



REPLY TO  
ATTENTION OF:

DEPARTMENT OF THE ARMY  
HEADQUARTERS, U.S. ARMY JOINT MUNITIONS COMMAND  
1 ROCK ISLAND ARSENAL  
ROCK ISLAND, IL 61299-6000  
September 21, 2006

**Safety/Rad Waste Directorate**

Mr. Loren Hueter  
Nuclear Regulatory Commission  
Nuclear Materials Licensing Branch  
Region III  
2443 Warrenville Road Ste 210  
Lisle, Illinois 60532-4352


Reference control number: 315644

Dear Sir:

We are responding to questions in your Conversation Record dated 29 August 2006 concerning the Lake City Army Ammunition Plant Area-31 Production Waste Landfill. We received your questions via facsimile on 6 September 2006 and forwarded to ARCADIS, the contractor involved with remediation activities at the Lake City plant. The attached information was written by ARCADIS, and we approve of their response. Let us know if you have any more questions.

The points of contact are Mr. Gary Buckrop and Mr. Mike Styvaert, AMSJM-SF, (309) 782-2969/0880, E-mail amsjm-sf@afsc.army.mil.

Sincerely,

  
Timothy J. Gallagher  
For Rosalene E. Graham  
Director, Safety/Rad Waste  
Directorate

# Response to NRC Comments on the Draft Area 31 Final Status Survey Plan

Comment No.	pp/§	Comment	Response
1	Section 1.1	Information provided indicates that sifting and/or screening activities have already taken place in Area 31. In support of the case that there is low likely-hood that additional DU sources remain, please describe what type of sifting specifically has already occurred and provide any additional details (screen size, equipment used, etc.) of the sifting operation.	The 3-inch screen mentioned in Section 1.1, which was used for the purpose of identifying and removing 81-mm mortar casings from the waste, was the only screen used in the initial waste screening process. The equipment consisted of a Terex vibratory power screen with 3-inch openings.
2	Section 1.4	The Conceptual Site Model describes the conditions of projectiles recovered during waste screening operations as intact, although noting "indications of oxidation ... suggesting that the projectiles have been exposed to weathering." The section goes on to suggest that it is possible "that the projectiles may have been exposed to high temperatures" and "DU may be present in the waste pile material in the form of 20-mm projectile bodies and, possibly as fine material resulting from oxidation." Please provide your best estimate of the amount of DU metal that may exist in the waste pile in Area 31? Is there any additional information, for example radiological soil samples, that would indicate any DU discovered will not be intact (resulting in diffuse contamination of the soil and surrounding area)? If so, please describe?	<p>The disposal of DU at Area 31 was not a sanctioned Army practice. Therefore, it is not anticipated that a significant quantity of additional projectiles remain in the waste. Four DU projectiles were identified previously by means of visual observation of the waste as it passed through the 3-inch screen. The use of radiation detection instruments over the entire 3,000 yd<sup>3</sup> of waste will ensure a more thorough search for DU. However, it is estimated that no more than 10 to 20 additional projectiles will be identified during the final status survey.</p> <p>No radiological soil sampling data is available for Area 31. If additional projectiles are identified during the final status survey, biased soil samples will be collected from the immediate vicinity of the projectile(s) to determine whether diffuse contamination is present.</p>
3	Section 2.3	Waste Pile Geometry states that "heavy equipment will be used to re-grade the waste pile" to allow for a survey "to be conducted in three one-foot lifts." When is this re-grading activity expected to begin? Also, approximately how long do you estimate the activity in Area 31 (re-grading, gamma walkover survey, removal of DU, soil sampling) will take from beginning to end?	The pile will be re-graded at the start of final status survey activities, which will begin two weeks following final approval of the work plan. Field activities are expected to require approximately two weeks to complete, and analytical results from the soil sampling are expected to be received 30 days later.

**Response to NRC Comments on the Draft Area 31 Final Status Survey Plan**

<b>Comment No.</b>	<b>pp/§/¶</b>	<b>Comment</b>	<b>Response</b>
4	Section 2.4	Designation of Survey Units describes the waste material lifts as MARSSIM Class 2 Areas, "based on the small number of DU projectiles previously identified... and on the low likelihood that DU has migrated into the soil in significant quantities." Was a scientific study or environmental sampling data used to reach this conclusion? Please discuss the rationale behind the Class 2 designations.	<p>Designation of the waste material lifts as Class 2 Areas is based on site observations and records of historical land use. No radiological data is available for Area 31; however, sampling results from the Area 10 sand piles indicates only minimal impact on general soil concentrations due to the long-term presence of DU fragments. In the event that preliminary surveys at Area 31 indicate radioactivity in excess of the DCGLw, the waste lifts will be reclassified as Class 1 survey units, and the survey and sampling requirements will be adjusted accordingly.</p> <p>It should be noted that differentiating between Class 1 and Class 2 status will have little practical impact on how the Area 31 survey is conducted. As indicated in the work plan, a 100% surface survey is already planned for each survey unit in order to ensure the detection of each remaining DU projectile. In addition, the estimated size of each Class 2 lift (2,675 m<sup>2</sup>) requires a sample spacing of 14 m, whereas a 2,000-m<sup>2</sup> Class 1 area would require a sample spacing of 12 m (difference of 14%).</p>
5	Section 2.6	Removal and Containerization of DU states that "DU rounds that are removed from the waste pile will be containerized appropriately and staged onsite at an approved location to await final disposition." Describe the status of the onsite location mentioned? How long does the licensee expect to store onsite any recovered DU?	It is anticipated that any DU recovered during the Area 31 final status survey will be staged at Area 10, which is listed on the license as a bulk storage area for LCAAP. The Area 10 sand piles are scheduled for remediation in 2008. Depending on the actual number of DU projectile bodies recovered from Area 31, this material will be disposed off-site either before or along with the Area 10 DU in 2008.
6	Section 3.2	Soil Sampling states the "Soil samples will be collected and sent to an accredited off-site laboratory for radioactivity analysis by gamma spectroscopy." The off-site laboratory is also mentioned extensively in Chapter 4. Please identify the accredited off-site laboratory the licensee has contracted to perform this analysis? Also, please specify the type of accreditation they possess?	Paragon Analytics, Inc. in Fort Collins, CO, will perform gamma spectroscopy analyses for the Area 31 samples. This laboratory has performed similar analyses for the Contractor at numerous other Army sites undergoing NRC decommissioning, and is certified by the National Environmental Laboratory Accreditation Program (NELAP).

Response to NRC Comments on the Draft Area 31 Final Status Survey Plan

Comment No.	piv/4	Comment	Response
7		Regarding Service Licensee (Cabrera Services) activities, please confirm that: a) A copy for the Administrative Agreement between you and the Service Licensee will be provided to us just before work begins; b) A minimum of two weeks notification will be provided to us before work begins; c) Provide us a Point of Contact for this work activity; and d) Confirm that Quality Assurance procedures, survey procedures, etc. will be onsite for inspection purposes.	The Contractor will provide NRC with items a through c in a separate transmittal two weeks prior to mobilization. Regarding item d, all documentation pertaining to the fieldwork (e.g., quality assurance procedures, survey procedures, health and safety procedures, etc.) will be maintained onsite during fieldwork and made available for inspection.
8		Also, it is necessary to address NRC's Dr. Peter Lee's previous discussion with the Contractor POC regarding the type of survey meter (scan sensitivity) to be used for the 100% walk-over survey, and the types of instruments to be used. During this call it was indicated that a test to demonstrate Scan MDC and ability of the instrumentation to detect DU in a 12-inch depth of soil during scans may be conducted. Please provide the results of this demonstration test.	See attached Technical Memorandum.

# Technical Memorandum

From: Hank Siegrist, CHP, PE, Cabrera Services, Inc.  
To: Project 07-1001.00 File  
Date: September 18, 2006  
Subject: Bremsstrahlung Effect in Depleted Uranium

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Beta particles present in large pieces of depleted uranium (DU) will produce bremsstrahlung X-radiation due to the direct interaction of the high-energy protactinium-234m beta particles within the uranium metal. This effect will produce a significant and predominant penetrating dose component of the DU for pieces of DU larger than the approximate range of beta particles in the uranium metal. This range is estimated as approximately 1 millimeter (mm) in uranium metal, and results in significant bremsstrahlung generation in particles of 1-mm radius or larger. Smaller sized particles present in soil will permit a greater fraction of the emitted beta particles to interact with lower atomic number materials such as oxygen, silicon, aluminum, hydrogen, and carbon that comprise the majority of soil constituents. This results in a significantly lower bremsstrahlung component.

To demonstrate the validity of the bremsstrahlung effect, empirical data was collected in the laboratory and compared to results obtained by computer modeling. Results are reported in the attached table: *DU Plate Calculated Photon and Bremsstrahlung Dose Rates versus Instrument Measured Dose Rates*. As indicated in the table, comparisons of measured dose rates from a 1,500 gram plate of DU to MicroShield calculations of dose rates from the same size DU plate indicate an approximate four-fold increase in the actual dose rates compared to those calculated considering only the gamma rays emitted from DU. This increase is due to bremsstrahlung radiation generated within the DU plate, which is unaccounted for in the MicroShield model.

Results of this study demonstrate that accurate estimates of penetrating dose rates from large pieces of DU may be calculated using the MicroShield code when both the traditional gamma ray and bremsstrahlung components of the penetrating dose are summed.

Attachments

**DU Plate Calculated Photon and Bremsstrahlung Dose Rates  
versus Instrument Measured Dose Rates**

Item	Dose Rate, microrem/hr @ 30 cm			
	Calculation/ Predicted	Measurement		
		Background	Gross Count	N
MicroShield photons dose rate only <sup>a</sup>	57.24			
MicroShield bremsstrahlung dose rate methodology <sup>b</sup>	202.8			
Predicted photon+bremsstrahlung dose rate	260.04			
Instrument, Bicron Microrem meter		3	225	
Instrument, Ludlum Micro-R		7	420	
Instrument, Ludlum 44-9 with 2241-3		12	1900	

Item	Dose Rate, microrem/hr @ 100 cm			
	Calculation/ Predicted	Measurement		
		Background	Gross Count	N
MicroShield photons dose rate only <sup>c</sup>	6.15			
MicroShield bremsstrahlung dose rate methodology <sup>d</sup>	21.8			
Predicted photon+bremsstrahlung dose rate	27.95			
Instrument, Bicron Microrem meter		3	30	
Instrument, Ludlum Micro-R		7	55	
Instrument, Ludlum 44-9 with 2241-3		12	115	

<sup>a</sup> MicroShield file DU\_PLATE.MS5

<sup>b</sup> MicroShield file DUPLATE2.MS5

<sup>c</sup> MicroShield file DUPLATE4.MS5

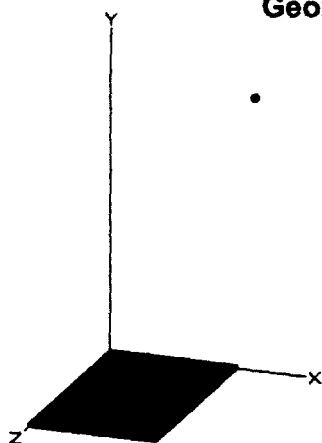
<sup>d</sup> MicroShield file DUPLATE3.MS5

**MicroShield v5.05 (5.05-00136)**  
**Cabrera Services, Inc.**

Page : 1  
 DOS File : DU\_PLATE.MS5  
 Run Date: September 12, 2006  
 Run Time: 3:03:36 PM  
 Duration : 00:02:40

File Ref: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 By: \_\_\_\_\_  
 Checked: \_\_\_\_\_

**Case Title: DU Plate 30 cm away**  
**Description: Air Exposure from DU Plate 50 y decay**  
**Geometry: 13 - Rectangular Volume**



**Source Dimensions**

Length	12.0 cm	4.7 in
Width	21.0 cm	8.3 in
Height	0.32 cm	0.1 in

**Dose Points**

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	17.5 cm 6.9 in	30.32 cm 11.9 in	10.5 cm 4.1 in

**Shields**

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	80.64 cm <sup>3</sup>	Uranium	18.7
Air Gap		Air	0.00122
Immersion		Air	0.00122

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

**Library : Grove**

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>µCi/cm<sup>3</sup></u>	<u>Bq/cm<sup>3</sup></u>
Ac-227	3.0536e-009	1.1298e+002	3.7868e-005	1.4011e+000
Bi-210	1.4891e-010	5.5096e+000	1.8466e-006	6.8323e-002
Bi-211	3.0421e-009	1.1256e+002	3.7725e-005	1.3958e+000
Bi-214	4.0623e-010	1.5031e+001	5.0376e-006	1.8639e-001
Fr-223	4.2140e-011	1.5592e+000	5.2257e-007	1.9335e-002
Pa-231	6.1110e-009	2.2611e+002	7.5781e-005	2.8039e+000
Pa-234	7.2000e-007	2.6640e+004	8.9286e-003	3.3036e+002
Pa-234m	4.5000e-004	1.6650e+007	5.5804e+000	2.0647e+005
Pb-210	1.4907e-010	5.5155e+000	1.8485e-006	6.8396e-002
Pb-211	3.0421e-009	1.1256e+002	3.7725e-005	1.3958e+000
Pb-214	4.0623e-010	1.5031e+001	5.0376e-006	1.8639e-001
Po-210	1.4461e-010	5.3506e+000	1.7933e-006	6.6352e-002
Po-211	8.3050e-012	3.0729e-001	1.0299e-007	3.8106e-003
Po-214	4.0615e-010	1.5027e+001	5.0365e-006	1.8635e-001
Po-215	3.0422e-009	1.1256e+002	3.7725e-005	1.3958e+000
Po-218	4.0631e-010	1.5034e+001	5.0386e-006	1.8643e-001
Ra-223	3.0422e-009	1.1256e+002	3.7725e-005	1.3958e+000

Page : 2  
 DOS File : DU\_PLATE.MS5  
 Run Date: September 12, 2006  
 Run Time: 3:03:36 PM  
 Duration : 00:02:40

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm<sup>3</sup></u>	<u>Bq/cm<sup>3</sup></u>
Ra-226	4.0656e-010	1.5043e+001	5.0416e-006	1.8654e-001
Rn-219	3.0422e-009	1.1256e+002	3.7725e-005	1.3958e+000
Rn-222	4.0631e-010	1.5034e+001	5.0386e-006	1.8643e-001
Th-227	3.0044e-009	1.1116e+002	3.7257e-005	1.3785e+000
Th-230	3.7811e-008	1.3990e+003	4.6889e-004	1.7349e+001
Th-231	5.7800e-006	2.1386e+005	7.1677e-002	2.6520e+003
Th-234	4.5000e-004	1.6650e+007	5.5804e+000	2.0647e+005
Tl-207	3.0338e-009	1.1225e+002	3.7622e-005	1.3920e+000
U-234	8.4052e-005	3.1099e+006	1.0423e+000	3.8565e+004
U-235	5.7800e-006	2.1386e+005	7.1677e-002	2.6520e+003
U-238	4.5000e-004	1.6650e+007	5.5804e+000	2.0647e+005

**Buildup**  
 The material reference is : Source

**Integration Parameters**

X Direction	51
Y Direction	51
Z Direction	51

**Results**

<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm<sup>2</sup>/sec</u>	<u>MeV/cm<sup>2</sup>/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	4.023e+02	1.047e-06	1.047e-06	8.978e-08	8.978e-08
0.02	1.026e+00	3.307e-09	3.307e-09	1.146e-10	1.146e-10
0.03	3.136e+04	2.653e-04	2.663e-04	2.629e-06	2.639e-06
0.04	3.320e+01	7.945e-07	8.009e-07	3.514e-09	3.542e-09
0.05	3.681e+03	1.979e-04	2.005e-04	5.271e-07	5.340e-07
0.06	6.527e+05	6.809e-02	6.931e-02	1.352e-04	1.377e-04
0.08	4.882e+04	1.445e-02	1.492e-02	2.287e-05	2.361e-05
0.1	1.046e+06	6.876e-01	7.202e-01	1.052e-03	1.102e-03
0.15	4.172e+04	2.862e-02	4.905e-02	4.713e-05	8.078e-05
0.2	1.376e+05	2.534e-01	3.193e-01	4.472e-04	5.636e-04
0.3	2.014e+03	1.341e-02	1.506e-02	2.545e-05	2.857e-05
0.4	1.671e+03	2.290e-02	2.533e-02	4.461e-05	4.935e-05
0.5	2.430e+03	5.172e-02	5.691e-02	1.015e-04	1.117e-04
0.6	9.933e+03	2.864e-01	3.125e-01	5.590e-04	6.099e-04
0.8	5.528e+04	2.406e+00	2.605e+00	4.576e-03	4.955e-03
1.0	1.767e+05	1.023e+01	1.098e+01	1.885e-02	2.025e-02
1.5	3.731e+03	3.455e-01	3.647e-01	5.813e-04	6.135e-04
2.0	4.850e+02	6.110e-02	6.442e-02	9.449e-05	9.962e-05
TOTALS:	2.214e+06	1.447e+01	1.560e+01	2.654e-02	2.862e-02

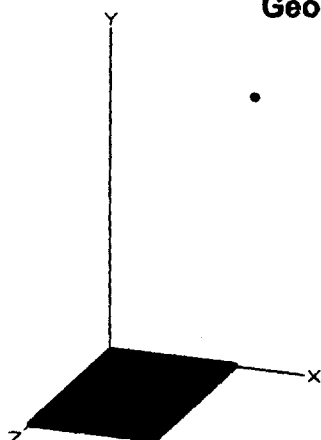


**MicroShield v5.05 (5.05-00136)**  
**Cabrera Services, Inc.**

Page : 1  
 DOS File : DUPLATE2.MS5  
 Run Date: September 12, 2006  
 Run Time: 3:14:56 PM  
 Duration : 00:00:13

File Ref: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 By: \_\_\_\_\_  
 Checked: \_\_\_\_\_

**Case Title: DU Plate 30 cm away**  
**Description: Bremsstrahlung 752 kev Air Expos 1500 g DU Plate 50y decay**  
**Geometry: 13 - Rectangular Volume**



**Source Dimensions**

Length	12.0 cm	4.7 in
Width	21.0 cm	8.3 in
Height	0.32 cm	0.1 in

**Dose Points**

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	17.5 cm 6.9 in	30.32 cm 11.9 in	10.5 cm 4.1 in

**Shields**

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	80.64 cm <sup>3</sup>	Uranium	18.7
Air Gap		Air	0.00122
Immersion		Air	0.00122

**Source Input**

**Grouping Method : User Defined Energies**

<u>Group</u>	<u>Energy</u>	<u>Activity</u>	<u>Volume Source</u>	<u>% Energy</u>
<u>#</u>	<u>(MeV)</u>	<u>Photons/sec</u>	<u>Photons/sec/cm<sup>3</sup></u>	<u>Activity</u>
1	0.752	1.2200e+006	1.5129e+004	100.000

**Buildup**

**The material reference is : Source**

**Integration Parameters**

X Direction	51
Y Direction	51
Z Direction	51

**Results**

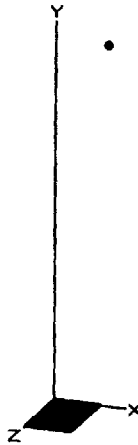
<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm<sup>2</sup>/sec</u>	<u>MeV/cm<sup>2</sup>/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.752	1.220e+06	4.884e+01	5.297e+01	9.354e-02	1.014e-01
<b>TOTALS:</b>	1.220e+06	4.884e+01	5.297e+01	9.354e-02	1.014e-01

**MicroShield v5.05 (5.05-00136)**  
**Cabrera Services, Inc.**

Page : 1  
 DOS File : DUPLATE4.MS5  
 Run Date: September 12, 2006  
 Run Time: 2:41:26 PM  
 Duration : 00:02:35

File Ref: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 By: \_\_\_\_\_  
 Checked: \_\_\_\_\_

**Case Title: DU Plate 100 cm away**  
**Description: Air Exposure from DU Plate 50 y decay**  
**Geometry: 13 - Rectangular Volume**



**Source Dimensions**

Length	12.0 cm	4.7 in
Width	21.0 cm	8.3 in
Height	0.32 cm	0.1 in

**Dose Points**

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	17.5 cm 6.9 in	100.32 cm 3 ft 3.5 in	10.5 cm 4.1 in

**Shields**

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	80.64 cm <sup>3</sup>	Uranium	18.7
Air Gap		Air	0.00122
Immersion		Air	0.00122

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

**Library : Grove**

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm<sup>3</sup></u>	<u>Bq/cm<sup>3</sup></u>
Ac-227	3.0536e-009	1.1298e+002	3.7868e-005	1.4011e+000
Bi-210	1.4891e-010	5.5096e+000	1.8466e-006	6.8323e-002
Bi-211	3.0421e-009	1.1256e+002	3.7725e-005	1.3958e+000
Bi-214	4.0623e-010	1.5031e+001	5.0376e-006	1.8639e-001
Fr-223	4.2140e-011	1.5592e+000	5.2257e-007	1.9335e-002
Pa-231	6.1110e-009	2.2611e+002	7.5781e-005	2.8039e+000
Pa-234	7.2000e-007	2.6640e+004	8.9286e-003	3.3036e+002
Pa-234m	4.5000e-004	1.6650e+007	5.5804e+000	2.0647e+005
Pb-210	1.4907e-010	5.5155e+000	1.8485e-006	6.8396e-002
Pb-211	3.0421e-009	1.1256e+002	3.7725e-005	1.3958e+000
Pb-214	4.0623e-010	1.5031e+001	5.0376e-006	1.8639e-001
Po-210	1.4461e-010	5.3506e+000	1.7933e-006	6.6352e-002
Po-211	8.3050e-012	3.0729e-001	1.0299e-007	3.8106e-003
Po-214	4.0615e-010	1.5027e+001	5.0365e-006	1.8635e-001
Po-215	3.0422e-009	1.1256e+002	3.7725e-005	1.3958e+000
Po-218	4.0631e-010	1.5034e+001	5.0386e-006	1.8643e-001
Ra-223	3.0422e-009	1.1256e+002	3.7725e-005	1.3958e+000

Page : 2  
 DOS File : DUPLATE4.MS5  
 Run Date : September 12, 2006  
 Run Time: 2:41:26 PM  
 Duration : 00:02:35

<u>Nuclide</u>	<u>curies</u>	<u>becquerels</u>	<u>μCi/cm³</u>	<u>Bq/cm³</u>
Ra-226	4.0656e-010	1.5043e+001	5.0416e-006	1.8654e-001
Rn-219	3.0422e-009	1.1256e+002	3.7725e-005	1.3958e+000
Rn-222	4.0631e-010	1.5034e+001	5.0386e-006	1.8643e-001
Th-227	3.0044e-009	1.1116e+002	3.7257e-005	1.3785e+000
Th-230	3.7811e-008	1.3990e+003	4.6889e-004	1.7349e+001
Th-231	5.7800e-006	2.1386e+005	7.1677e-002	2.6520e+003
Th-234	4.5000e-004	1.6650e+007	5.5804e+000	2.0647e+005
Tl-207	3.0338e-009	1.1225e+002	3.7622e-005	1.3920e+000
U-234	8.4052e-005	3.1099e+006	1.0423e+000	3.8565e+004
U-235	5.7800e-006	2.1386e+005	7.1677e-002	2.6520e+003
U-238	4.5000e-004	1.6650e+007	5.5804e+000	2.0647e+005

### Buildup

The material reference is : Source

### Integration Parameters

X Direction	51
Y Direction	51
Z Direction	51

### Results

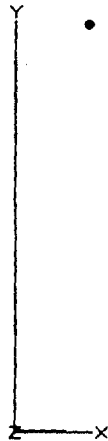
<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.015	4.023e+02	1.051e-07	1.051e-07	9.014e-09	9.014e-09
0.02	1.026e+00	3.550e-10	3.550e-10	1.230e-11	1.230e-11
0.03	3.136e+04	2.943e-05	2.955e-05	2.917e-07	2.929e-07
0.04	3.320e+01	8.884e-08	8.956e-08	3.929e-10	3.961e-10
0.05	3.681e+03	2.219e-05	2.248e-05	5.911e-08	5.990e-08
0.06	6.527e+05	7.643e-03	7.782e-03	1.518e-05	1.546e-05
0.08	4.882e+04	1.621e-03	1.674e-03	2.565e-06	2.649e-06
0.1	1.046e+06	7.714e-02	8.084e-02	1.180e-04	1.237e-04
0.15	4.172e+04	3.216e-03	5.535e-03	5.296e-06	9.114e-06
0.2	1.376e+05	2.851e-02	3.600e-02	5.031e-05	6.353e-05
0.3	2.014e+03	1.499e-03	1.683e-03	2.844e-06	3.193e-06
0.4	1.671e+03	2.522e-03	2.786e-03	4.915e-06	5.429e-06
0.5	2.430e+03	5.641e-03	6.191e-03	1.107e-05	1.215e-05
0.6	9.933e+03	3.104e-02	3.376e-02	6.058e-05	6.590e-05
0.8	5.528e+04	2.590e-01	2.796e-01	4.926e-04	5.318e-04
1.0	1.767e+05	1.097e+00	1.175e+00	2.022e-03	2.166e-03
1.5	3.731e+03	3.695e-02	3.891e-02	6.217e-05	6.546e-05
2.0	4.850e+02	6.529e-03	6.868e-03	1.010e-05	1.062e-05
TOTALS:	2.214e+06	1.559e+00	1.676e+00	2.858e-03	3.075e-03

**MicroShield v5.05 (5.05-00136)**  
**Cabrera Services, Inc.**

Page : 1  
 DOS File : DUPLATE3.MS5  
 Run Date : September 12, 2006  
 Run Time : 2:16:57 PM  
 Duration : 00:00:12

File Ref: \_\_\_\_\_  
 Date: \_\_\_\_\_  
 By: \_\_\_\_\_  
 Checked: \_\_\_\_\_

**Case Title: DU Plate 100 cm away**  
**Description: Bremsstrahlung 752 kev Air Expos 1500 g DU Plate 50y decay**  
**Geometry: 13 - Rectangular Volume**



**Source Dimensions**

Length	12.0 cm	4.7 in
Width	21.0 cm	8.3 in
Height	0.32 cm	0.1 in

**Dose Points**

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	17.5 cm 6.9 in	100.32 cm 3 ft 3.5 in	10.5 cm 4.1 in

**Shields**

<u>Shield Name</u>	<u>Dimension</u>	<u>Material</u>	<u>Density</u>
Source	80.64 cm <sup>3</sup>	Uranium	18.7
Air Gap		Air	0.00122
Immersion		Air	0.00122

**Source Input**

**Grouping Method : User Defined Energies**

<u>Group</u>	<u>Energy</u>	<u>Activity</u>	<u>Volume Source</u>	<u>% Energy</u>
<u>#</u>	<u>(MeV)</u>	<u>Photons/sec</u>	<u>Photons/sec/cm<sup>3</sup></u>	<u>Activity</u>
1	0.752	1.2200e+006	1.5129e+004	100.000

**Buildup**

The material reference is : Source

**Integration Parameters**

X Direction	51
Y Direction	51
Z Direction	51

**Results**

<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm<sup>2</sup>/sec</u>	<u>MeV/cm<sup>2</sup>/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.752	1.220e+06	5.263e+00	5.691e+00	1.008e-02	1.090e-02
<b>TOTALS:</b>	1.220e+06	5.263e+00	5.691e+00	1.008e-02	1.090e-02

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NUCLEAR REGULATORY COMMISSION  
NUCLEAR MATERIALS LICENSING BRANCH  
REGION III  
2443 WARRENVILLE ROAD STE 210  
LISLE IL 60532 4352