirosafe, 2000. "Notification of a Class I Modification, Administrative and Informational Changes to Waste Acceptance Parameters, Appendix A, ResRad Modeling of Post Closure Dose, p.2, Envirosafe Services of Idaho, Inc., 2000.

3 CH2M Hill, 1993. "Hydrogeological Characterization and Ground Water Monitoring Considerations for Proposed Cell 14 Expansion Area at Envirosafe Services of Idaho-Site B, pp.35-39, Envirosafe Services of Idaho, 1993

4 Health and Environmental Consequences of Depleted Uranium Use in the Army Technical Report June 1995 (U.S. Army Environmental policy Institute)

5 Cabrera Services, 2005. "Bradley Vehicle M2A2 Depleted Uranium Content", Technical Memorandum, 2005.

Enclosure 1

Bradley Vehicle M2A2 Depleted Uranium Content Technical Memorandum

BRADLEY VEHICLE M2A2 DEPLETED URANIUM CONTENT TECHNICAL MEMORANDUM

1.0 INTRODUCTION

The Aberdeen Proving Ground (APG) requested an evaluation of the radioactive content for two (2) Bradley Fighting Vehicles (M2A2). The vehicles were damaged under battle conditions in Iraq and returned to APG for removal of hazardous and radioactive materials. The vehicles are slated for disposal at a Resource Conservation and Recovery Act (RCRA) licensed disposal facility in Idaho.

The subject vehicles include a near intact Bradley vehicle with a burnt out interior and a fully destroyed, and partially melted Bradley vehicle. The fully destroyed vehicle has been reduced to melted aluminum containing burnt residue lying on the interior floor and chassis of the vehicle. Both vehicles had Depleted Uranium (DU) munitions on board. Optical sighting lenses containing thorium were also present. APG has removed any remaining optical sighting lenses, munitions boxes containing residual deactivated rounds, and RCRA materials.

Only relatively small residual amounts of DU contamination from fragments of DU containing munitions remain onboard the Bradley Vehicles. The material is present in a dispersed and spotty fashion throughout the Bradley Vehicles.

1.1 Objectives

Cabrera Services, Inc. (CABRERA) was requested to evaluation and provide an estimate of the residual DU contamination for each Bradley vehicle. This technical memorandum presents the methodology and radiation surveys used to determine the residual DU content in these Bradley Vehicles. The amount of DU remaining on the Bradley Vehicles is provided in terms of total microcuries (μCi) and as a weight fraction of the remaining vehicle weight.

2.0 VEHICLE PHYSICAL AND RADIOLOGICAL CONDITIONS

The subject Bradley Vehicles were treated as separate entities with respect to radiological content, due to the vastly different physical shape and weight characteristics of each vehicle. The vehicles are described below:

Item # 2ADR3313R

This Bradley Vehicle is in relatively complete form with the approximate outside physical dimensions (21.5 feet long x 10.9 feet wide x 9.9 feet high) (Gary, 2005) associated with the Bradley M2A2. The 25 mm gun and other firing armaments, tracks have been removed. The interior of the vehicle has been completely burned with no generally recognizable interior features.

Visual and radiological inspection was performed on the vehicle on March 15, 2005. The radiological inspection indicated the presence of residual DU deposits on the debris present on the interior floor of the vehicle. The residual material has since been removed.

A summary table showing the remaining weight of the vehicle, radiological survey data, and estimated mass of DU remaining is shown on Appendix A.

Item # 2AD21078

This Bradley Vehicle is totally destroyed with the outside physical dimensions resembling the footprint of the M2A2 (21.5 feet long x 10.9 feet wide). The height of the vehicle has been reduced to approximately 2.5 feet (from 9.9 feet height). No gun, upper structure, tread, or vehicle interior exists. Burnt debris mixed within a melted aluminum matrix exists on what was once the floor area above the chassis of the vehicle. The vehicle has been cut in half to aid in removal of RCRA and radioactive materials.

Visual and radiological inspection was performed on the vehicle on March 15, 2005. The radiological inspection indicated the presence of residual DU deposits in the burnt debris and melted aluminum matrix present on the floor area of the vehicle. Lesser amounts of contamination were found in other areas of the burnt hulk. The highest count rates were detected in areas where spent munitions shell casings were observed and in the area of a munitions ammo box surrounded by the melted aluminum metal matrix.

A summary table showing the remaining weight of the vehicle, radiological survey data, and estimated mass of DU remaining is shown on Appendix B.

3.0 INSTRUMENTATION AND DATA COLLECTION

A calibrated Ludlum Model 3 count rate meter with a 44-9 alpha beta-gamma GM probe was used to survey the subject vehicles. Due to the physical nature of the vehicles it was decided to collect data over the accessible locations of each vehicle. A significant number of survey points on the vehicles (28-40 survey points each) were taken to provide reasonable assurance that "average" contamination values used to determine overall contamination levels are appropriate.

The primary radiations detected by the Ludlum model 44-9 probe are alpha and beta radiation. Due to the potential for a thin layer of ash and burnt material covering any residual DU, it is expected that only a small portion of the probe response will be due to alpha radiation. The majority of the probe response will be from the uranium-238 (^{238}U) progeny, protactinium-234m (^{234m}Pa). The ^{234m}Pa emits a beta particle that is highly energetic (2.2 MeV_{max} energy with a 99.8% emission rate; BNL, 2005) and will penetrate short distances through metal. On a mass basis over 99 percent of DU is comprised of ^{238}U.

Appendices A and B provide summaries of the survey data collected from the Ludlum Model 3 with 44-9 probe for Item #'s 2ADR3313R and 2AD21078 respectively.

4.0 CALCULATION METHODOLOGY

The methodology used to determine the DU content of the Bradley Vehicles utilizes two scenarios. The first scenario assumes that all the DU present and hence all the response is due to surface or near surface DU contamination. The second scenario assumes that the DU is uniformly mixed with the melted aluminum matrix.

4.1 Surface and Near Surface DU Activity

4.1.1 Area Assumptions

A measure of the DU content present on the surface or near surface areas of the Bradley Vehicle may be estimated utilizing the surface area of an imaginary box surrounding the vehicle. The box has dimensions associated with a "whole" Bradley Fighting Vehicle M2A2 (21.5 feet long x 10.9 feet wide x 9.9 feet high).

The area described by this imaginary box is expected to provide a surface area equal to that of the first described Bradley (Item # 2ADR3313R). The larger area presented by this assumption will account for the tank interior surfaces and vehicle surface "roughness" caused by hand holds and other irregular surfaces.

The area associated with 2ADR3313R is:

$$\text{Area } (\text{cm}^2) = [(2 \times \text{length} \times \text{width})] + [(2 \times \text{length} \times \text{height})] + [(2 \times \text{width} \times \text{height})] \times 929$$

(*Equation 1*)

Where,

Length = length of Bradley Vehicle, 21.5 feet

Width = width of Bradley Vehicle, 10.9 feet

Height = height of Bradley Vehicle, 9.9 feet

929 = conversion factor, square feet to square cm

and

$$\text{Area } (\text{cm}^2) = [(2 \times 21.5 \times 10.9)] + [(2 \times 21.5 \times 9.9)] + [(2 \times 10.9 \times 9.9)] \times 929 = 1.03 \times 10^6$$

The second described Bradley (Item # 2AD21078) has vertical dimensions reduced by a factor of approximately 4 (9.9 feet high vs 2.5 feet) based on the current vehicle physical state. In this case, the assumed surface area of contamination based on a whole Bradley is conservative.

The area for 2AD21078 is considered to be the same as presented by the first area calculation (*Equation 1*)

4.1.2 DU content of Vehicle

Item # 2ADR3313R

The instrument counts per minute (cpm) reading presented in Appendices A and B may be converted from cpm to activity per sur face area by the following relation:

$$\text{Activity } (\mu Ci/cm^2) = \frac{\text{average gross cpm}}{(\text{probe efficiency}) \times (\text{probe area}) \times (2.22 \times 10^6)}$$

(*Equation 2*)

Where,

Average gross cpm = arithmetic average of gross cpm for subject vehicle

Probe efficiency = Ludlum 44-9 efficiency for uranium beta energy, 0.22 cpm/dpm

Probe area = Ludlum active area, 15 cm^2

2.22×10^6 = conversion factor, dpm per µCi

and

$$\text{Activity } (\mu Ci/cm^2) = \frac{42}{(0.22) \times (15) \times (2.22 \times 10^6)} = 5.73 \times 10^{-6}$$

And finally based on an area of 1.03×10^6 cm^2 (*Equation 1*) have a total activity of

Activity (µCi) = $(1.03 \times 10^6\ cm^2) \times (5.73 \times 10^{-6}\ \mu Ci/cm^2) = 5.9\ \mu Ci$ depleted uranium

Item # 2AD21078

The activity of the second Bradley based on *Equation 2* is:

$$\text{Activity } (\mu Ci/cm^2) = \frac{2730}{(0.22) \times (15) \times (2.22 \times 10^6)} = 3.73 \times 10^{-4}$$

And finally based on an area of 1.03 x 10^6 cm^2 (*Equation 1*) of

Activity (μCi) = (1.03 x 10^6 cm^2) x (3.73 x 10^{-4} μCi/cm^2)= 384 μCi depleted uranium

4.2 Volumetric DU Activity

4.2.1 Volume and Activity Adjustments for Beta Instrument Response

The DU in the melted aluminum portion of the Bradley Vehicle may be dispersed and imbedded in the melted metal matrix. The melted aluminum may provide shielding of the beta radiation emitted by the DU described previously in section 3.0. Adjustments for this shielding effect are made. This volumetric analysis applies only to the Bradley Vehicle exhibiting significant melted portions

The range of a beta particle (CHP, 1999) may be estimated based on the following relation:

$$\text{Range}_{\beta} = 412E^{(1.256-0.0954\ln E))} \quad \text{for } E = 0.01 - 2.5 \text{ MeV}$$

(*Equation 3*)

Where,

Range_{β} = range of the beta in the material of concern, mg/cm^2

E = maximum energy of the beta particle, MeV

ln = the natural logarithm of the number in base e

Based on *Equation 3*, the range of a 2.2 Mev ^{234m}Pa beta based is approximately 1050 mg/cm^2 and the range for an average energy particle of ^{234m}Pa (0.825 MeV) is approximately 320 mg/cm^2.

Assuming that all DU is uniformly entrained within the melted aluminum metal matrix the response of the Ludlum 44-9 will be reduced by approximately 50 percent after traveling through 320 mg/cm^2 of aluminum. The linear distance a beta particle travels through a material may be determined from the following relation:

$$\text{Material Thickness} = \frac{\text{Material Density Thickness}}{\text{Material Density} \times 1000}$$

(*Equation 4*)

Where,

Material thickness = cm

Material Density Thickness = 320 mg/cm^2

Material Density = g/cm^3, 2.7 g/cm^3

1000 = conversion factor, g/cm^3 to mg/cm^3

Average energy ^{234m}Pa betas, with a range of 320 mg/cm^2, and traveling through aluminum (density of 2.7 g/cm^3) are expected to travel through a material thickness of:

$$\text{Material Thickness} = \frac{320}{2.7 \times 1000} = 0.12 \text{ cm}$$

Aluminum metal with DU contamination distributed through the metal will therefore have beta attenuation of up to 50 percent through the first 0.12 cm of aluminum. A conservative estimate of the betas detected by the 44-9, and hence an estimate of the DU activity within the metal, may be made by assuming all counts emitted are from a depth of 0.12 cm. An additional adjustment to reduce the depth to 0.084 cm (70% of the average range) to account for beta particles projected at angles other than normal to the surface is made. Since the detectable beta radiation has been reduced by approximately 50 percent due to attenuation in the metal, the activity based on surface efficiency are adjusted to result in an increase in the calculated DU activity upward by a factor of two.

The active area of the Ludlum 44-9 probe multiplied by the 0.084 cm thickness corresponding to the beta particles emitted and detected from the metal surface provides an estimate of the volume of contaminated metal "seen" by the probe. Finally, adjusting for the probe efficiency, and converting the metal volume into mass using the density of aluminum, the activity concentration of DU in the upper thin layer of the melted aluminum metal matrix can be determined by:

$$\text{Activity Conc} = \frac{\text{Ave cpm} \times 2}{\text{eff} \times \text{probe area} \times \text{depth} \times 2.7 \times (2.22 \times 10^6)}$$

(*Equation 5*)

Where,

Activity Conc = depleted uranium activity in the melted aluminum matrix, µCi/g

Ave cpm = arithmetic average of 38 Ludlum 44-9 probe readings, 2730 cpm

2 = factor to adjust activity for beta particle detection/attenuation by aluminum

eff = efficiency of probe for detecting ^{234m}Pa beta particles, 0.22 dpm/cpm

probe area = active area of Ludlum 44-9 probe, 15 cm^2

depth = assumed depth from surface at which beta particle originates, 0.084 cm

2.7 = density of aluminum, g/cm^3

2.22×10^6 = conversion factor dpm/µCi

and

$$\text{Activity Conc} = \frac{2730 \times 2}{0.22 \times 15 \times 0.084 \times 2.7 \times (2.22 \times 10^6)} = 3.3 \times 10^{-3}\ \mu Ci/g \text{ in melted matrix}$$

The majority of the DU activity is incorporated into the melted aluminum matrix rather than gross contamination of the steel portions of the Bradley Vehicle. A visual inspection of the remains of the vehicle shows a volume of melted aluminum estimated at several cubic feet. Based on a volume of 3 cubic feet of melted aluminum matrix (505 lbs), an aluminum density of 2.7 g/cm^3, and results from equation 5, the Bradley vehicle contains an estimated activity of:

$$\text{Activity } (\mu Ci) = \text{Volume matrix} \times \text{Al density} \times 2.83 \times 10^4 \times \text{Activity Concentration}$$

where,

Activity = uranium activity, µCi

Volume matrix = volume of melted aluminum matrix, 3 ft^3

Al Density = aluminum density, 2.7 g/cm^3

2.83×10^4 = conversion factor, ft^3 to cm^3

Activity Conc = 3.3×10^{-3} µCi/g for depleted uranium aluminum matrix

And

$$\text{Activity } (\mu\text{Ci}) = 3 \times 2.7 \times 2.83 \times 10^{4} \times 3.3 \times 10^{-3} = 7.56 \times 10^{2} \ \mu\text{Ci depleted uranium}$$

4.3 DU Activity to Pounds Weight

The calculated depleted uranium activity may be converted into pounds weight of DU by the following:

$$\text{Weight DU(lbs)} = \frac{\text{Activity}}{0.36 \times 454}$$

where,

Weight DU	= pounds weight of DU dispersed over the Bradley Vehicle
Activity	= uranium activity, μCi
0.36	= specific activity of DU, 0.36 μCi/g (10CFR20, 2003)
454	= conversion factor grams to pounds

And

Item # 2ADR3313R (surface) $\text{Weight DU(lbs)} = \frac{5.9}{0.36 \times 454} = 0.036$ lbs

Item # 2AD21078 (surface) $\text{Weight DU(lbs)} = \frac{384}{0.36 \times 454} = 2.3$ lbs

Item # 2AD21078 (volumetric) $\text{Weight DU(lbs)} = \frac{756}{0.36 \times 454} = 4.6$ lbs

4.4 DU Weight Percent of Total Vehicle

The DU weight percent as a fraction of the remaining weight of the vehicle is determined by the following:

$$\text{Weight percent DU} = \frac{\text{DU mass}}{\text{Weight of Vehicle}} \times 100$$

where,

Weight percent DU	= Weight of DU as a percent of the vehicle mass, limit 0.05 wt %
DU mass	= Mass of DU remaining as part of the vehicle, pounds
Weight of Vehicle	= Remaining mass of vehicle, pounds
100	= Conversion factor weight fraction to percent fraction

And

Item # 2ADR3313R (surface) $\text{Weight \% DU} = \frac{0.036}{42000} \times 100 = 0.00008$

Item # 2AD21078 (surface) $\text{Weight \% DU} = \frac{2.3}{15700} \times 100 = 0.015$

Item # 2AD21078 (volumetric) $\text{Weight \% DU} = \frac{4.6}{15700} \times 100 = 0.029$

5.0 CONCLUSION

The uranium content of the Bradley Vehicles was calculated in terms of both the total activity and as a weight percent of the remaining vehicle mass. The DU is dispersed over the vehicle and in melted metal matrix spread over the vehicle chassis.

Both vehicles combined contain small residual amounts of DU totaling less than 5 pounds of DU. The weight percent of DU is estimated as less than 0.0001 weight percent for the intact burnt Bradley Vehicle (Item # 2ADR3313R). A range of 0.015 to 0.029 weight percent is estimated for the melted Bradley Vehicle (Item # 2AD21078).

Both vehicles have dispersed DU that is less than 10 CFR 40.13 "Unimportant Quantities of Source Material" of one-twentieth of 1 percent (0.05 percent).

6.0 REFERENCES

10CFR20, 2003 Appendix B to 10 CFR Part 20, footnote 3.

BNL, 2005 Brookhaven National Laboratory, "*NuDat2 –Decay Radiation*" database, version 2/28/2005

CHP, 1999 The American Academy of Health Physics CHP News, Volume 9, No. 1, July 1999

Gary, 2005 "*Gary's Combat Vehicle Reference Guide*", http://www.inetres.com/gp/military/cv/inf/M2.html

APPENDIX A

Summary Item # 2ADR3313R

Physical State:	Intact Bradley Vehicle, burnt interior
Weight:	42,000 lbs
DU Activity, microcuries:	5.9 μCi
DU mass, lbs	0.036 lbs
DU Concentration:	<0.0001 percent by weight

Gross cpm with Ludlum 44-9[a,c] (survey date 3-15-2005)				
Port Side	**Starboard Side**	**Front**	**Back**	**Top**
20	20	60	20	40
20	20	60	40	40
40	40			60
60	40			
40	40	Inside general areas 20-500[b]		
40	40			
60	60			
60	40			
40	60			
40	40			
		Average Net cpm	42	
		SD Net cpm	14	

Notes

[a] Ludlum 44-9 probe with model 3 serial number 104702, calibrated 9/03/04 due 9/03/05

[b] Single area DU deposits on floor tray of 160,000 cpm not recorded on table - interior debris scheduled for removal. Removed on 3/31/05

[c] Survey data taken uniformly over vehicle

APPENDIX B
Item # 2AD21078

Physical State:	Bradley Vehicle, melted metal matrix
Weight:	15,700 lbs
DU Activity, microcuries	384 - 756 μCi
DU mass, lbs	2.3 - 4.6 lbs
DU Concentration:	0.015 - 0.029 percent by weight[f]

Gross cpm with Ludlum 44-9[a,d,e] (survey date 3-15-2005)	
Front End	**Back End**
50000[b]	60
600	140
2000	500
40	1000
40	20000[c,f]
40	60000[c,f]
300	300
80	400
40	1000
40	1000
40	1200
2000	8000
300	28000[b]
60	1000
200	2300
500	300
600	200
100	300
60	140
500	360

Notes

[a] Ludlum 44-9 probe with model 3 serial number 104702, calibrated 9/03/04 due 9/03/05

[b] Shell casing area; slated for further remediation

[c] Area of ammunition box; removed 3/31/05

[d] Survey data taken uniformly over vehicle with hot spots noted by notes b and c

[e] Average countrate based on all 40 intial readings is 4,594 cpm

[f] Average countrate based on 38 readings after removal of ammunition box is 2,730 cpm

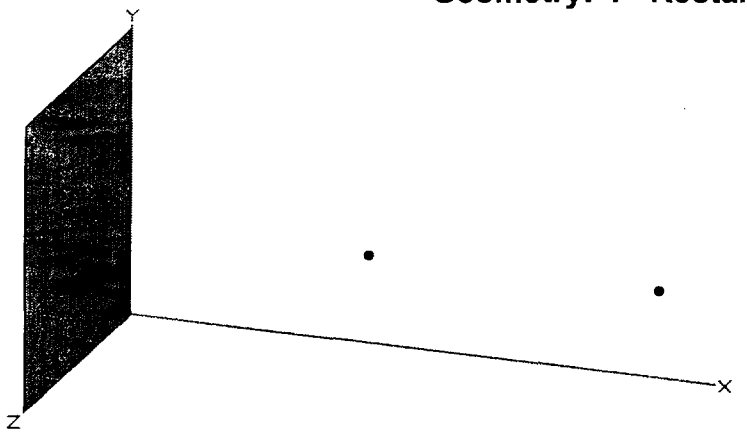
Enclosure 2

MicroShield Exposure Rates for Hypotethical Transportation Worker, Members of the General Public, and Disposal Facility Workers

Page : 1
DOS File : Case1
Run Date: August 9, 2005
Run Time: 1:28:27 PM
Duration : 00:00:17

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: 762 uCi DU on 1m2
Description: 762 uCi DU w/50 yr daughter ingrowth
Geometry: 4 - Rectangular Area - Vertical



Source Dimensions

Width	100.0 cm	3 ft 3.4 in
Height	100.0 cm	3 ft 3.4 in

Dose Points

	X	Y	Z
# 1	100 cm	50 cm	50 cm
	3 ft 3.4 in	1 ft 7.7 in	1 ft 7.7 in
# 2	200 cm	50 cm	50 cm
	6 ft 6.7 in	1 ft 7.7 in	1 ft 7.7 in

Shields

Shield Name	Material	Density
Air Gap	Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Ac-227	4.3057e-009	1.5931e+002	4.3057e-007	1.5931e-002
Bi-210	2.0918e-010	7.7397e+000	2.0918e-008	7.7397e-004
Bi-211	4.2895e-009	1.5871e+002	4.2895e-007	1.5871e-002
Bi-214	5.7066e-010	2.1114e+001	5.7066e-008	2.1114e-003
Fr-223	5.9419e-011	2.1985e+000	5.9419e-009	2.1985e-004
Pa-231	8.6167e-009	3.1882e+002	8.6167e-007	3.1882e-002
Pa-234	1.0160e-006	3.7592e+004	1.0160e-004	3.7592e+000
Pa-234m	6.3500e-004	2.3495e+007	6.3500e-002	2.3495e+003
Pb-210	2.0940e-010	7.7479e+000	2.0940e-008	7.7479e-004
Pb-211	4.2895e-009	1.5871e+002	4.2895e-007	1.5871e-002
Pb-214	5.7066e-010	2.1114e+001	5.7066e-008	2.1114e-003
Po-210	2.0314e-010	7.5163e+000	2.0314e-008	7.5163e-004
Po-211	1.1710e-011	4.3328e-001	1.1710e-009	4.3328e-005
Po-214	5.7054e-010	2.1110e+001	5.7054e-008	2.1110e-003
Po-215	4.2895e-009	1.5871e+002	4.2895e-007	1.5871e-002
Po-218	5.7077e-010	2.1119e+001	5.7077e-008	2.1119e-003
Ra-223	4.2895e-009	1.5871e+002	4.2895e-007	1.5871e-002
Ra-226	5.7112e-010	2.1131e+001	5.7112e-008	2.1131e-003

DOS File : Case1
Run Date: August 9, 2005
Run Time: 1:28:27 PM
Duration : 00:00:17

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Rn-219	4.2895e-009	1.5871e+002	4.2895e-007	1.5871e-002
Rn-222	5.7077e-010	2.1119e+001	5.7077e-008	2.1119e-003
Th-227	4.2363e-009	1.5674e+002	4.2363e-007	1.5674e-002
Th-230	5.3116e-008	1.9653e+003	5.3116e-006	1.9653e-001
Th-231	8.1500e-006	3.0155e+005	8.1500e-004	3.0155e+001
Th-234	6.3500e-004	2.3495e+007	6.3500e-002	2.3495e+003
Tl-207	4.2778e-009	1.5828e+002	4.2778e-007	1.5828e-002
U-234	1.1807e-004	4.3687e+006	1.1807e-002	4.3687e+002
U-235	8.1500e-006	3.0155e+005	8.1500e-004	3.0155e+001
U-238	6.3500e-004	2.3495e+007	6.3500e-002	2.3495e+003

Buildup
The material reference is : Air Gap

Integration Parameters

Z Direction	69
Y Direction	69

Results - Dose Point # 1 - (100,50,50) cm

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	5.673e+02	4.790e-05	5.012e-05	4.109e-06	4.299e-06
0.02	1.446e+00	1.809e-07	1.893e-07	6.267e-09	6.556e-09
0.03	4.421e+04	8.739e-03	9.170e-03	8.661e-05	9.088e-05
0.04	4.685e+01	1.250e-05	1.311e-05	5.528e-08	5.799e-08
0.05	5.170e+03	1.732e-03	1.815e-03	4.615e-06	4.836e-06
0.06	9.211e+05	3.711e-01	3.880e-01	7.372e-04	7.708e-04
0.08	6.886e+04	3.708e-02	3.856e-02	5.868e-05	6.102e-05
0.1	1.475e+06	9.946e-01	1.029e+00	1.522e-03	1.574e-03
0.15	5.884e+04	5.962e-02	6.126e-02	9.818e-05	1.009e-04
0.2	1.940e+05	2.626e-01	2.680e-01	4.634e-04	4.731e-04
0.3	2.843e+03	5.782e-03	5.873e-03	1.097e-05	1.114e-05
0.4	2.358e+03	6.404e-03	6.485e-03	1.248e-05	1.264e-05
0.5	3.429e+03	1.165e-02	1.178e-02	2.288e-05	2.312e-05
0.6	1.402e+04	5.722e-02	5.776e-02	1.117e-04	1.127e-04
0.8	7.801e+04	4.251e-01	4.283e-01	8.086e-04	8.147e-04
1.0	2.494e+05	1.700e+00	1.711e+00	3.134e-03	3.155e-03
1.5	5.265e+03	5.393e-02	5.419e-02	9.074e-05	9.117e-05
2.0	6.843e+02	9.356e-03	9.391e-03	1.447e-05	1.452e-05
TOTALS:	3.124e+06	4.005e+00	4.081e+00	7.181e-03	7.314e-03

Results - Dose Point # 2 - (200,50,50) cm

DOS File : Case1
Run Date: August 9, 2005
Run Time: 1:28:27 PM
Duration : 00:00:17

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	5.673e+02	1.112e-05	1.212e-05	9.542e-07	1.040e-06
0.02	1.446e+00	4.619e-08	5.033e-08	1.600e-09	1.743e-09
0.03	4.421e+04	2.338e-03	2.562e-03	2.317e-05	2.539e-05
0.04	4.685e+01	3.381e-06	3.702e-06	1.495e-08	1.637e-08
0.05	5.170e+03	4.705e-04	5.142e-04	1.253e-06	1.370e-06
0.06	9.211e+05	1.010e-01	1.099e-01	2.006e-04	2.183e-04
0.08	6.886e+04	1.011e-02	1.089e-02	1.600e-05	1.724e-05
0.1	1.475e+06	2.716e-01	2.896e-01	4.155e-04	4.430e-04
0.15	5.884e+04	1.631e-02	1.717e-02	2.686e-05	2.828e-05
0.2	1.940e+05	7.194e-02	7.481e-02	1.270e-04	1.320e-04
0.3	2.843e+03	1.587e-03	1.635e-03	3.011e-06	3.101e-06
0.4	2.358e+03	1.760e-03	1.803e-03	3.429e-06	3.513e-06
0.5	3.429e+03	3.206e-03	3.272e-03	6.294e-06	6.423e-06
0.6	1.402e+04	1.575e-02	1.604e-02	3.075e-05	3.130e-05
0.8	7.801e+04	1.172e-01	1.189e-01	2.229e-04	2.261e-04
1.0	2.494e+05	4.691e-01	4.749e-01	8.647e-04	8.753e-04
1.5	5.265e+03	1.490e-02	1.503e-02	2.507e-05	2.529e-05
2.0	6.843e+02	2.587e-03	2.605e-03	4.000e-06	4.029e-06
TOTALS:	3.124e+06	1.100e+00	1.140e+00	1.972e-03	2.042e-03

Enclosure 3

RESRAD Computer Code Summary Report
Resident Farmer

Summary : Bradley M2A2 Waste Debris at USEcology Idaho Facility
File : Usei-Bradley.rad

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: HEAST 2001 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(2)
B-1	Pb-210+D	2.320E-02	2.320E-02	DCF2(3)
B-1	Ra-226+D	8.600E-03	8.600E-03	DCF2(4)
B-1	Th-230	3.260E-01	3.260E-01	DCF2(5)
B-1	U-234	1.320E-01	1.320E-01	DCF2(6)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(7)
B-1	U-238+D	1.180E-01	1.180E-01	DCF2(8)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Pa-231	1.060E-02	1.060E-02	DCF3(2)
D-1	Pb-210+D	7.270E-03	7.270E-03	DCF3(3)
D-1	Ra-226+D	1.330E-03	1.330E-03	DCF3(4)
D-1	Th-230	5.480E-04	5.480E-04	DCF3(5)
D-1	U-234	2.830E-04	2.830E-04	DCF3(6)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(7)
D-1	U-238+D	2.690E-04	2.690E-04	DCF3(8)
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	Th-230 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Th-230 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Th-230 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(5,3)
D-34				
D-34	U-234 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(6,1)
D-34	U-234 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(6,2)
D-34	U-234 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(6,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(7,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(7,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(7,3)
D-34				

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: HEAST 2001 Morbidity

enu	Parameter	Current Value	Default	Parameter Name
-34	U-238+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(8,1)
-34	U-238+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(8,2)
-34	U-238+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(8,3)
-5	Bioaccumulation factors, fresh water, L/kg:			
-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
-5				
-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(2,1)
-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(2,2)
-5				
-5	Pb-210+D , fish	3.000E+02	3.000E+02	BIOFAC(3,1)
-5	Pb-210+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
-5				
-5	Ra-226+D , fish	5.000E+01	5.000E+01	BIOFAC(4,1)
-5	Ra-226+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(4,2)
-5				
-5	Th-230 , fish	1.000E+02	1.000E+02	BIOFAC(5,1)
-5	Th-230 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(5,2)
-5				
-5	U-234 , fish	1.000E+01	1.000E+01	BIOFAC(6,1)
-5	U-234 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(6,2)
-5				
-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(7,1)
-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(7,2)
-5				
-5	U-238+D , fish	1.000E+01	1.000E+01	BIOFAC(8,1)
-5	U-238+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(8,2)

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)	8.822E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	3.360E+01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	5.420E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+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): U-234	1.555E+01	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): U-235	1.070E+00	0.000E+00	---	S1(7)
R012	Initial principal radionuclide (pCi/g): U-238	8.338E+01	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): U-234	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): U-235	not used	0.000E+00	---	W1(7)
R012	Concentration in groundwater (pCi/L): U-238	not used	0.000E+00	---	W1(8)
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)	3.160E+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	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	6.700E+00	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	7.000E-03	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+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

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	6.100E+01	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for U-234				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.433E-05	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.433E-05	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for U-238				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.433E-05	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)
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	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	8.537E-05	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	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.433E-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
C16	Distribution coefficients for daughter Pb-210				
C16	Contaminated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCC(3)
C16	Unsaturated zone 1 (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCU(3,1)
C16	Saturated zone (cm**3/g)	1.000E+02	1.000E+02	---	DCNUCS(3)
C16	Leach rate (/yr)	0.000E+00	0.000E+00	1.719E-05	ALEACH(3)
C16	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
C16	Distribution coefficients for daughter Ra-226				
C16	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(4)
C16	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(4,1)
C16	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(4)
C16	Leach rate (/yr)	0.000E+00	0.000E+00	2.454E-05	ALEACH(4)
C16	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
C16	Distribution coefficients for daughter Th-230				
C16	Contaminated zone (cm**3/g)	6.000E-04	6.000E+04	---	DCNUCC(5)
C16	Unsaturated zone 1 (cm**3/g)	6.000E-04	6.000E+04	---	DCNUCU(5,1)
C16	Saturated zone (cm**3/g)	6.000E-04	6.000E+04	---	DCNUCS(5)
C16	Leach rate (/yr)	0.000E+00	0.000E+00	2.870E-08	ALEACH(5)
C16	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
C17	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
C17	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
C17	Exposure duration	3.000E+01	3.000E+01	---	ED
C17	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
C17	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
C17	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
C17	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
C17	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
C17	Radii of shape factor array (used if FS = -1):				
C17	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
C17	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
C17	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
C17	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
C17	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
C17	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
C17	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
C17	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
C17	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
C17	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
C17	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
C17	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	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	not used	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	5.000E-01	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
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	not used	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)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
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
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
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)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	-1.000E+00	2.000E-06	5.471E-07	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E-00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
INITL	Number of graphical time points	256	---	---	NPTS
INITL	Maximum number of integration points for dose	17	---	---	LYMAX
INITL	Maximum number of integration points for risk	257	---	---	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	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : Bradley M2A2 Waste Debris at USEcology Idaho Facility
File : Usei-Bradley.rad

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	88221.00 square meters	U-234	1.555E+01
Thickness:	33.60 meters	U-235	1.070E+00
Cover Depth:	3.60 meters	U-238	8.338E+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):	1.738E-25	1.741E-25	1.746E-25	1.768E-25	1.838E-25	2.213E-25	4.828E-25	6.505E-24
M(t):	6.951E-27	6.962E-27	6.986E-27	7.070E-27	7.352E-27	8.852E-27	1.931E-26	2.602E-25

Maximum TDOSE(t): 6.505E-24 mrem/yr at t = 1.000E+03 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 = 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.
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	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	1.738E-25	1.0000	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
Total	1.738E-25	1.0000	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

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.
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	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	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	1.738E-25	1.0000
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	1.738E-25	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.
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	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	1.741E-25	1.0000	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
Total	1.741E-25	1.0000	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

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.
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	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	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	1.741E-25	1.0000
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	1.741E-25	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-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.
U-234	1.865E-29	0.0001	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-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	1.746E-25	0.9999	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
Total	1.746E-25	1.0000	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

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-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.
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	1.865E-29	0.0001
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	1.746E-25	0.9999
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	1.746E-25	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.
U-234	1.684E-28	0.0010	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-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	1.766E-25	0.9990	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
Total	1.768E-25	1.0000	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

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.
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	1.684E-28	0.0010
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	1.766E-25	0.9990
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	1.768E-25	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.
U-234	1.459E-27	0.0079	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-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	1.823E-25	0.9921	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
Total	1.838E-25	1.0000	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

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.
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	1.458E-27	0.0079
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	1.823E-25	0.9921
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	1.838E-25	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.
I-234	1.734E-26	0.0784	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
I-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
I-238	2.040E-25	0.9216	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
Total	2.213E-25	1.0000	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

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.
I-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	1.734E-26	0.0784
I-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
I-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	2.040E-25	0.9216
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	2.213E-25	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.
U-234	2.016E-25	0.4175	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-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	2.813E-25	0.5825	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
Total	4.828E-25	1.0000	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

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.
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	2.016E-25	0.4175
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	2.813E-25	0.5825
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	4.828E-25	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.
U-234	5.614E-24	0.8630	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-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	8.914E-25	0.1370	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
Total	6.505E-24	1.0000	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

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.
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	5.614E-24	0.8630
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	8.914E-25	0.1370
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	6.505E-24	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)	Branch Fraction*	DSR(j,t) (mrem/yr)/(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
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	1.000E+00	3.230E-32	2.264E-31	1.199E-30	1.083E-29	9.373E-29	1.115E-27	1.296E-26	3.610E-25
U-234	Pb-210	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	∑DSR(j)		3.230E-32	2.264E-31	1.199E-30	1.083E-29	9.373E-29	1.115E-27	1.296E-26	3.610E-25
U-235	U-235	1.000E+00	1.663E-39	1.667E-39	1.675E-39	1.704E-39	1.789E-39	2.119E-39	3.440E-39	1.874E-38
U-235	Pa-231	1.000E+00	5.894E-39	1.771E-38	4.149E-38	1.263E-37	3.818E-37	1.449E-36	6.491E-36	8.886E-35
U-235	Ac-227	1.000E+00	3.415E-40	2.373E-39	1.234E-38	1.043E-37	7.569E-37	5.590E-36	3.212E-35	4.816E-34
U-235	∑DSR(j)		7.898E-39	2.175E-38	5.551E-38	2.322E-37	1.141E-36	7.041E-36	3.861E-35	5.704E-34
U-238	U-238	1.000E+00	2.084E-27	2.088E-27	2.094E-27	2.118E-27	2.187E-27	2.446E-27	3.370E-27	1.034E-26
U-238	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-238	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-238	Ra-226	1.000E+00	2.289E-38	3.438E-37	4.021E-36	1.077E-34	2.705E-33	1.063E-31	3.717E-30	3.523E-28
U-238	Pb-210	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-238	∑DSR(j)		2.084E-27	2.088E-27	2.094E-27	2.118E-27	2.187E-27	2.446E-27	3.373E-27	1.069E-26

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) 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
U-234	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09	*6.245E+09
U-235	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06	*2.160E+06
U-238	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+05	*3.360E+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 = 1.000E+03 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
U-234	1.555E+01	1.000E+03	3.610E-25	*6.245E+09	3.610E-25	*6.245E+09
U-235	1.070E+00	0.000E+00	0.000E+00	*2.160E-06	0.000E+00	*2.160E+06
U-238	8.338E+01	1.000E+03	1.069E-26	*3.360E+05	1.069E-26	*3.360E+05

*At specific activity limit

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

Nuclide (j)	Parent (i)	BRF(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
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	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	∑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	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	∑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
Ra-226	U-234	1.000E+00	0.000E+00	0.000E+00	1.865E-29	1.684E-28	1.458E-27	1.734E-26	2.016E-25	5.614E-24
Ra-226	U-238	1.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.100E-28	2.938E-26
Ra-226	∑DOSE(j)		0.000E+00	0.000E+00	1.865E-29	1.684E-28	1.458E-27	1.734E-26	2.019E-25	5.643E-24
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	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	∑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	0.000E+00	0.000E+00
U-238	U-238	1.000E+00	1.738E-25	1.741E-25	1.746E-25	1.766E-25	1.823E-25	2.040E-25	2.810E-25	8.620E-25

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(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
U-234	U-234	1.000E+00	1.555E+01	1.555E+01	1.555E+01	1.554E+01	1.553E+01	1.549E+01	1.538E+01	1.498E+01
U-234	U-238	1.000E+00	0.000E+00	2.364E-04	7.091E-04	2.363E-03	7.084E-03	2.355E-02	7.016E-02	2.281E-01
U-234	∑S(j):		1.555E+01	1.555E+01	1.555E+01	1.555E+01	1.554E+01	1.552E+01	1.545E+01	1.521E+01
Th-230	U-234	1.000E+00	0.000E+00	1.400E-04	4.199E-04	1.399E-03	4.196E-03	1.397E-02	4.170E-02	1.368E-01
Th-230	U-238	1.000E+00	0.000E+00	1.064E-09	9.575E-09	1.064E-07	9.568E-07	1.061E-05	9.499E-05	1.036E-03
Th-230	∑S(j):		0.000E+00	1.400E-04	4.199E-04	1.400E-03	4.197E-03	1.398E-02	4.180E-02	1.378E-01
Ra-226	U-234	1.000E+00	0.000E+00	3.032E-08	2.727E-07	3.027E-06	2.715E-05	2.982E-04	2.596E-03	2.576E-02
Ra-226	U-238	1.000E+00	0.000E+00	1.536E-13	4.147E-12	1.534E-10	4.132E-09	1.516E-07	3.985E-06	1.348E-04
Ra-226	∑S(j):		0.000E+00	3.032E-08	2.728E-07	3.027E-06	2.716E-05	2.983E-04	2.600E-03	2.590E-02
Pb-210	U-234	1.000E+00	0.000E+00	3.117E-10	8.285E-09	2.908E-07	6.795E-06	1.657E-04	2.107E-03	2.426E-02
Pb-210	U-238	1.000E+00	0.000E+00	1.186E-15	9.490E-14	1.122E-11	8.086E-10	7.060E-08	2.957E-06	1.230E-04
Pb-210	∑S(j):		0.000E+00	3.117E-10	8.285E-09	2.908E-07	6.796E-06	1.658E-04	2.110E-03	2.439E-02
U-235	U-235	1.000E+00	1.070E+00	1.070E+00	1.070E+00	1.070E+00	1.069E+00	1.066E+00	1.059E+00	1.034E+00
Pa-231	U-235	1.000E+00	0.000E+00	2.264E-05	6.791E-05	2.263E-04	6.783E-04	2.254E-03	6.701E-03	2.165E-02
Ac-227	U-235	1.000E+00	0.000E+00	3.566E-07	3.142E-06	3.248E-05	2.413E-04	1.574E-03	5.993E-03	2.094E-02
U-238	U-238	1.000E+00	8.338E+01	8.338E+01	8.337E+01	8.335E+01	8.329E+01	8.309E+01	8.253E+01	8.057E-01

BRF(i) is the branch fraction of the parent nuclide.

RESCALC.EXE execution time = 2.67 seconds

This is to acknowledge the receipt of your letter/application dated

04/13/2005, and to inform you that the initial processing which includes an administrative review has been performed.

Amendment 0400735 4/SUB-834

☒ There were no administrative omissions. Your application was assigned to a technical reviewer. Please note that the technical review may identify additional omissions or require additional information.

☐ Please provide to this office within 30 days of your receipt of this card

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A copy of your action has been forwarded to our License Fee & Accounts Receivable Branch, who will contact you separately if there is a fee issue involved.

Your action has been assigned **Mail Control Number** 137815.
When calling to inquire about this action, please refer to this control number.
You may call us on (610) 337-5398, or 337-5260.

NRC FORM 532 (RI)
(6-96)

Sincerely,
Licensing Assistance Team Leader