Attachment G

Oil and Gas Exploration and Production (E&P) NORM Waste Acceptance

SOP 15.WAC.04 was developed to implement a method to evaluate shipments of oil and gas field waste to verify that the material meets radioactive material license concentration limits for disposal. NORM waste from Oil and Gas Exploration and Production is ubiquitous in the environment and stakeholders desire more efficient methods of waste characterization. CHDT believes that careful screening procedures can ensure that this waste is well within license limits.

This new SOP provides a method for accepting waste streams consisting of NORM-containing filter socks and tank bottoms generated by oil and gas field operations. The method in the SOP requires generators to document the process (oil and gas exploration and production) that produced the waste along with detailed field surveys of the waste in order to characterize it for disposal at CHDT. Limitation to use of the SOP to oil and gas production and exploration provides assurance that the potential hazards and radionuclides are well understood.

The method in this SOP implements exposure rate measurements of each container upon arrival at CHDT along with gamma isotope identification to verify that the waste meets the requirements of the Adams County Amended Certificate of Designation and the Colorado Department of Public Health and Environment Radioactive Materials License.

A Technical Basis document is provided that derives and documents the exposure rate limits that must be met to verify that material meets the CHDT Waste Acceptance Criteria. The technical basis uses the radium isotopic mixture found in these oil and gas field waste streams.

STANDARD OPERATING PROCEDURE

15.WAC.04

OIL AND GAS E&P NORM WASTE ACCEPTANCE

1.0 OBJECTIVE

To define alternate methods and procedures for characterization and acceptance of oil and gas production waste proposed for acceptance at the Clean Harbors Deer Trail (CHDT) facility comply with the Adams County Amended Certificate of Designation (Amended CD) and the Colorado Department of Public Health and Environment (CDPHE) Radioactive Materials License.

2.0 SCOPE

This SOP defines the survey process and exposure rate acceptance criteria for receipt of oil and gas production waste containing Naturally Occurring Radioactive Material (NORM) and Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM). The acceptance criteria contained in this procedure will be used be provide assurance that materials accepted at the facility conform to the waste acceptance criteria. This procedure may be used for sludges and filters, and similar wastes but may not be used for pipes and process equipment.

3.0 POLICY

Oil and gas production wastes will be evaluated for acceptability at CHDT according to the procedures in this SOP. Radiation surveys of the waste shall be conducted to ensure that average contamination levels do not exceed the CHDT waste acceptance criteria. CHDT can accept oil and gas production waste containing NORM/TENORM with a total activity of less than 2,000 pCi/g (natural uranium and thorium decay chain products only), and with a maximum ^{226}Ra concentration of less than 222 pCi/g. Generators following this procedure are required to complete the standard CHDT Waste Profile and Supplemental NORM questionnaire provided in 15.WAC.01, Waste Acceptance, to certify that no man-made or other unacceptable radionuclides are present and that generating process and method of characterization is specified.

4.0 RESPONSIBILTITES OF CHDT

Responsibilities of the CHDT Radiation Safety Officer ("RSO"), management, and staff are defined in the CHDT Radiation Protection Plan (SOP 15.RPP.01). Surveys at generators sites may be performed by the generator, Clean Harbors on behalf of the generator, or an independent party, such as a licensed waste broker. Acceptance surveys at CHDT will be performed by trained CHDT personnel.

5.0 PRE-ACCEPTANCE REQUIREMENTS

Any waste generator proposing to send oil or gas production waste to CHDT shall document the radiological properties. The waste generator or authorized representative

shall provide pre-acceptance survey results and documentation in accordance with the following requirements:

5.1 Waste Documentation

5.1.1 Waste Material Profile Sheet

The waste generator shall submit a Waste Material Profile Sheet to CHDT. The waste generator may submit other forms or supporting documents as long as the data and information required in the Waste Profile are fully and completely provided in such alternate documents.

5.1.2 Supplemental NORM Questionnaire

The waste generator shall also submit a Supplemental NORM Questionnaire to CHDT. The waste generator shall complete all requested information and certify by signature of a responsible official that the information is complete. The waste generator shall provide supporting documents to support the Supplemental NORM Questionnaire. The waste generator shall document the characterization method and sampling/survey protocol for the wastes and the generating process. Other forms or documentation may be used as long as the required information is provided.

5.1.3 Oil and Gas NORM Field Survey Report

The waste generator or authorized representative shall attach to the Questionnaire a signed and complete Oil and Gas NORM Field Survey Report or equivalent. The Survey Report shall support and confirm the description of radionuclides set forth and described in the Waste Profile and the Questionnaire by demonstrating that exposure rates are within the acceptance criteria of this SOP. The Survey Report shall serve as a representative sample of the waste for acceptance purposes. Photo-documentation of survey meter readings, calibration dates and waste materials is strongly encouraged.

5.2 Pre-Acceptance Evaluation

5.2.1 CHDT Review of Characterization

Before any oil and gas production waste is approved for acceptance, the RSO shall ensure that such waste's radiological, physical, and chemical characteristics meet the sire acceptance criteria. CHDT shall use the Waste Material Profile Sheet, the Supplemental NORM Questionnaire, Survey Reports and any other supporting information received from the waste generator such as photographs of instrument readings, calibration stickers and the waste, to confirm that the oil and gas production waste is acceptable for disposal. Properly documented oil and gas production waste that has exposure rates meeting the criteria in Section 7 of this SOP are assumed to meet CHDT waste acceptance criteria.

5.2.2 Documentation of Acceptance

If the oil and gas production waste is confirmed to be appropriate for acceptance at the facility, the waste stream will be approved. CHDT shall maintain all documents, data, and information that it used to make the determination and include the information and documents with the Waste Profile. A copy of the approval, and the supporting documentation, will be kept on file and be available for review.

5.2.3 Annual Recertification

At the one year anniversary of the date of approval, the waste stream shall be reevaluated for compliance with this the Amended CD and the Radioactive Materials License ("Annual Recertification"). A generator may certify by re-signature of the Waste Materials Profile Sheet and Supplemental NORM Questionnaire that the original characterization is still complete and still applicable and the oil and gas production waste acceptance can continue. The waste generator's certification shall be evaluated by CHDT in the same manner as before. If CHDT re-confirms that the waste stream meets the requirements of the Amended CD and the Radioactive Materials License, the oil and gas production waste may be re-approved for acceptance. All documentation for any Annual Recertification of an oil and gas production waste or waste stream will be kept on file and be available for inspection.

6.0 CHDT ON-SITE ACCEPTANCE REQUIREMENTS

6.1.1 Gamma Isotopic Identification

Upon arrival at CHDT, each shipment of oil and gas waste will be analyzed for isotopic identification. Shipments of waste will be surveyed for radionuclide identification using an approved portable gamma spectroscopy unit per SOP 15.OPS.03, Operation of Portable Gamma Spectroscopy Unit. If man-made radionuclides are detected above background, the waste shipment shall be rejected and returned to the Generator or alternate facility.

6.1.2 Exposure Rate Survey

All shipments of oil and gas production wastes received at the Facility for acceptance and disposal shall be screened for radiation exposure rate at the outside of the shipment package. Exposure rate meters shall be operated in accordance with License SOP 15.OPS.07, Exposure/Dose Rate Meters. Criteria for acceptance or rejection using exposure rate surveys are detailed in Section 7.0 of this SOP. In addition, contamination surveys will be performed on the received waste materials per SOP 15.OPS.21 (Package Receipt Surveys) as required. If exposure rate surveys determine that the waste is above CHDT acceptance limits, the waste shipment shall be rejected and returned to the Generator or alternate facility. Alternatively, other means such as laboratory analysis may be used in order to confirm that the shipment is in compliance.

6.1.3 Documentation Review

All documents accompanying the oil production pipe waste shipment will be reviewed and kept on file to ensure that the requirements of CHDT are met.

6.1.4 On-Site Tracking

CHDT shall maintain data, information and other documentation that conforms to industry standards and prudent practices for on-site waste shipments and the disposal location of all wastes. Such information shall document and track the location and final disposition of each oil production pipe waste shipment.

7.0 PROCEDURE FOR SURVEYING AND APPLYING ACCEPTANCE CRITERIA

7.1 Overview

Oil and gas production waste shall be tested and analyzed as indicated below to assure the waste meets the Waste Acceptance Criteria and to ensure compliance with the requirements of the Amended CD and this SOP. If the oil and gas production waste shipment meets the measurement criteria stated below, the waste may be accepted for treatment, storage and disposal at CHDT.

7.2 Bulk Truck, Roll-off, or Steel Box Survey

Oil and gas production waste, while essentially homogenous in content will display variations in concentration. Concentration of radioactive materials will directly affect measured exposure rates. Distance from the source allows the detector to view a greater surface area and, therefore, tends to obscure local variations. For that reason, **survey** the truck, roll-off container, or box **at contact** using a meter capable of **detecting and displaying at least 500 micro-R/hour** (0.5 millirem/hour).

7.2.1 First Check

Check the status of the gate monitor to determine if it has alarmed. **IF** the gate monitor **ALARMED** as the material in question entered the site, **THEN** consider rejecting the material. This procedure may be exited. **IF** the gate alarm **DID NOT ALARM, PROCEED to the next step.**

7.2.2 Second Check

Survey the truck, roll-off, or steel box at contact. Trucks or roll-offs often have ribs. Scan each side, end, and bottom (if accessible). Collect exposure rates for acceptance determination from the non-ribbed sections of the truck or roll-off. IF no exposure rate is found to exceed **300 micro-R/hour, THEN** the material conforms to the acceptance criterion.

7.2.3 Additional Information for Second Check

IF exposure rates exceed 3**00 micro-R/hour *but* do not exceed 330 micro-R hour**, the material **MEETS** the acceptance criterion. Exposure rates in excess of 330 micro-R/hour should be identified to RSO for decision making about averaging higher and lower exposure rates and acceptance or rejection of the material.

7.3 Small or Individual Unshielded Items

Individual items should be surveyed at **1 foot** for contamination control purposes. **IF** individual, small, unshielded items present exposure rates less than **45 micro-R/hour** above the prevailing background, **THEN** the material meets the acceptance criterion.

8.0 ENFORCEMENT POLICY

If exposure rates exceed the acceptance levels shown in Section 7.0, then the oil and gas production waste shall be rejected. The waste may alternatively be analyzed and characterized using the procedures in 15.WAC.01, using laboratory analysis. The RSO may, based on actual survey data, average exposure rate readings to account for a small number (e.g., 10%) of elevated locations in an otherwise conforming shipment.

ATTACHMENT A

Supplemental NORM Questionnaire

Supplemental NORM Questionnaire

Clean Harbors Deer Trail Facility

General Information

Waste Name: _____

Profile Number: _____

Generator Name: _____

EPA ID: _____

Site Address: _____

Regulatory Information

Is the Waste Subject to an NRC, State or other Radioactive Materials License?	Yes ☐	No ☐
Does the Waste contain NORM (Naturally Occurring Radioactive Material)?	Yes ☐	No ☐
Does the Waste contain TENORM (Techologically Enhanced NORM)?	Yes ☐	No ☐
Does the Waste contain Source Material?	Yes ☐	No ☐
Does the Waste Contain Byproduct Material?	Yes ☐	No ☐
Does the Waste Contain Man Made or Artificial Radionuclides?	Yes ☐	No ☐
Does the Waste Contain Special Nuclear Material?	Yes ☐	No ☐

Please describe the process which produced the waste:

Radiological Information

What is the maximum dose rate at the surface of the waste (microR/hour)? _____

Please list the isotope, average specific activity, and maximum specific activity for each radionuclide present

Isotope	Ave (pCi/g)	Max (pCi/g)	Isotope	Ave (pCi/g)	Max (pCi/g)

Generators Certification

I hereby certify that all information submitted in this and attached documents is correct to the best of my knowledge. I also certify that any samples submitted are representative of the actual waste. I also certify that the Specific Acitivity (radioactivity per gram) of waste prepared for shipment to the facility meets the acceptance criteria for Regulated Waste at the Facility.

Authorized Signature	Name (Print)	Title	Date

Generators Outside the Rocky Mtn. Compact Region (CO, NM, NV) Certification

I hereby certify that the generator is licensed or permitted to, and agrees to, receive back the waste and residues if they cannot be disposed of. (In the case of oil and gas waste collectors/processors, this certification may be signed by the processor/collector.) I agree to provide the Clean Harbors Deer Trail Facility written or e-mail notification at least five days in advance of the initial shipment of waste.

Authorized Signature	Name (Print)	Title	Date

Clean Harbors Deer Trail, LLC
108555 East Highway 36,
Deer Trail, CO 80105
Phone 970-386-2293, Fax 970-386-2262

ATTACHMENT B

Oil and Gas NORM Field Survey Report Form

Oil and Gas NORM Field Survey Report

Clean Harbors Deer Trail Facility

General Information

Waste Name: _____

Profile Number: _____

Generator Name: _____

EPA ID: _____

Site Address: _____

Container ID: _____

Did the gate monitor alarm? Yes ☐ No ☐ N/A ☐

Survey Instrument Information

µR instrument Make: _____ Model: _____ Serial No. _____

Calibrated within the last year? Yes ☐ No ☐

Battery/Instrument check OK? Yes ☐ No ☐

µR instrument Make: _____ Model: _____ Serial No. _____

Calibrated within the last year? Yes ☐ No ☐

Battery/Instrument check OK? Yes ☐ No ☐

Survey Results

What is the maximum dose rate at the surface of the container (µR/hour)? _____

Location	Average	Maximum

Location	Average	Maximum

Diagram

Does the container pass 15.WAC.04? Yes ☐ No ☐

Surveyor Signature | Name (Print) | Title | Date

Clean Harbors Deer Trail, LLC
108555 East Highway 36,
Deer Trail, CO 80105
Phone 970-386-2293, Fax 970-386-2262

TECHNICAL MEMORANDUM

Deer Trail Exposure Rate Acceptance Criteria

To: Jack Kehoe, Facility General Manager
Clean Harbors Deer Trail

From: Mark O. Somerville Ph.D., CHP
CB&I Federal Services

Date: March 30, 2015

1.0 Executive Summary

Naturally Occurring or Technologically Enhanced Radioactive Materials (NORM and TENORM) are by-products associated with the oil and natural gas industry as well as other industrial sectors. The concentration of naturally occurring radioactive materials in wastes, process filters, process equipment, produced waters, and other derived-from materials is a function of natural, in-situ concentrations, concentrating processes, and contaminant load capacity.

Standards and regulations exist in the various States for the handling and disposition of NORM and TENORM. Individual locations may be granted or issued specific limits that are deemed protective to worker and members of the public. These limits are set above the concentrations typically found in nature.

For the purposes of this document, the primary radionuclide of concern is Radium-226 in equilibrium with its daughter products. Radium-228 is present at an assumed concentration of 50% of that of Ra-226. Natural uranium is not a significant contributor, meaning that it accounts for less than 10% of the activity. Additionally, the limits used as a basis for action are conservative with respect to the absolute acceptance limits.

This is a companion document to previously performed work and, therefore, will not repeat the detailed decay schemes, operational descriptions, or industry history.

2.0 Introduction

The purpose of this report is to provide the basis for field level acceptance criteria for NORM/TENORM related material surveyed for acceptance at the Clean Harbors, Deer trail

Facility. The subject material is described as loose material, from tank bottoms and sock filters with entrained contaminants.

The material is transported in covered trucks, roll offs, drums, and/or smaller packages containing filters.

Oil field wastes and related equipment and materials typically contain and concentrate NORM. The background, nature, and specific decay modes for the most commonly encountered radionuclides have been previously described for this facility (Kennedy Jr., Winslow, & Ikenberry, 2009).

A key difference between the assumptions in previous reports and the assumptions here is the form and location of the material. Pipe scale adherent to the inner wall of piping has been described with a density ranging from 1.7 to 3.5 g/cm^3 (Kennedy Jr. et al., 2009, p. 2-1). This report assumes the material has been freed from the pipe surface and is containerized in a form approximated by loose soil. Loose, moist soil has a density of 1200 kg/m^3 or 1.2 g/cm^3. Compact soil has a density of 1.6 g/cm^3 (The Engineering Toolbox, n.d., Table 1).

Truck box sides are assumed to be of standard double wall design with the inner layer consisting of 0.19 inch steel and the outer wall of 10 gauge steel, equivalent to 0.1406 inch USG.

3.0 Method

The point-kernel software MicroShield version 9.07 was used to model radionuclide concentration to exposure rate relationships. Dump truck boxes and roll offs were set to the same dimensions of 20 feet in length, 8 feet in width, and 3.38 feet in height. The value for height corresponds to the depth of material in the truck or roll off and the overall dimensions allow for the modeling of less than full containers. The individual dimensions are not critically important because when detectors of small volume are placed in close proximity to relatively large, planer sources, the angle viewed by the detector is a very small portion of the total source.

Because roll off construction is typically less robust than dump truck construction, roll off conversion factors will be conservative due to a higher modeled shielding component than actually exists.

The truck and roll off model is also acceptable for use with smaller steel boxes, such as B-25 or equivalent containers. As above, measurements taken close to the container sides diminishes the importance of any specific dimension as the presenting plane is much larger than the detector volume.

Drums were modeled as 1A2, 55-gallon open head drums with a 35-inch height and a 22.5-inch diameter. Such a drum has an 18 gauge shell and lid. This is a thickness of 0.0478 inches.

A one-cubic-foot unshielded item was also modeled. This element is intended to characterize small packages or individual sock-filters and similar items or elements.

The source term was defined as Radium-226 with an initial concentration of 222 pCi/gram of material. This is the derived acceptance concentration used in other facility related technical reports (Clean Harbors Deer Trail, LLC [Clean Harbors], 2005).

The source was decayed through an interval of 1 year. This is a short time period with respect to the 1,600-year half-life of Radium-226 but forces the in-growth of decay daughters into the activity to exposure rate calculation.

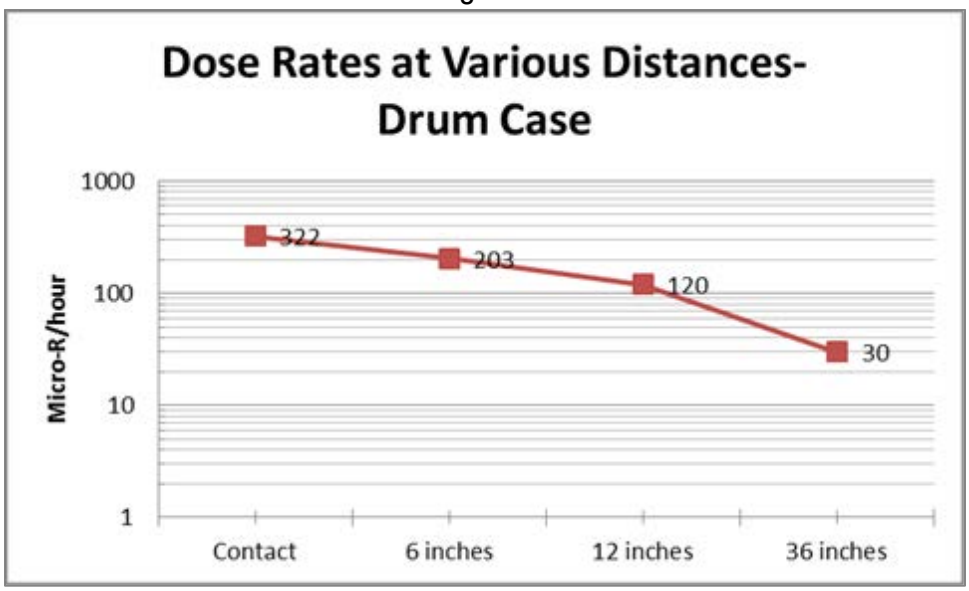
Exposure rates were calculated for 4 source-to-detector distances. The distances are 2 inches or contact with the container side, 6 inches (15 cm), 12 inches (30 cm), and 36 inches.

The results of the MicroShield case runs are attached in Appendix A.

4.0 Results

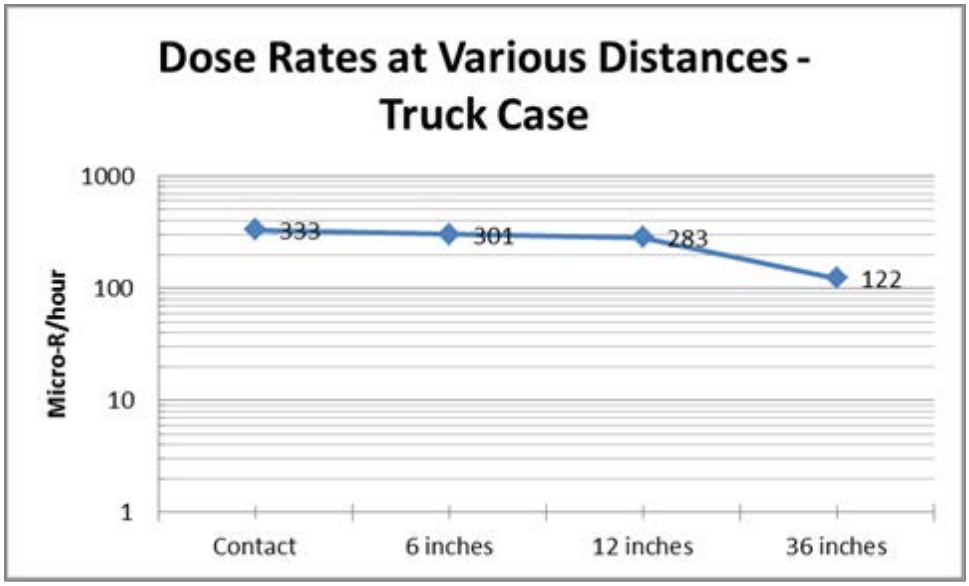
The results for the drum case are shown in Figure 1. The exposure rate is in micro-R/hour and is above background.

Figure 1



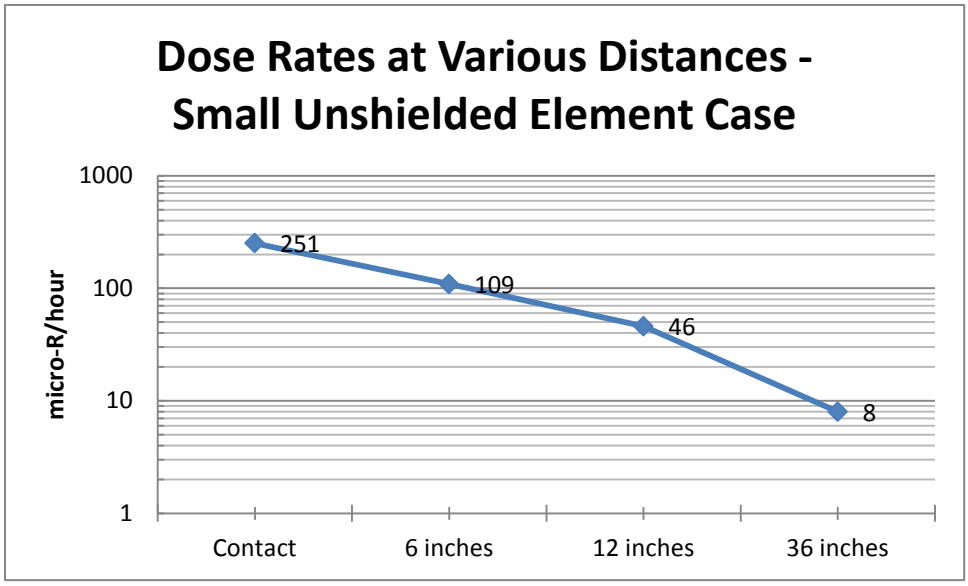
The results for the truck case, which includes roll off-type containers and metal boxes is shown in Figure 2.

Figure 2



Finally, the results for the 1 cubic-foot unshielded item are shown in Figure 3.

Figure 3



5.0 Discussion

There is consistency in the derived exposure rate values in the near-field as would be expected when the radionuclide concentration is held constant and the source to detector distance is small with respect to the size of the defined source. The main source of variability in this simplified model is the shielding and, ultimately, the total volume of source.

Because of the consistency in results, a simple and efficient approach will be to utilize a **CONTACT** exposure rate reading of 3**00 micro-R/hour above background** (0.3 mR/hr) as the acceptance screening value for trucks, drums, roll offs, and boxes.

Small, individual and unshielded items should be assessed at **one foot (30 cm)** for contamination control purposes and use an acceptance screening value **of 45 micro-R/hour above background.**

Surveys should be performed in a manner suitable for the exposure rate instrument in use and background in the survey area should be known or assessed prior to beginning any survey. Particular attention should be paid to the contribution to ambient, general area exposure rates by vehicles, containers, or objects near the survey area. The acceptance values are most useful when the only source of non-background radiation readings is from the container or vehicle of immediate interest.

For Trucks, Roll Offs, Boxes, and Drums:

Calculations and models such as this necessarily assume homogeneity of the source. It is possible that an array of exposure rates will be detected upon the performance of an acceptance survey. If exposure rates in excess of 1.7 times the acceptance screening value are discovered (500 micro-R/hour or 0.5 mrem/hour) supervision should be notified. The 500 micro-R/hour value is equivalent to the limit for exposure rate on contact with a limited quantity package and, while most shipments will be excepted, may represent an issue that requires follow up. If multiple locations are found by survey that reach 500 micro-R/hour, consider rejecting the shipment.

When surveys show most or all locations assessed in excess of the **300 micro-R/hour** screening criterion, but no points exceed 330 micro-R/hour, the shipment should be accepted.

If less than 10% of points surveyed exceed the 300 micro-R/hour screening criterion, the shipment can likely be accepted based on average concentrations and the notion that the radioactive material is “essentially evenly distributed.”

The license or regulatory-based requirements for concentration determination and averaging should be factored into the use of any screening criteria.

For Small, Unshielded Items:

When exposure rates exceed the values in Table 3, place the object in a secure location to preclude the spread of contamination and to control the object. Consider rejecting the individual item or combining in a permissible manner with lower activity concentration items for characterization and acceptance.

Best Use Procedure:

- To properly focus on the potential radiological impact of the material being evaluated, radiation reading should be made with a detector and meter that reads out in micro-R/hour or has a scale that allows the values listed in this document to be easily read and distinguished from background fluctuations.

- Surveys should be performed essentially in contact with the vehicle or package except, as mention, in the case of un-packaged items.

- The speed of the survey must be in accordance with the ability of the meter to resolve and process signal. Use of detectors and meters by qualified, experienced personnel will typically demonstrate understanding of proper use protocols.

- Because of the variability in natural and technologically enhanced sources of radiation, there should be an expectation of variability in survey data.

- It should be expected that sources, concentrations, quantities, and forms of radioactive materials will vary widely. If a particular condition creates uncertainty, the best course of action is to reject the material or to request assistance in making an acceptance or rejection decision.

- The radionuclide mixture should be validated periodically. A representative composite sample or an individual sample the is representative of the waste streams entering the site should be sent for off-site analysis and the results used to validate the exposure rate acceptance criteria. Typically, periodically means annually but other definitions can be supported.

6.0 References

Clean Harbors Deer Trail, LLC. (2005). *Radioactive materials Application* [Radioactive Materials License Application]. Deer Trails, CO: Author.

Kennedy Jr., W. E., Winslow, R. C., & Ikenberry, T. A. (2009). *Technical basis for the acceptance of oil production piping and equipment containing radioactive pipe scale at the Deer Trail landfill* (DMA-TR-42, Rev 0). Richland, WA: Dade Moeller & Associates, Inc.

The Engineering Toolbox. (n.d.). www.engineeringtoolbox.com/dirt-mud-densities-d_1727.html

Appendix A

MicroShield 9.07
CB&I Federal Services-Mark O. Somerville (9.07-0000)

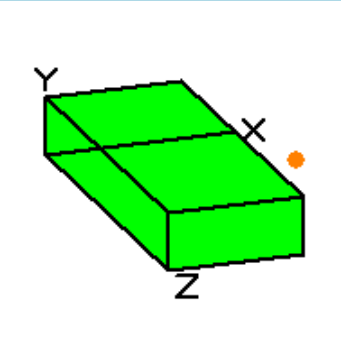
Date	By	Checked

Filename	Run Date	Run Time	Duration
DUmp and Rolloff Case deer trail 222 pCi Ra226 and 111 pCi Ra228.msd	March 30, 2015	3:21:57 PM	00:00:01

Project Info	
Case Title	TENORM Rev1
Description	Colorado Rolloff Case Includes Ra-226/228 decayed 1y
Geometry	13 - Rectangular Volume

Source Dimensions	
Length	243.84 cm (8 ft)
Width	609.6 cm (20 ft 0.0 in)
Height	103.022 cm (3 ft 4.6 in)

Dose Points			
A	X	Y	Z
#1	250.027 cm (8 ft 2.4 in)	51.511 cm (1 ft 8.3 in)	304.8 cm (10 ft 0.0 in)
#2	260.177 cm (8 ft 6.4 in)	51.511 cm (1 ft 8.3 in)	304.8 cm (10 ft 0.0 in)
#3	265.267 cm (8 ft 8.4 in)	51.511 cm (1 ft 8.3 in)	304.8 cm (10 ft 0.0 in)
#4	341.467 cm (11 ft 2.4 in)	51.511 cm (1 ft 8.3 in)	304.8 cm (10 ft 0.0 in)



Shields			
Shield N	Dimension	Material	Density
Source	1.53e+07 cm³	Compact Soil	1.6
Shield 1	.482 cm	Iron	7.86
Shield 2	.254 cm	Air	0.00122
Shield 3	.357 cm	Iron	7.86
Air Gap		Air	0.00122

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

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Ac-228	2.4112e-003	8.9213e+007	1.5745e-004	5.8257e+000
Bi-210	1.6090e-004	5.9535e+006	1.0507e-005	3.8877e-001
Bi-212	7.6560e-004	2.8327e+007	4.9994e-005	1.8498e+000
Bi-214	5.4359e-003	2.0113e+008	3.5497e-004	1.3134e+001
Pb-210	1.6416e-004	6.0738e+006	1.0720e-005	3.9662e-001
Pb-212	7.6570e-004	2.8331e+007	5.0001e-005	1.8500e+000
Pb-214	5.4359e-003	2.0113e+008	3.5497e-004	1.3134e+001
Po-210	8.5697e-005	3.1708e+006	5.5961e-006	2.0706e-001
Po-212	4.9052e-004	1.8149e+007	3.2031e-005	1.1852e+000
Po-214	5.4347e-003	2.0109e+008	3.5489e-004	1.3131e+001
Po-216	7.6675e-004	2.8370e+007	5.0069e-005	1.8526e+000
Po-218	5.4370e-003	2.0117e+008	3.5504e-004	1.3136e+001
Ra-224	7.6675e-004	2.8370e+007	5.0069e-005	1.8526e+000
Ra-226	5.4369e-003	2.0117e+008	3.5504e-004	1.3136e+001

Ra-228	2.4109e-003	8.9202e+007	1.5743e-004	5.8249e+000
Rn-220	7.6675e-004	2.8370e+007	5.0069e-005	1.8526e+000
Rn-222	5.4370e-003	2.0117e+008	3.5504e-004	1.3136e+001
Th-228	7.7529e-004	2.8686e+007	5.0627e-005	1.8732e+000
Tl-208	2.7508e-004	1.0178e+007	1.7963e-005	6.6463e-001

Buildup: The material reference is Source Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

Results - Dose Point # 1 - (2.50e+02,51.5112,304.8) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	7.592e+07	3.520e-203	4.215e-26	3.019e-204	3.615e-27	2.636e-204	3.156e-27	2.636e-206	3.156e-29
0.04	2.896e+05	1.297e-16	6.455e-16	5.735e-19	2.855e-18	5.006e-19	2.492e-18	5.006e-21	2.492e-20
0.05	2.469e+06	9.642e-10	7.951e-09	2.569e-12	2.118e-11	2.242e-12	1.849e-11	2.242e-14	1.849e-13
0.06	4.473e+05	9.048e-08	9.892e-07	1.797e-10	1.965e-09	1.569e-10	1.715e-09	1.569e-12	1.715e-11
0.08	5.990e+07	2.387e-03	2.858e-02	3.778e-06	4.522e-05	3.298e-06	3.948e-05	3.298e-08	3.948e-07
0.1	6.179e+06	2.041e-03	2.237e-02	3.123e-06	3.423e-05	2.726e-06	2.988e-05	2.726e-08	2.988e-07
0.15	3.568e+06	8.769e-03	7.398e-02	1.444e-05	1.218e-04	1.261e-05	1.064e-04	1.261e-07	1.064e-06
0.2	4.026e+07	2.260e-01	1.608e+00	3.988e-04	2.837e-03	3.482e-04	2.477e-03	3.482e-06	2.477e-05
0.3	6.076e+07	8.236e-01	4.660e+00	1.562e-03	8.839e-03	1.364e-03	7.716e-03	1.364e-05	7.716e-05
0.4	7.902e+07	1.865e+00	8.994e+00	3.634e-03	1.753e-02	3.173e-03	1.530e-02	3.173e-05	1.530e-04
0.5	1.097e+07	3.925e-01	1.674e+00	7.704e-04	3.287e-03	6.725e-04	2.869e-03	6.725e-06	2.869e-05
0.6	1.069e+08	5.349e+00	2.065e+01	1.044e-02	4.031e-02	9.114e-03	3.519e-02	9.114e-05	3.519e-04
0.8	3.543e+07	3.003e+00	1.001e+01	5.712e-03	1.903e-02	4.986e-03	1.662e-02	4.986e-05	1.662e-04
1.0	1.140e+08	1.454e+01	4.345e+01	2.681e-02	8.009e-02	2.340e-02	6.992e-02	2.340e-04	6.992e-04
1.5	4.817e+07	1.286e+01	3.210e+01	2.164e-02	5.400e-02	1.889e-02	4.715e-02	1.889e-04	4.715e-04
2.0	5.398e+07	2.392e+01	5.379e+01	3.699e-02	8.317e-02	3.229e-02	7.261e-02	3.229e-04	7.261e-04
3.0	1.016e+07	8.880e+00	1.751e+01	1.205e-02	2.375e-02	1.052e-02	2.074e-02	1.052e-04	2.074e-04
Totals	**7.084e+08**	**7.188e+01**	**1.946e+02**	**1.200e-01**	**3.331e-01**	**1.048e-01**	**2.908e-01**	**1.048e-03**	**2.908e-03**

Results - Dose Point # 2 - (2.60e+02,51.5112,304.8) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	7.592e+07	2.724e-191	3.489e-26	2.337e-192	2.992e-27	2.040e-192	2.612e-27	2.040e-194	2.612e-29
0.04	2.896e+05	3.989e-16	1.936e-15	1.764e-18	8.561e-18	1.540e-18	7.474e-18	1.540e-20	7.474e-20
0.05	2.469e+06	1.312e-09	1.041e-08	3.494e-12	2.772e-11	3.051e-12	2.420e-11	3.051e-14	2.420e-13
0.06	4.473e+05	8.826e-08	9.260e-07	1.753e-10	1.839e-09	1.530e-10	1.606e-09	1.530e-12	1.606e-11
0.08	5.990e+07	2.005e-03	2.404e-02	3.172e-06	3.804e-05	2.770e-06	3.321e-05	2.770e-08	3.321e-07

0.1	6.179e+06	1.762e-03	2.011e-02	2.696e-06	3.076e-05	2.354e-06	2.686e-05	2.354e-08	2.686e-07
0.15	3.568e+06	8.037e-03	7.079e-02	1.323e-05	1.166e-04	1.155e-05	1.018e-04	1.155e-07	1.018e-06
0.2	4.026e+07	2.108e-01	1.537e+00	3.720e-04	2.713e-03	3.248e-04	2.369e-03	3.248e-06	2.369e-05
0.3	6.076e+07	7.759e-01	4.404e+00	1.472e-03	8.353e-03	1.285e-03	7.292e-03	1.285e-05	7.292e-05
0.4	7.902e+07	1.761e+00	8.426e+00	3.431e-03	1.642e-02	2.995e-03	1.433e-02	2.995e-05	1.433e-04
0.5	1.097e+07	3.704e-01	1.558e+00	7.270e-04	3.057e-03	6.347e-04	2.669e-03	6.347e-06	2.669e-05
0.6	1.069e+08	5.041e+00	1.910e+01	9.839e-03	3.727e-02	8.589e-03	3.254e-02	8.589e-05	3.254e-04
0.8	3.543e+07	2.819e+00	9.165e+00	5.361e-03	1.743e-02	4.680e-03	1.522e-02	4.680e-05	1.522e-04
1.0	1.140e+08	1.359e+01	3.949e+01	2.504e-02	7.279e-02	2.186e-02	6.355e-02	2.186e-04	6.355e-04
1.5	4.817e+07	1.188e+01	2.876e+01	1.998e-02	4.838e-02	1.744e-02	4.224e-02	1.744e-04	4.224e-04
2.0	5.398e+07	2.188e+01	4.774e+01	3.383e-02	7.383e-02	2.954e-02	6.446e-02	2.954e-04	6.446e-04
3.0	1.016e+07	8.018e+00	1.538e+01	1.088e-02	2.087e-02	9.496e-03	1.822e-02	9.496e-05	1.822e-04
Totals	**7.084e+08**	**6.635e+01**	**1.757e+02**	**1.110e-01**	**3.013e-01**	**9.687e-02**	**2.630e-01**	**9.687e-04**	**2.630e-03**

Results - Dose Point # 3 - (2.65e+02,51.5112,304.8) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	7.592e+07	4.881e-190	3.219e-26	4.187e-191	2.761e-27	3.655e-191	2.410e-27	3.655e-193	2.410e-29
0.04	2.896e+05	3.908e-16	1.891e-15	1.728e-18	8.363e-18	1.509e-18	7.301e-18	1.509e-20	7.301e-20
0.05	2.469e+06	1.196e-09	9.477e-09	3.187e-12	2.525e-11	2.782e-12	2.204e-11	2.782e-14	2.204e-13
0.06	4.473e+05	8.199e-08	8.673e-07	1.629e-10	1.723e-09	1.422e-10	1.504e-09	1.422e-12	1.504e-11
0.08	5.990e+07	1.981e-03	2.401e-02	3.135e-06	3.799e-05	2.737e-06	3.317e-05	2.737e-08	3.317e-07
0.1	6.179e+06	1.763e-03	2.012e-02	2.697e-06	3.078e-05	2.354e-06	2.687e-05	2.354e-08	2.687e-07
0.15	3.568e+06	7.986e-03	6.937e-02	1.315e-05	1.142e-04	1.148e-05	9.972e-05	1.148e-07	9.972e-07
0.2	4.026e+07	2.080e-01	1.488e+00	3.672e-04	2.627e-03	3.206e-04	2.293e-03	3.206e-06	2.293e-05
0.3	6.076e+07	7.597e-01	4.218e+00	1.441e-03	8.002e-03	1.258e-03	6.986e-03	1.258e-05	6.986e-05
0.4	7.902e+07	1.715e+00	8.028e+00	3.342e-03	1.564e-02	2.917e-03	1.366e-02	2.917e-05	1.366e-04
0.5	1.097e+07	3.594e-01	1.479e+00	7.054e-04	2.903e-03	6.158e-04	2.534e-03	6.158e-06	2.534e-05
0.6	1.069e+08	4.875e+00	1.809e+01	9.516e-03	3.530e-02	8.308e-03	3.082e-02	8.308e-05	3.082e-04
0.8	3.543e+07	2.712e+00	8.650e+00	5.159e-03	1.645e-02	4.504e-03	1.436e-02	4.504e-05	1.436e-04
1.0	1.140e+08	1.302e+01	3.717e+01	2.400e-02	6.852e-02	2.095e-02	5.982e-02	2.095e-04	5.982e-04
1.5	4.817e+07	1.130e+01	2.695e+01	1.901e-02	4.535e-02	1.660e-02	3.959e-02	1.660e-04	3.959e-04
2.0	5.398e+07	2.072e+01	4.463e+01	3.204e-02	6.902e-02	2.797e-02	6.025e-02	2.797e-04	6.025e-04
3.0	1.016e+07	7.554e+00	1.434e+01	1.025e-02	1.946e-02	8.946e-03	1.699e-02	8.946e-05	1.699e-04
Totals	**7.084e+08**	**6.324e+01**	**1.652e+02**	**1.059e-01**	**2.835e-01**	**9.241e-02**	**2.475e-01**	**9.241e-04**	**2.475e-03**

Results - Dose Point # 4 - (3.41e+02,51.5112,304.8) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	7.592e+07	1.850e-188	1.426e-26	1.587e-189	1.223e-27	1.385e-189	1.068e-27	1.385e-191	1.068e-29
0.04	2.896e+05	3.167e-16	1.535e-15	1.401e-18	6.789e-18	1.223e-18	5.927e-18	1.223e-20	5.927e-20
0.05	2.469e+06	1.040e-09	8.273e-09	2.771e-12	2.204e-11	2.419e-12	1.924e-11	2.419e-14	1.924e-13

0.06	4.473e+05	7.090e-08	7.437e-07	1.408e-10	1.477e-09	1.229e-10	1.290e-09	1.229e-12	1.290e-11
0.08	5.990e+07	1.481e-03	1.702e-02	2.344e-06	2.694e-05	2.047e-06	2.352e-05	2.047e-08	2.352e-07
0.1	6.179e+06	1.163e-03	1.215e-02	1.779e-06	1.859e-05	1.553e-06	1.623e-05	1.553e-08	1.623e-07
0.15	3.568e+06	4.523e-03	3.487e-02	7.448e-06	5.743e-05	6.502e-06	5.013e-05	6.502e-08	5.013e-07
0.2	4.026e+07	1.110e-01	7.037e-01	1.959e-04	1.242e-03	1.710e-04	1.084e-03	1.710e-06	1.084e-05
0.3	6.076e+07	3.845e-01	1.910e+00	7.294e-04	3.623e-03	6.368e-04	3.163e-03	6.368e-06	3.163e-05
0.4	7.902e+07	8.445e-01	3.568e+00	1.645e-03	6.953e-03	1.436e-03	6.070e-03	1.436e-05	6.070e-05
0.5	1.097e+07	1.736e-01	6.509e-01	3.408e-04	1.278e-03	2.975e-04	1.115e-03	2.975e-06	1.115e-05
0.6	1.069e+08	2.322e+00	7.902e+00	4.532e-03	1.542e-02	3.956e-03	1.346e-02	3.956e-05	1.346e-04
0.8	3.543e+07	1.264e+00	3.743e+00	2.405e-03	7.119e-03	2.099e-03	6.215e-03	2.099e-05	6.215e-05
1.0	1.140e+08	5.975e+00	1.598e+01	1.101e-02	2.945e-02	9.616e-03	2.571e-02	9.616e-05	2.571e-04
1.5	4.817e+07	5.056e+00	1.148e+01	8.506e-03	1.932e-02	7.426e-03	1.686e-02	7.426e-05	1.686e-04
2.0	5.398e+07	9.141e+00	1.893e+01	1.414e-02	2.927e-02	1.234e-02	2.555e-02	1.234e-04	2.555e-04
3.0	1.016e+07	3.286e+00	6.066e+00	4.458e-03	8.230e-03	3.892e-03	7.185e-03	3.892e-05	7.185e-05
Totals	**7.084e+08**	**2.857e+01**	**7.100e+01**	**4.797e-02**	**1.220e-01**	**4.188e-02**	**1.065e-01**	**4.188e-04**	**1.065e-03**

MicroShield 9.07
CB&I Federal Services-Mark O. Somerville (9.07-0000)

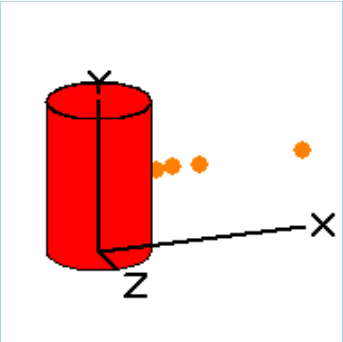
Date	By	Checked

Filename	Run Date	Run Time	Duration
Deer trails drum.msd	March 30, 2015	3:18:54 PM	00:00:01

Project Info	
Case Title	Deer Trails Drum
Description	222 pCi p gram Ra226 and 111 pCi p gram Ra228 drum
Geometry	7 - Cylinder Volume - Side Shields

Source Dimensions	
Height	88.9 cm (2 ft 11.0 in)
Radius	28.575 cm (11.3 in)

Dose Points			
A	X	Y	Z
#1	33.655 cm (1 ft 1.3 in)	44.45 cm (1 ft 5.5 in)	0.0 cm (0 in)
#2	43.815 cm (1 ft 5.3 in)	44.45 cm (1 ft 5.5 in)	0.0 cm (0 in)
#3	59.055 cm (1 ft 11.3 in)	44.45 cm (1 ft 5.5 in)	0.0 cm (0 in)
#4	120.015 cm (3 ft 11.3 in)	44.45 cm (1 ft 5.5 in)	0.0 cm (0 in)



Shields			
Shield N	Dimension	Material	Density
Source	2.28e+05 cm³	Compact Soil	1.6
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	.122 cm	Iron	7.86
Top Clad	.122 cm	Iron	7.86

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

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Ac-228	3.5906e-005	1.3285e+006	1.5745e-004	5.8257e+000
Bi-210	2.3961e-006	8.8657e+004	1.0507e-005	3.8877e-001
Bi-212	1.1401e-005	4.2184e+005	4.9994e-005	1.8498e+000
Bi-214	8.0949e-005	2.9951e+006	3.5497e-004	1.3134e+001
Pb-210	2.4446e-006	9.0449e+004	1.0720e-005	3.9662e-001
Pb-212	1.1403e-005	4.2189e+005	5.0001e-005	1.8500e+000
Pb-214	8.0949e-005	2.9951e+006	3.5497e-004	1.3134e+001
Po-210	1.2762e-006	4.7219e+004	5.5961e-006	2.0706e-001
Po-212	7.3047e-006	2.7027e+005	3.2031e-005	1.1852e+000
Po-214	8.0932e-005	2.9945e+006	3.5489e-004	1.3131e+001
Po-216	1.1418e-005	4.2247e+005	5.0069e-005	1.8526e+000
Po-218	8.0965e-005	2.9957e+006	3.5504e-004	1.3136e+001
Ra-224	1.1418e-005	4.2247e+005	5.0069e-005	1.8526e+000
Ra-226	8.0965e-005	2.9957e+006	3.5504e-004	1.3136e+001
Ra-228	3.5902e-005	1.3284e+006	1.5743e-004	5.8249e+000

Rn-220	1.1418e-005	4.2247e+005	5.0069e-005	1.8526e+000
Rn-222	8.0965e-005	2.9957e+006	3.5504e-004	1.3136e+001
Th-228	1.1545e-005	4.2718e+005	5.0627e-005	1.8732e+000
Tl-208	4.0964e-006	1.5157e+005	1.7963e-005	6.6463e-001

Buildup: The material reference is Source Integration Parameters	
Radial	10
Circumferential	10
Y Direction (axial)	20

Results - Dose Point # 1 - (33.655,44.45,0) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	1.131e+06	1.691e-32	9.721e-27	1.450e-33	8.338e-28	1.266e-33	7.279e-28	1.266e-35	7.279e-30
0.04	4.313e+03	2.321e-06	5.852e-06	1.026e-08	2.588e-08	8.960e-09	2.259e-08	8.960e-11	2.259e-10
0.05	3.677e+04	2.674e-04	8.645e-04	7.124e-07	2.303e-06	6.219e-07	2.010e-06	6.219e-09	2.010e-08
0.06	6.661e+03	1.929e-04	7.314e-04	3.831e-07	1.453e-06	3.345e-07	1.268e-06	3.345e-09	1.268e-08
0.08	8.920e+05	1.094e-01	4.755e-01	1.731e-04	7.524e-04	1.511e-04	6.569e-04	1.511e-06	6.569e-06
0.1	9.201e+04	2.375e-02	1.058e-01	3.634e-05	1.619e-04	3.172e-05	1.413e-04	3.172e-07	1.413e-06
0.15	5.313e+04	3.426e-02	1.409e-01	5.641e-05	2.320e-04	4.925e-05	2.025e-04	4.925e-07	2.025e-06
0.2	5.995e+05	6.324e-01	2.379e+00	1.116e-03	4.200e-03	9.744e-04	3.666e-03	9.744e-06	3.666e-05
0.3	9.048e+05	1.778e+00	5.814e+00	3.373e-03	1.103e-02	2.944e-03	9.628e-03	2.944e-05	9.628e-05
0.4	1.177e+06	3.546e+00	1.045e+01	6.910e-03	2.037e-02	6.032e-03	1.778e-02	6.032e-05	1.778e-04
0.5	1.634e+05	6.852e-01	1.861e+00	1.345e-03	3.654e-03	1.174e-03	3.190e-03	1.174e-05	3.190e-05
0.6	1.592e+06	8.752e+00	2.220e+01	1.708e-02	4.334e-02	1.491e-02	3.783e-02	1.491e-04	3.783e-04
0.8	5.276e+05	4.455e+00	1.022e+01	8.474e-03	1.944e-02	7.398e-03	1.697e-02	7.398e-05	1.697e-04
1.0	1.697e+06	2.004e+01	4.263e+01	3.694e-02	7.857e-02	3.225e-02	6.859e-02	3.225e-04	6.859e-04
1.5	7.173e+05	1.559e+01	2.919e+01	2.623e-02	4.912e-02	2.290e-02	4.288e-02	2.290e-04	4.288e-04
2.0	8.038e+05	2.673e+01	4.636e+01	4.134e-02	7.169e-02	3.609e-02	6.259e-02	3.609e-04	6.259e-04
3.0	1.513e+05	8.988e+00	1.412e+01	1.219e-02	1.915e-02	1.065e-02	1.672e-02	1.065e-04	1.672e-04
Totals	**1.055e+07**	**9.137e+01**	**1.860e+02**	**1.553e-01**	**3.217e-01**	**1.356e-01**	**2.809e-01**	**1.356e-03**	**2.809e-03**

Results - Dose Point # 2 - (43.815,44.45,0) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	1.131e+06	1.742e-30	5.893e-27	1.494e-31	5.055e-28	1.304e-31	4.413e-28	1.304e-33	4.413e-30
0.04	4.313e+03	1.405e-06	3.506e-06	6.213e-09	1.550e-08	5.424e-09	1.354e-08	5.424e-11	1.354e-10
0.05	3.677e+04	1.669e-04	5.535e-04	4.446e-07	1.474e-06	3.881e-07	1.287e-06	3.881e-09	1.287e-08
0.06	6.661e+03	1.305e-04	5.159e-04	2.592e-07	1.025e-06	2.263e-07	8.945e-07	2.263e-09	8.945e-09
0.08	8.920e+05	7.761e-02	3.381e-01	1.228e-04	5.350e-04	1.072e-04	4.671e-04	1.072e-06	4.671e-06
0.1	9.201e+04	1.663e-02	7.173e-02	2.544e-05	1.097e-04	2.221e-05	9.580e-05	2.221e-07	9.580e-07
0.15	5.313e+04	2.317e-02	9.138e-02	3.816e-05	1.505e-04	3.331e-05	1.314e-04	3.331e-07	1.314e-06
0.2	5.995e+05	4.216e-01	1.529e+00	7.440e-04	2.699e-03	6.495e-04	2.356e-03	6.495e-06	2.356e-05

0.3	9.048e+05	1.171e+00	3.716e+00	2.221e-03	7.049e-03	1.939e-03	6.154e-03	1.939e-05	6.154e-05
0.4	1.177e+06	2.322e+00	6.668e+00	4.524e-03	1.299e-02	3.950e-03	1.134e-02	3.950e-05	1.134e-04
0.5	1.634e+05	4.469e-01	1.185e+00	8.772e-04	2.326e-03	7.658e-04	2.030e-03	7.658e-06	2.030e-05
0.6	1.592e+06	5.691e+00	1.411e+01	1.111e-02	2.755e-02	9.697e-03	2.405e-02	9.697e-05	2.405e-04
0.8	5.276e+05	2.884e+00	6.480e+00	5.485e-03	1.232e-02	4.788e-03	1.076e-02	4.788e-05	1.076e-04
1.0	1.697e+06	1.293e+01	2.696e+01	2.383e-02	4.969e-02	2.080e-02	4.338e-02	2.080e-04	4.338e-04
1.5	7.173e+05	9.988e+00	1.838e+01	1.680e-02	3.092e-02	1.467e-02	2.700e-02	1.467e-04	2.700e-04
2.0	8.038e+05	1.705e+01	2.909e+01	2.636e-02	4.499e-02	2.301e-02	3.928e-02	2.301e-04	3.928e-04
3.0	1.513e+05	5.698e+00	8.824e+00	7.730e-03	1.197e-02	6.748e-03	1.045e-02	6.748e-05	1.045e-04
Totals	**1.055e+07**	**5.871e+01**	**1.174e+02**	**9.987e-02**	**2.033e-01**	**8.718e-02**	**1.775e-01**	**8.718e-04**	**1.775e-03**

Results - Dose Point # 3 - (59.055,44.45,0) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	1.131e+06	2.000e-30	3.387e-27	1.715e-31	2.905e-28	1.498e-31	2.536e-28	1.498e-33	2.536e-30
0.04	4.313e+03	1.022e-06	2.577e-06	4.519e-09	1.140e-08	3.945e-09	9.951e-09	3.945e-11	9.951e-11
0.05	3.677e+04	1.230e-04	4.040e-04	3.278e-07	1.076e-06	2.861e-07	9.395e-07	2.861e-09	9.395e-09
0.06	6.661e+03	9.079e-05	3.467e-04	1.803e-07	6.886e-07	1.574e-07	6.012e-07	1.574e-09	6.012e-09
0.08	8.920e+05	4.964e-02	2.082e-01	7.855e-05	3.294e-04	6.857e-05	2.876e-04	6.857e-07	2.876e-06
0.1	9.201e+04	1.032e-02	4.364e-02	1.579e-05	6.677e-05	1.379e-05	5.829e-05	1.379e-07	5.829e-07
0.15	5.313e+04	1.417e-02	5.538e-02	2.333e-05	9.120e-05	2.036e-05	7.962e-05	2.036e-07	7.962e-07
0.2	5.995e+05	2.570e-01	9.221e-01	4.535e-04	1.627e-03	3.959e-04	1.421e-03	3.959e-06	1.421e-05
0.3	9.048e+05	7.121e-01	2.225e+00	1.351e-03	4.221e-03	1.179e-03	3.685e-03	1.179e-05	3.685e-05
0.4	1.177e+06	1.409e+00	3.976e+00	2.746e-03	7.746e-03	2.397e-03	6.762e-03	2.397e-05	6.762e-05
0.5	1.634e+05	2.707e-01	7.043e-01	5.313e-04	1.382e-03	4.638e-04	1.207e-03	4.638e-06	1.207e-05
0.6	1.592e+06	3.441e+00	8.370e+00	6.716e-03	1.634e-02	5.863e-03	1.426e-02	5.863e-05	1.426e-04
0.8	5.276e+05	1.737e+00	3.831e+00	3.305e-03	7.287e-03	2.885e-03	6.361e-03	2.885e-05	6.361e-05
1.0	1.697e+06	7.765e+00	1.590e+01	1.431e-02	2.932e-02	1.249e-02	2.559e-02	1.249e-04	2.559e-04
1.5	7.173e+05	5.965e+00	1.080e+01	1.004e-02	1.818e-02	8.761e-03	1.587e-02	8.761e-05	1.587e-04
2.0	8.038e+05	1.014e+01	1.706e+01	1.568e-02	2.639e-02	1.369e-02	2.304e-02	1.369e-04	2.304e-04
3.0	1.513e+05	3.372e+00	5.162e+00	4.574e-03	7.004e-03	3.993e-03	6.114e-03	3.993e-05	6.114e-05
Totals	**1.055e+07**	**3.514e+01**	**6.927e+01**	**5.982e-02**	**1.200e-01**	**5.222e-02**	**1.047e-01**	**5.222e-04**	**1.047e-03**

Results - Dose Point # 4 - (120.015,44.45,0) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	1.131e+06	8.894e-31	8.645e-28	7.629e-32	7.415e-29	6.660e-32	6.474e-29	6.660e-34	6.474e-31
0.04	4.313e+03	3.677e-07	9.092e-07	1.626e-09	4.021e-09	1.420e-09	3.510e-09	1.420e-11	3.510e-11
0.05	3.677e+04	3.715e-05	1.181e-04	9.896e-08	3.145e-07	8.639e-08	2.746e-07	8.639e-10	2.746e-09
0.06	6.661e+03	2.544e-05	9.525e-05	5.053e-08	1.892e-07	4.411e-08	1.652e-07	4.411e-10	1.652e-09
0.08	8.920e+05	1.345e-02	5.606e-02	2.129e-05	8.871e-05	1.859e-05	7.745e-05	1.859e-07	7.745e-07
0.1	9.201e+04	2.763e-03	1.148e-02	4.227e-06	1.756e-05	3.690e-06	1.533e-05	3.690e-08	1.533e-07
0.15	5.313e+04	3.714e-03	1.404e-02	6.116e-06	2.312e-05	5.339e-06	2.018e-05	5.339e-08	2.018e-07

0.2	5.995e+05	6.673e-02	2.319e-01	1.178e-04	4.093e-04	1.028e-04	3.573e-04	1.028e-06	3.573e-06
0.3	9.048e+05	1.832e-01	5.585e-01	3.476e-04	1.059e-03	3.034e-04	9.248e-04	3.034e-06	9.248e-06
0.4	1.177e+06	3.608e-01	9.982e-01	7.031e-04	1.945e-03	6.138e-04	1.698e-03	6.138e-06	1.698e-05
0.5	1.634e+05	6.910e-02	1.771e-01	1.356e-04	3.476e-04	1.184e-04	3.034e-04	1.184e-06	3.034e-06
0.6	1.592e+06	8.764e-01	2.107e+00	1.711e-03	4.112e-03	1.493e-03	3.590e-03	1.493e-05	3.590e-05
0.8	5.276e+05	4.414e-01	9.665e-01	8.395e-04	1.838e-03	7.329e-04	1.605e-03	7.329e-06	1.605e-05
1.0	1.697e+06	1.970e+00	4.019e+00	3.631e-03	7.408e-03	3.170e-03	6.467e-03	3.170e-05	6.467e-05
1.5	7.173e+05	1.511e+00	2.737e+00	2.542e-03	4.606e-03	2.220e-03	4.021e-03	2.220e-05	4.021e-05
2.0	8.038e+05	2.569e+00	4.328e+00	3.972e-03	6.692e-03	3.468e-03	5.843e-03	3.468e-05	5.843e-05
3.0	1.513e+05	8.550e-01	1.312e+00	1.160e-03	1.780e-03	1.013e-03	1.554e-03	1.013e-05	1.554e-05
Totals	**1.055e+07**	**8.922e+00**	**1.752e+01**	**1.519e-02**	**3.033e-02**	**1.326e-02**	**2.648e-02**	**1.326e-04**	**2.648e-04**

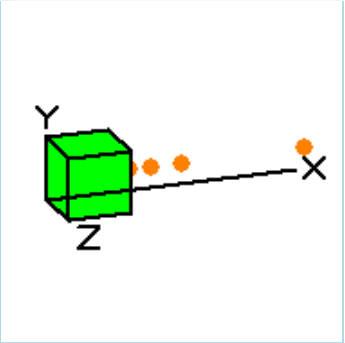
MicroShield 9.07
CB&I Federal Services-Mark O. Somerville (9.07-0000)

Date	By	Checked

Filename	Run Date	Run Time	Duration
Deer Trail s Blob.msd	March 30, 2015	3:21:01 PM	00:00:01

Project Info	
Case Title	Blob Rev2
Description	Now includes Ra-228
Geometry	13 - Rectangular Volume

Source Dimensions	
Length	30.48 cm (1 ft)
Width	30.48 cm (1 ft)
Height	30.48 cm (1 ft)



Dose Points			
A	X	Y	Z
#1	35.56 cm (1 ft 2.0 in)	15.24 cm (6.0 in)	15.24 cm (6.0 in)
#2	45.72 cm (1 ft 6.0 in)	15.24 cm (6.0 in)	15.24 cm (6.0 in)
#3	60.96 cm (2 ft)	15.24 cm (6.0 in)	15.24 cm (6.0 in)
#4	121.92 cm (4 ft)	15.24 cm (6.0 in)	15.24 cm (6.0 in)

Shields			
Shield N	Dimension	Material	Density
Source	2.83e+04 cm³	Loose Soil	1.2
Air Gap		Air	0.00122

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

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Ac-228	4.4585e-006	1.6496e+005	1.5745e-004	5.8257e+000
Bi-210	2.9753e-007	1.1009e+004	1.0507e-005	3.8877e-001
Bi-212	1.4157e-006	5.2380e+004	4.9994e-005	1.8498e+000
Bi-214	1.0052e-005	3.7191e+005	3.5497e-004	1.3134e+001
Pb-210	3.0354e-007	1.1231e+004	1.0720e-005	3.9662e-001
Pb-212	1.4159e-006	5.2387e+004	5.0001e-005	1.8500e+000
Pb-214	1.0052e-005	3.7191e+005	3.5497e-004	1.3134e+001
Po-210	1.5846e-007	5.8632e+003	5.5961e-006	2.0706e-001
Po-212	9.0703e-007	3.3560e+004	3.2031e-005	1.1852e+000
Po-214	1.0049e-005	3.7183e+005	3.5489e-004	1.3131e+001
Po-216	1.4178e-006	5.2459e+004	5.0069e-005	1.8526e+000
Po-218	1.0054e-005	3.7198e+005	3.5504e-004	1.3136e+001
Ra-224	1.4178e-006	5.2459e+004	5.0069e-005	1.8526e+000
Ra-226	1.0053e-005	3.7198e+005	3.5504e-004	1.3136e+001
Ra-228	4.4579e-006	1.6494e+005	1.5743e-004	5.8249e+000
Rn-220	1.4178e-006	5.2459e+004	5.0069e-005	1.8526e+000
Rn-222	1.0054e-005	3.7198e+005	3.5504e-004	1.3136e+001

Th-228	1.4336e-006	5.3043e+004	5.0627e-005	1.8732e+000
Tl-208	5.0865e-007	1.8820e+004	1.7963e-005	6.6463e-001

Buildup: The material reference is Source Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

Results - Dose Point # 1 - (35.56,15.24,15.24) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	1.404e+05	4.272e-05	4.607e-05	3.665e-06	3.952e-06	3.199e-06	3.450e-06	3.199e-08	3.450e-08
0.04	5.356e+02	3.018e-04	4.589e-04	1.335e-06	2.030e-06	1.165e-06	1.772e-06	1.165e-08	1.772e-08
0.05	4.566e+03	5.171e-03	9.527e-03	1.377e-05	2.538e-05	1.203e-05	2.216e-05	1.203e-07	2.216e-07
0.06	8.271e+02	1.524e-03	3.305e-03	3.027e-06	6.565e-06	2.642e-06	5.731e-06	2.642e-08	5.731e-08
0.08	1.108e+05	3.812e-01	9.780e-01	6.032e-04	1.548e-03	5.266e-04	1.351e-03	5.266e-06	1.351e-05
0.1	1.143e+04	5.806e-02	1.572e-01	8.883e-05	2.405e-04	7.755e-05	2.100e-04	7.755e-07	2.100e-06
0.15	6.597e+03	6.057e-02	1.588e-01	9.974e-05	2.615e-04	8.708e-05	2.283e-04	8.708e-07	2.283e-06
0.2	7.444e+04	9.995e-01	2.439e+00	1.764e-03	4.304e-03	1.540e-03	3.757e-03	1.540e-05	3.757e-05
0.3	1.124e+05	2.535e+00	5.472e+00	4.809e-03	1.038e-02	4.198e-03	9.061e-03	4.198e-05	9.061e-05
0.4	1.461e+05	4.754e+00	9.389e+00	9.263e-03	1.829e-02	8.087e-03	1.597e-02	8.087e-05	1.597e-04
0.5	2.029e+04	8.764e-01	1.617e+00	1.720e-03	3.174e-03	1.502e-03	2.771e-03	1.502e-05	2.771e-05
0.6	1.977e+05	1.076e+01	1.878e+01	2.101e-02	3.665e-02	1.834e-02	3.199e-02	1.834e-04	3.199e-04
0.8	6.551e+04	5.137e+00	8.281e+00	9.770e-03	1.575e-02	8.530e-03	1.375e-02	8.530e-05	1.375e-04
1.0	2.108e+05	2.192e+01	3.336e+01	4.040e-02	6.150e-02	3.527e-02	5.369e-02	3.527e-04	5.369e-04
1.5	8.907e+04	1.541e+01	2.143e+01	2.593e-02	3.605e-02	2.263e-02	3.147e-02	2.263e-04	3.147e-04
2.0	9.981e+04	2.460e+01	3.249e+01	3.805e-02	5.024e-02	3.322e-02	4.386e-02	3.322e-04	4.386e-04
3.0	1.878e+04	7.530e+00	9.350e+00	1.022e-02	1.268e-02	8.918e-03	1.107e-02	8.918e-05	1.107e-04
Totals	**1.310e+06**	**9.503e+01**	**1.439e+02**	**1.637e-01**	**2.511e-01**	**1.429e-01**	**2.192e-01**	**1.429e-03**	**2.192e-03**

Results - Dose Point # 2 - (45.72,15.24,15.24) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	1.404e+05	3.893e-05	4.195e-05	3.339e-06	3.598e-06	2.915e-06	3.141e-06	2.915e-08	3.141e-08
0.04	5.356e+02	1.382e-04	2.049e-04	6.110e-07	9.064e-07	5.334e-07	7.913e-07	5.334e-09	7.913e-09
0.05	4.566e+03	2.314e-03	4.175e-03	6.164e-06	1.112e-05	5.382e-06	9.710e-06	5.382e-08	9.710e-08
0.06	8.271e+02	6.737e-04	1.432e-03	1.338e-06	2.844e-06	1.168e-06	2.483e-06	1.168e-08	2.483e-08
0.08	1.108e+05	1.664e-01	4.196e-01	2.634e-04	6.640e-04	2.299e-04	5.796e-04	2.299e-06	5.796e-06
0.1	1.143e+04	2.521e-02	6.729e-02	3.858e-05	1.029e-04	3.368e-05	8.987e-05	3.368e-07	8.987e-07
0.15	6.597e+03	2.618e-02	6.799e-02	4.312e-05	1.120e-04	3.764e-05	9.774e-05	3.764e-07	9.774e-07
0.2	7.444e+04	4.314e-01	1.047e+00	7.613e-04	1.848e-03	6.647e-04	1.613e-03	6.647e-06	1.613e-05
0.3	1.124e+05	1.093e+00	2.359e+00	2.073e-03	4.474e-03	1.810e-03	3.906e-03	1.810e-05	3.906e-05
0.4	1.461e+05	2.049e+00	4.058e+00	3.991e-03	7.906e-03	3.485e-03	6.902e-03	3.485e-05	6.902e-05

0.5	2.029e+04	3.776e-01	7.000e-01	7.413e-04	1.374e-03	6.471e-04	1.199e-03	6.471e-06	1.199e-05
0.6	1.977e+05	4.639e+00	8.139e+00	9.055e-03	1.589e-02	7.905e-03	1.387e-02	7.905e-05	1.387e-04
0.8	6.551e+04	2.215e+00	3.595e+00	4.213e-03	6.838e-03	3.678e-03	5.970e-03	3.678e-05	5.970e-05
1.0	2.108e+05	9.458e+00	1.450e+01	1.743e-02	2.672e-02	1.522e-02	2.333e-02	1.522e-04	2.333e-04
1.5	8.907e+04	6.661e+00	9.325e+00	1.121e-02	1.569e-02	9.783e-03	1.370e-02	9.783e-05	1.370e-04
2.0	9.981e+04	1.065e+01	1.416e+01	1.647e-02	2.189e-02	1.438e-02	1.911e-02	1.438e-04	1.911e-04
3.0	1.878e+04	3.266e+00	4.079e+00	4.431e-03	5.534e-03	3.868e-03	4.831e-03	3.868e-05	4.831e-05
Totals	**1.310e+06**	**4.106e+01**	**6.251e+01**	**7.073e-02**	**1.091e-01**	**6.175e-02**	**9.521e-02**	**6.175e-04**	**9.521e-04**

Results - Dose Point # 3 - (60.96,15.24,15.24) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	1.404e+05	2.287e-05	2.460e-05	1.961e-06	2.110e-06	1.712e-06	1.842e-06	1.712e-08	1.842e-08
0.04	5.356e+02	5.317e-05	7.856e-05	2.351e-07	3.475e-07	2.053e-07	3.033e-07	2.053e-09	3.033e-09
0.05	4.566e+03	8.947e-04	1.624e-03	2.383e-06	4.327e-06	2.081e-06	3.778e-06	2.081e-08	3.778e-08
0.06	8.271e+02	2.619e-04	5.632e-04	5.201e-07	1.119e-06	4.541e-07	9.766e-07	4.541e-09	9.766e-09
0.08	1.108e+05	6.528e-02	1.688e-01	1.033e-04	2.671e-04	9.018e-05	2.332e-04	9.018e-07	2.332e-06
0.1	1.143e+04	9.953e-03	2.744e-02	1.523e-05	4.197e-05	1.329e-05	3.664e-05	1.329e-07	3.664e-07
0.15	6.597e+03	1.043e-02	2.822e-02	1.717e-05	4.647e-05	1.499e-05	4.057e-05	1.499e-07	4.057e-07
0.2	7.444e+04	1.727e-01	4.382e-01	3.048e-04	7.734e-04	2.661e-04	6.752e-04	2.661e-06	6.752e-06
0.3	1.124e+05	4.406e-01	9.941e-01	8.357e-04	1.886e-03	7.296e-04	1.646e-03	7.296e-06	1.646e-05
0.4	1.461e+05	8.303e-01	1.716e+00	1.618e-03	3.343e-03	1.412e-03	2.918e-03	1.412e-05	2.918e-05
0.5	2.029e+04	1.537e-01	2.965e-01	3.017e-04	5.820e-04	2.634e-04	5.081e-04	2.634e-06	5.081e-06
0.6	1.977e+05	1.895e+00	3.452e+00	3.699e-03	6.737e-03	3.229e-03	5.882e-03	3.229e-05	5.882e-05
0.8	6.551e+04	9.101e-01	1.527e+00	1.731e-03	2.904e-03	1.511e-03	2.536e-03	1.511e-05	2.536e-05
1.0	2.108e+05	3.904e+00	6.166e+00	7.196e-03	1.137e-02	6.282e-03	9.923e-03	6.282e-05	9.923e-05
1.5	8.907e+04	2.772e+00	3.978e+00	4.664e-03	6.693e-03	4.072e-03	5.843e-03	4.072e-05	5.843e-05
2.0	9.981e+04	4.457e+00	6.050e+00	6.892e-03	9.356e-03	6.016e-03	8.168e-03	6.016e-05	8.168e-05
3.0	1.878e+04	1.376e+00	1.747e+00	1.866e-03	2.370e-03	1.629e-03	2.069e-03	1.629e-05	2.069e-05
Totals	**1.310e+06**	**1.700e+01**	**2.659e+01**	**2.925e-02**	**4.637e-02**	**2.553e-02**	**4.049e-02**	**2.553e-04**	**4.049e-04**

Results - Dose Point # 4 - (121.92,15.24,15.24) 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	Absorbed Dose Rate mrad/hr No Buildup	Absorbed Dose Rate mrad/hr With Buildup	Absorbed Dose Rate mGy/hr No Buildup	Absorbed Dose Rate mGy/hr With Buildup
0.015	1.404e+05	3.517e-06	3.779e-06	3.016e-07	3.242e-07	2.633e-07	2.830e-07	2.633e-09	2.830e-09
0.04	5.356e+02	7.220e-06	1.079e-05	3.193e-08	4.770e-08	2.788e-08	4.164e-08	2.788e-10	4.164e-10
0.05	4.566e+03	1.238e-04	2.300e-04	3.299e-07	6.127e-07	2.880e-07	5.349e-07	2.880e-09	5.349e-09
0.06	8.271e+02	3.686e-05	8.218e-05	7.322e-08	1.632e-07	6.392e-08	1.425e-07	6.392e-10	1.425e-09
0.08	1.108e+05	9.426e-03	2.588e-02	1.492e-05	4.095e-05	1.302e-05	3.575e-05	1.302e-07	3.575e-07
0.1	1.143e+04	1.460e-03	4.341e-03	2.234e-06	6.642e-06	1.951e-06	5.798e-06	1.951e-08	5.798e-08
0.15	6.597e+03	1.563e-03	4.640e-03	2.574e-06	7.641e-06	2.247e-06	6.671e-06	2.247e-08	6.671e-08
0.2	7.444e+04	2.620e-02	7.312e-02	4.624e-05	1.291e-04	4.037e-05	1.127e-04	4.037e-07	1.127e-06
0.3	1.124e+05	6.791e-02	1.679e-01	1.288e-04	3.184e-04	1.125e-04	2.780e-04	1.125e-06	2.780e-06

0.4	1.461e+05	1.295e-01	2.912e-01	2.523e-04	5.675e-04	2.202e-04	4.954e-04	2.202e-06	4.954e-06
0.5	2.029e+04	2.419e-02	5.049e-02	4.748e-05	9.911e-05	4.145e-05	8.653e-05	4.145e-07	8.653e-07
0.6	1.977e+05	3.005e-01	5.891e-01	5.865e-04	1.150e-03	5.120e-04	1.004e-03	5.120e-06	1.004e-05
0.8	6.551e+04	1.461e-01	2.615e-01	2.778e-04	4.975e-04	2.425e-04	4.343e-04	2.425e-06	4.343e-06
1.0	2.108e+05	6.324e-01	1.059e+00	1.166e-03	1.952e-03	1.018e-03	1.704e-03	1.018e-05	1.704e-05
1.5	8.907e+04	4.566e-01	6.866e-01	7.682e-04	1.155e-03	6.706e-04	1.008e-03	6.706e-06	1.008e-05
2.0	9.981e+04	7.418e-01	1.048e+00	1.147e-03	1.620e-03	1.001e-03	1.414e-03	1.001e-05	1.414e-05
3.0	1.878e+04	2.320e-01	3.039e-01	3.147e-04	4.123e-04	2.747e-04	3.599e-04	2.747e-06	3.599e-06
Totals	**1.310e+06**	**2.770e+00**	**4.566e+00**	**4.755e-03**	**7.958e-03**	**4.151e-03**	**6.947e-03**	**4.151e-05**	**6.947e-05**