KBC-40179
Revision 0

ALARA Assessment of Settler Sludge Sampling Methods

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

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L. A. Nelsen
CH2M HILL Plateau Remediation Company

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KBC-40179
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ALARA Assessment of Settler Sludge Sampling Methods

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Purpose:

The purpose of this assessment is to compare underwater and above water settler sludge sampling methods to determine if the added cost for underwater sampling for the sole purpose of worker dose reductions is justified. Initial planning for sludge sampling included container, settler and knock-out-pot (KOP) sampling. Due to the significantly higher dose consequence of KOP sludge, a decision was made to sample KOP underwater to achieve worker dose reductions. Additionally, initial plans were to utilize the underwater sampling apparatus for settler sludge. Since there are no longer plans to sample KOP sludge, the decision for underwater sampling for settler sludge needs to be revisited. The present sampling plan calls for spending an estimated $2,500,000 to design and construct a new underwater sampling system (per A21C-PL-001 Rev0E). This evaluation will compare and contrast the present method of above water sampling to the underwater method that is planned by the Sludge Treatment Project (STP) and determine if settler samples can be taken using the existing sampling cart (with potentially minor modifications) while maintaining doses to workers As Low As Reasonably Achievable (ALARA) and eliminate the need for costly redesigns, testing and personnel retraining.

Background:

The sludge material has been collected from various areas in the KE and KW basins and is being stored in the engineered containers (SCS-CON-210,-220,-240,-250 and -260). The project requires that samples be taken of the sludge material so that appropriate safety and operational features can be built into the transportation, storage and processing equipment to verify that the waste forms will meet the various state and federal requirements.

The present location of the six sludge containers is in the center and east bay of the K West Basin. Three containers (SCS-CON-240, -250, and -260) are filled with sludge that originated in the K East Basin. Two containers (SCS-CON-210 and -220) are filled with sludge from K West Basin. The remaining container (SCS-CON-230, presently empty) will be used for sludge that is scheduled to be transferred from the 10 settler tanks. The material that will be transferred to SCS-CON-230 is referred to as "settler" sludge, and the material from the other 5 containers (SCS-CON-210, -220, -240, -250, and -260) is referred to as "container" sludge.

Prior to the collection of settler sludge samples from SCS-CON-230, container sludge samples will be taken from SCS-CON-210, -220, -240, -250, and -260. The method scheduled to be used to conduct sampling of these first 5 containers is an above water sampling cart which is very similar to the equipment that has been used during previous sampling campaigns (see Figure 1).

The next phase of the sludge sampling will entail the sampling of the settler sludge which will have been transferred into SCS-CON-230. The method presently planned to complete settler sampling (see figure 2) differs from the container sampling method in the following ways:

- Sample bottles will be filled underwater in the basin.
- The guide, isolation, and extraction tubes will change to allow the sample material to be diverted to the sample bottles while maintaining a water cover (see Figure 3 for representation of container with isolation and guide tubes)
- A larger sample bottle set will be used so that bottles do not have to be changed during the sampling of one location

- A shielded shipping container (pig) is planned due to the anticipated radiological content of the sludge

The sludge that will be transferred into engineered container SCS-CON-230 is still located in the settler tanks (See Figure 4 for view of settler tanks). The material from the settler tanks is anticipated to have higher curie content and be denser than the sludge that is in the remaining containers. Once the settler contents have been relocated into the engineered container, sampling will be performed. The planned sample method will use an underwater method to provide the required shielding and maintain worker dose ALARA. The resulting sample bottles will be transferred from KW Basin to the analytical laboratory using a PAS-1 cask.

While the settler sludge sampling campaign has not yet been designed, the sampling process for the remaining container sludge (SCS-CON-210,-220,-240,-250 and -260) is well understood and employs a systems for above water sampling that has been successfully employed during previous sludge sampling campaigns at the K-basins (see Figure 1). Some of the ALARA features incorporated into the design and operations of the container sludge sampling system include the following (those items will also be applicable if used for settler sludge sampling):

- The use of the MASF Building for training.
- In Basin (dry run) Testing.
- Shielded sample cart pigs to house sample bottles, while in cart
- HEPA filers used on pump outlet and vacuum breaker vents.
- Negative Vacuum system that minimizes leaks during sampling and a shielded sample cart that contains any spill that maybe encountered during sampling or during bottle handling.
- Radiological controls have been imbedded into the operating procedure that include dose limits, backflushing of lines, and provisions for handling sample bottles with excessive dose rates.
- Radiological survey requirements have been incorporated as well when there is a potential for individuals to encounter dose rates $\geq$ 100 mrem/hr. In addition, radiological action limits have been incorporated into the procedure to reduce the chance of exceeding RWP void limits.
- An engineered frame is available to cover the above water sludge sampling line with shielding.
- Handling of filled sample bottles will be minimized (no decanting of samples). A T-bar will be used to maximize the distance between the worker and the filled sample bottles.

KBC-40179
REV 0

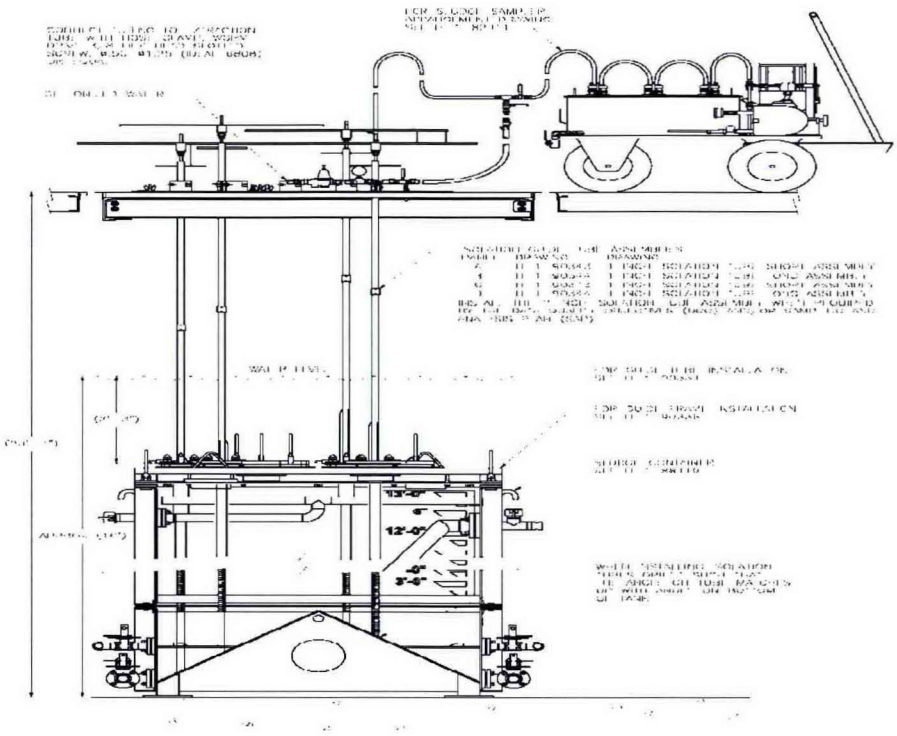

Figure 1 - STP Container Sludge Sampling Cart (Above Water Sampling)

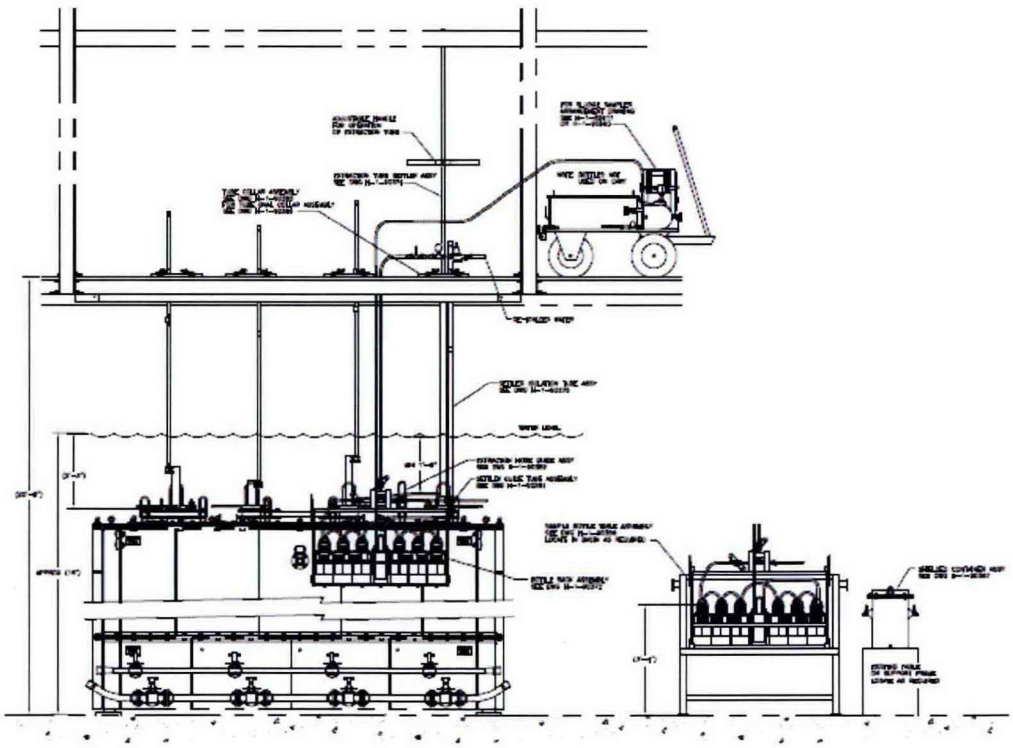

Figure 2 - Present STP "Proposed" Settler Sludge Sampling Method (Underwater)

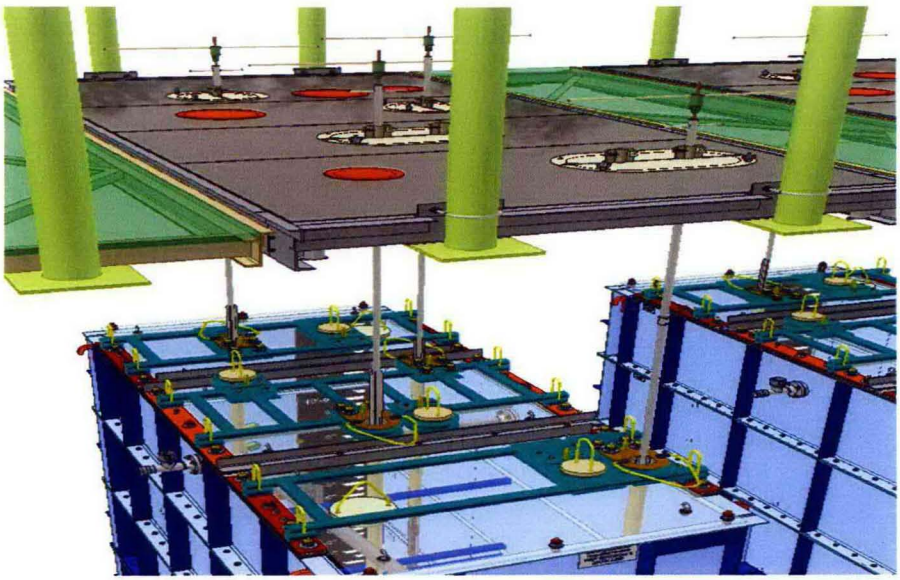

Figure 3 - Grating Level Work Platforms with isolation tubes in place

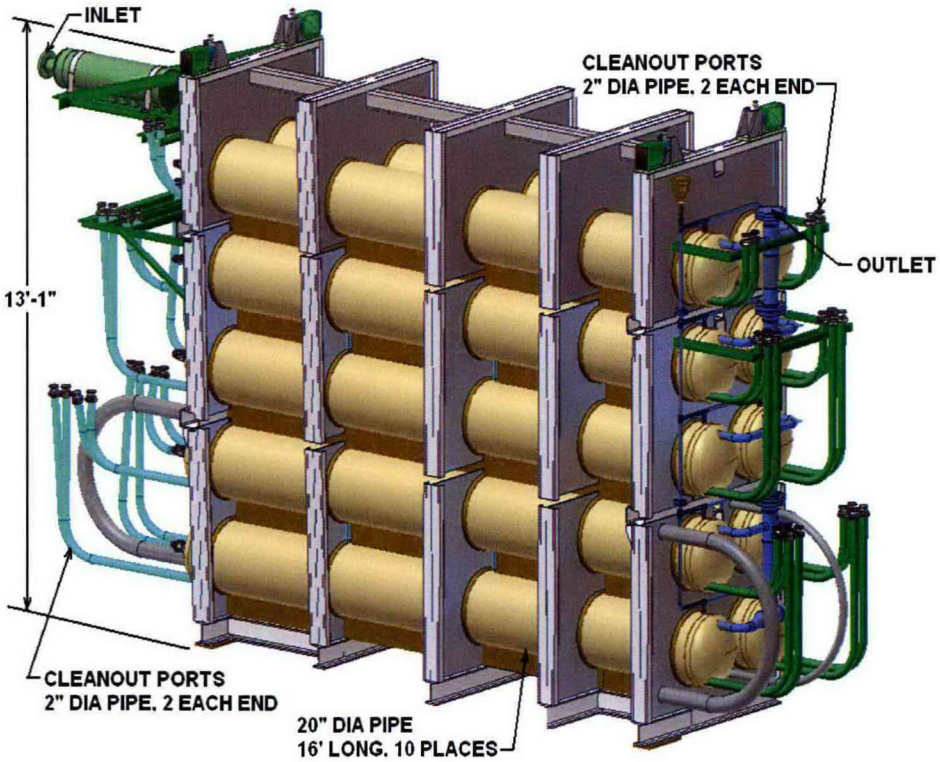

Figure 4 – Settler Tanks

Assessment:

Calculations completed during this assessment were performed using a Dell Optiplex 755, Intel Core 2 Duo processor, CHPRC Computer #WC95262. The calculations were performed using site wide licensed Microshield, version 7.02, issued under document #CHPRC-00064, The proper installation and functionality of Microshield, Version 7.02 on CHPRC computer #WC95262 has been documented in the STP Radiological Engineers field logbook by successful completion of the installed Verification and Validation, results are attached.

This assessment performs a number of calculations to evaluate dose rates for settler sludge during various sampling activities. The methods used in these calculations were the same as were used in ALARA report KBC-37814 to determine dose rates for container sludge sampling. The dose rates calculated using the methods outline in the ALARA report were then used to determine expected person-rem doses for the settler sludge sampling evolution. This is same process that is outlined in Letter #09-100K-GLH-003 for container sludge. The processes outlined in these two documents were used for this assessment to determine the dose that can be anticipated if settler samples are taken above water using the existing sampling equipment.

The following assumptions were used throughout this assessment and for the calculations associated with this assessment.

Assumptions:

- All samples were assumed to be based on 400 ml of sludge contained in the 4 L Nalgene bottle with 2.6 liters of basin water.
- Source terms for settler sludge and container sludge is as described in HNF-SD-SNF-TI-015 Rev.13A, Spent Nuclear Fuel Project Technical Data Book, Vol. 2, Sludge, Table 4-21. The resulting values have been condensed in Figure 5.0 below.
- Standard densities were used for common items: water 1.0 gm/cm^3, steel 7.86 gm/cm^3, air 0.00122 gm/cm^3
- Settler tanks dimensions: 20 in diameter; 16 feet long; walls are schedule 10 pipe (0.25 inch thickness).
- The settler tanks are assumed to be 54% full, per the HNF-SD-SNF-TI-015 data book.
- Settler tanks contain a total of 5.4 m^3 of sludge. %volume = 5.4m^3 / V (volume of single settler tank) where = $V = \pi r^2 \mathrm{h}$
- Dose measurement taken with RO-07 with distance to center of detector of 1 inch.
- A Dose Decision Value for Optimization of $25,000/person-Rem was used.
- KW basin general area background dose rate is assumed to be ~1mr/hr.
- The neutron dose rate from this source term is negligible compared to the photon dose rate and was not included (see calculation A21C-N-003).
- The number of sample bottles per core sample will vary depending on sludge depth in the container. The total samples per core is assumed to not exceed 1 liter total sludge, at a maximum of 400 ml per bottle, it is therefore assumed 10 bottles will be necessary.
- One settler sample bottle per PAS-1 Cask shipment.
- The dimensions for the KW basin sludge sample bottle are Height 54.61 cm and the OD is 16.193 cm.
- The primary exposure occurs during the sample pull and transferring of samples from the sample cart to the SSC for shipment. Minimal exposure will result from the KW basin background (~1.0 mrem/h).

Figure 5.0 Sludge Source Term

STP SOURCE TERMS FOR SHIELDING AND DOSE RATE CALCULATIONS DURING CONTAINER AND SETTLER SLUDGE SAMPLING ACTIVITIES

01/07/2009 rev 0

Isotope	Containers 240,250 and 260[2,4]	Containers 210 and 220[2,4]	Settler Tanks (Container 230)[2,3]	K-Basin Water[2,7]
Am-241	1.9e+01	6.7e+01	4.8e+02	2.2e-04
Np-237	4.5e-03	7.2e-03	2.9e-02	*
Pu-238	3.5e+00	1.2e+01	6.8e+01	4.3e-05
Pu-239	1.4e+01	4.1e+01	2.9e+02	2.6e-04
Pu-240	7.7e+00	2.5e+01	1.7e+02	2.6e-04
Pu-241	4.1e+02	1.0e+03	5.9e+03	*
Pu-242	3.7e-03	1.0e-02	6.3e-02	*
Co-60	9.9e-01	1.1e+00	7.8e-01	3.4e-04
Cs-134	7.6e-02	2.5e+00	2.9e+00	1.9e-03
Cs-137	3.1e+02	1.3e+03	7.8e+03	1.2e+00
(Ba-137m)[1]	2.9e+02	1.2e+03	7.0e+03	*
Eu-152	*	*	*	<8.0e-03
Eu-154	2.8e+00	9.4e+00	3.4e+01	<2.2e-04
Eu-155	1.4e+00	2.8e+00	1.2e+01	<5.0e-03
Sr-90	3.0e+02	1.3e+03	8.7e+03	1.5e-02
(Y-90)[1]	3.0e+02	1.3e+03	8.7e+03	*
Tc-99	1.3e-01	3.3e-01	2.1e+00	*
Sm-151	7.6e-02	2.5e+00	2.9e+00	*

1) Ba-137m and Y-90 assumed to be in equilibrium with parent materials Cs-137 and Sr-90, respectively, if values are not listed in table above the user can calculate values using standard health physics formulas or use values obtained when grouping photons, if using the Microshield program.
2) All Results are in Ci/m^3 and have been rounded to 2 significant digits.
3) Settler Sludge is based on KW Canister sludge from Table 4-21 of HNF-SD-SNF-TI-015 rev 13A, "Spent Nuclear Fuel Project Technical Data book, Vol.2, Sludge"
4) Values based on source term contained in table 5-3 of HNF-SD-SNF-TI-015 rev 14 Draft, "Spent Nuclear Fuel Project Technical Data book, Vol.2, Sludge"
5) *= No data provided
6) Density values, Containers 240,250,260 - 1.43g/cm^3, Containers 210,220 – 1.59 g/cm^3 (from KBC-37814 rev0), Settler Sludge Density 3.0 g/cm^3 (from HNF-SD-SNF-TI-015 rev 13A, table 4-1), K-basin Water Density 1.0 g/cm^3 (based on conservative assessment of standard pure water density)
7) Values are from Table 4-1 of SNF-SD-SNF-TI-009, rev 4 "105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities, Volume 2, Sludge", Radiological values are conservative and are not representative of bulk basin water, for those values use HNF-SD-SNF-TI-015 table 4-22 values.
8) Values in tables have not been decayed and are assumed to be produced on 5/31/1998, see section 3.4 of HNF-SD-SNF-TI-015 rev 13A, "Spent Nuclear Fuel Project Technical Data book, Vol.2, Sludge"
9) "<" symbol identifies data that were reported as "less than" values.
10) Values are reference only the values shall be verified against the source document prior to formalizing in shielding/dose rate calculations.

To compare calculations it was first necessary to verify that the source terms identified in Figure 5 are the same and that the geometry of the source will yield similar result as found in KBC-37814 (this is especially important in this case since different shielding codes are being employed, Microshield vs. MCNP). To accomplish this, calculations were conducted assuming an unshielded sample bottle containing 400 ml of settled sludge from each of the three defined source terms (containers 210/220, 240/250/260 and from settler sludge, see Microshield runs KBC40179_1,2 and 3). The results from these runs were compared against the results in KBC-37814 and are outlined in Table 1 below:

KBC-40179 REV 0

Table 1 - Comparison of Unshielded Sample Bottle Dose Rates

	Dose Rate (mr/hr)	Container 210/220	Container 240/250/260	Settler Sludge
Results for KBC-40179_1 KBC-40179_2 KBC-40179_3	1 inch	18540	4548	87230
	1 foot	990.2	244.3	4350
	1 meter	122.7	30.3	531.1
	10 feet	14.5	3.58	62.3
Results from ALARA Report KBC-37814	**1 cm***	**23491**	**5196**	N/A
	1 foot	1001	220.7	N/A
	1 meter	141.4	30.9	N/A
	10 feet	15.5	3.4	N/A

* MCNP allows for calculation of contact dose rates, the Microshield code is unreliable at distances less than 1 inch. Items N/A'ed were not part of the ALARA report calculations.

A review of the results of Table 1 shows, that the source term and geometry are comparable with the results that have been received in the previous ALARA report. This allows it to be said with some certainty, that this is a good model to work from and we can scale results obtained from the ALARA report, when necessary.

With the model validated, the next step was to determine a dose reduction factor (DRF) for the settler tanks, as was completed in Table 14 of KBC-37814. The dose reduction factor is used to relate calculated doses to those that have been found on the actual, field deployed equipment. The dose reduction factor is determine by calculating the expected dose using the maximum source term for settler sludge, as identified in Figure 5 and modeling it in the configuration of the settler tanks, the dose reduction factor is then the ratio of the highest dose rate calculated to the highest that was obtained using underwater radiation detection devised (results can be seen in Figure 6 below and were obtained 08/28/07 under work package 1K-07-03241)

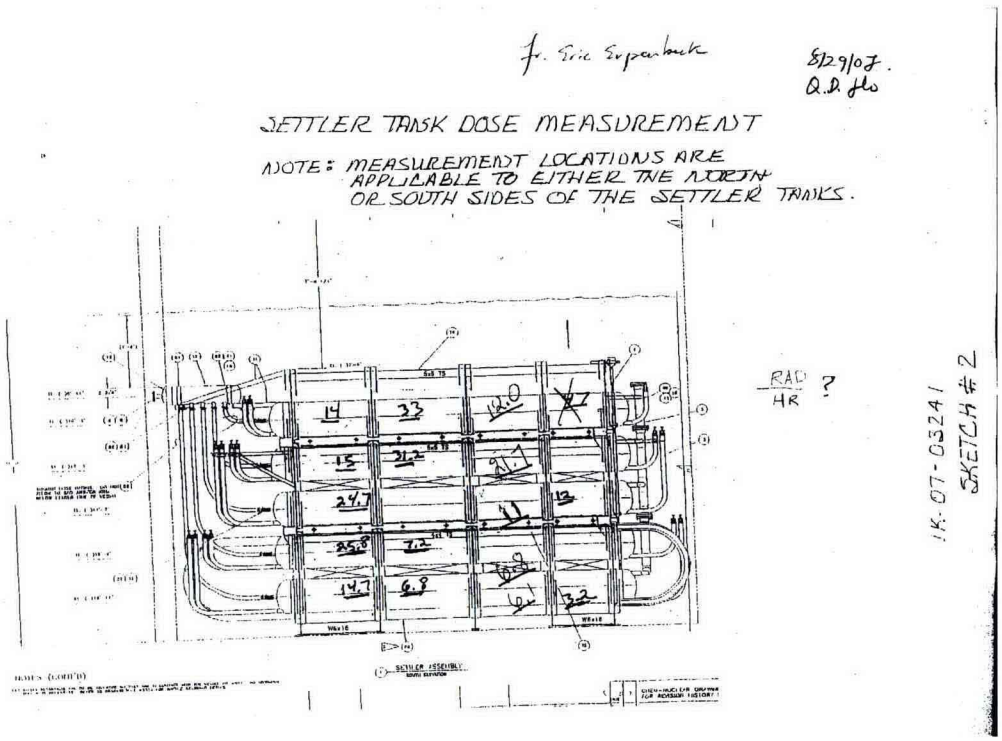

Figure 6 – Settler Tank Dose Rates

To complete the calculation to determine the highest calculated dose rate, a Microshield run was completed modeling the settler tanks as follows: 20 in diameter, 16 feet long, with skin of schedule 10 steel (0.25 inches). The model was then filled with settler sludge with an activity that was multiplied by 54%(see assumptions). This is a conservative assessment since the model had more self shielding than would normally be evident and lowers the maximum dose rate obtained thus reducing the dose reduction factor (See Microshield run KBC40179_4). Table 2 show the DRF that was calculated for the settler tanks, the table also lists for comparison, the DRF's calculated in KBC-37418

Table 2 Dose Reduction Factor

Container Material	Calculated Dose Rate, Rem/hr	Maximum measured dose rate, Rem/hr	Dose reduction factor
Settler Tank (Container 230)	363.9	33	11.0
Container 210/220	37.1	4	9.3
Container 240/250/260	12.5	9	1.4

The next portion of the assessment deals with calculating the various dose rates that can be anticipated from the unshielded sludge sample bottle (USSB). This was done by modeling a source in the shape of the Nalgene bottle, that contains 400 ml of settler sludge, and evaluating it at similar distances as were modeled in calculation, KBC-37418 (see Microshield run KBS-40179_3). The model used for USSB was then used in a calculation that was surrounded in lead shielding to simulate the bottle being placed in the sample cart shielded containers (see Microshield run KBS-40179_5). The results are presented in Table 3 below, also included in the table are the estimated dose rates for the sample lines that will be laying on the basin decking.

Table 3 Container Dose Rates Compared to Settler Dose Rates

Source and dose point locations	Containers 210 and 220		Containers 240/250, and 260		Settler Sludge (Container 230)	
	Calculated Dose Rate, mrem/h***	With Dose Reduction Factor, mrem/h	Calculated dose rate, mrem/h***	With Dose Reduction Factor, mrem/h	Calculated Dose Rate, mrem/hr***	With reduction factor, mrem/h
Unshielded Sludge Sample Bottle (USSB)						
1cm/1in*	23,491.0	2,531.2	5,196.5	3,749.3	87,230*	7930
1 ft	1,001.9	108.0	220.7	159.2	4350*	395
1 m	141.4	15.2	30.9	22.3	531*	48
10 ft	15.5	1.7	3.4	2.5	62*	5.6
Shielded Sample Bottle in Cart (PIG)						
1cm/1in*	165.7	17.8	35.1	25.3	605.2	55.0
1 ft	22.3	2.4	4.7	3.4	39.5	3.6
1 m	1.3	0.1	0.3	0.2	5.2	0.5
10 ft	0.2	0.0	0.0	0.0	0.6	0
Unshielded Sludge Sample Hose (USSL)**						
1cm/in*	8,388.7	903.9	1,783.4	1,286.7	36407	3309.7
1 ft	693.2	74.7	146.2	105.5	3008.5	273.5
1 m	131.7	14.2	27.9	20.2	571.6	52.0
10 ft	15.6	1.7	3.4	2.4	67.27	6.1

* Dose rates calculated using Microshield over estimate dose rates at very close distances ≤ 1inch to the source, and should be evaluated closely prior to us and with this overestimation in mind.

KBC-40179
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** Are items that are ratios from the ALARA report and Microshield calculation done for this assessment, the most conservative value of 4.34 was used to determine settler sludge unshielded sludge sample hose (USSL) dose rates.
***It is unlikely any dose rates will meet or exceed the calculated values, the calculations employ very conservative source terms and geometries

Using the information provided in Table 3 above, the values have been incorporated into the following tables so that the doses can be compared for above water sampling of container sampling and settler sampling. The spreadsheet was developed initially to calculate the collective dose for the container sampling activities (see letter 09-100K-GLH-003). The tables below utilize the same methodology, quantity of personnel, and times for the settler sampling only substituting dose rates calculated for settler sludge to determine the total collective dose.

Table 4
Collective Dose for Preparation of the Work Area and Setup of Sampling Equipment

	NCO's	5
	RCT's	2
	FWS	1
	Engineer	1
	TOTAL	9
This does not take into account the installation of the Extraction/Isolation tubes. Which is performed under a separate work package.	**Hours per day for this activity =**	**1.0**
	Shifts worked per day =	**1**
	Total Days Worked =	**5**
	Total Person-Hours =	45
	Highest Projected Dose Rate (2mr/hr) assigned (2 minutes) =	3 mrem
	Average Projected Dose Rate (1mr/hr) assigned (8 minutes) =	6 mrem
	Lowest Projected Dose Rate (0.5mr/hr) assigned (50 minutes) =	19 mrem
	Person-Dose in mrem =	28

Table 5
Collective Dose for Sample Collection

Supports the collection of 2 samples/day, changing out of bottle cap assembly unit, transferring of sample bottles to SSC, and transfer of SSC to Storage/Staging area.	NCO's	5
	RCT's	2
	FWS	1
	Engineer	1
	TOTAL	9
	Hours per day for this activity =	**2.0**
	Shifts worked per day =	**1**
	Total Days Worked =	**5**
	Total Person-Hours =	90
	Highest Projected Dose Rate (395mr/hr) assigned (2 minutes) =	1185 mrem
	Average Projected Dose Rate (48mr/hr) assigned (8 minutes) =	576 mrem
	Lowest Projected Dose Rate (2mr/hr) assigned (50 minutes) =	150 mrem
	Person-Dose in mrem =	1911

Table 6
Collective Dose for Sample Measurement and Shipment

If core is completed, remove T-handle from extraction tube.	NCO's	5
Confirm sludge depth, lift sample bottle from SSC	RCT's	2
after 12 hrs, measure sludge height, and perform	FWS	1
required surveys.	Engineer	1
	TOTAL	9
	Hours per day for this activity =	**1.0**
	Shifts worked per day =	**1**
	Total Days Worked =	**5**
	Total Person-Hours =	45
	Highest Projected Dose Rate (395mr/hr) assigned (2 minutes) =	592 mrem
	Average Projected Dose Rate (48mr/hr) assigned (2 minutes) =	72 mrem
	Lowest Projected Dose Rate (2mr/hr) assigned (56 minutes) =	84 mrem
	Person-Dose in mrem =	748

Table 7
Collective Dose for Contingency Work

Assume an extra 30 days for any additional	NCO's	5
installation of extraction and isolation tubes, complications,	RCT's	2
or work delays, that do not perform sludge sampling.	FWS	1
	Engineer	1
	TOTAL	9
	Hours per day for this activity =	**4.0**
	Shifts worked per day =	**1**
	Total Days Worked =	**30**
	Total Person-Hours =	1080
	Highest Projected Dose Rate (2mr/hr) assigned (2 minutes) =	72 mrem
	Average Projected Dose Rate (1mr/hr) assigned (8 minutes) =	144 mrem
	Lowest Projected Dose Rate (0.5mr/hr) assigned (50 minutes) =	450 mrem
	Person-Dose in mrem =	666

Table 8 Collective Dose Results		
• Assumes 10 samples pulled from Container SCS-CON-230. • Assume a maximum of 5 days to pull 10 sludge samples. • Average basin entry time for workers is ~4 hr/shift. • Assume an extra 30 days for any additional installation of extraction and isolation tubes, complications, or work delays. • Assume only day shift will support the KW Basin Sludge Sampling campaign. • Spreadsheet is based letter 09-100K-GLH-003	**Activity**	**Collective Dose**
	Preparation of the Work Area and Setup of Sampling Equipment – Table 4	28 person-mrem
	Sample Collection – Table 5	1911 person-mrem
	Sample Measurement and Shipment – Table 6	685 person-mrem
	Contingency Work – Table 7	666 person-mrem
	Total Collective Dose	**3290** person-mrem
	Average Dose per Sample	329 person-mrem
	Total person-hours	1260 hours

Cost/Benefit analysis:

The total collective dose anticipated for settler sampling, Table 8 above, is 3.290 person-Rem, with the average per sample dose being 0.329 person-Rem. This dose compares to the total anticipated collective dose for the Container Sludge sampling of 5.453 person-Rem, with the average per sample dose being 0.101 person-Rem.

For the purpose of this assessment it is assumed that the retrieval of settler sludge via the underwater method will result in no personnel dose (most conservative estimate possible). Therefore, the cost-benefit analysis will use a total calculated person-dose for above water settler sludge sampling of 3.290 person-rem. The ALARA dose decision value for optimization is procedurally established at $25,000/person-rem (per PRO-24889). Therefore, expenditure of funds of up to $82,250 could be justified to avoid an estimated collective dose of 3.290 person-rem.

Conclusion:

While the dose rates for the unshielded settler sludge samples are anticipated to be higher than container sludge sampling, the collective dose is measurably lower. Controls that have been or that will be put in place for container sludge sampling will help further reduce collective doses, and by using the same sampling technique for settler sludge, operational lessons learned can be applied. Additionally, using the sampling process that operators have experience with could contribute to fewer unanticipated radiological events, which in themselves can be a significant contributor to workers collective dose.

The current STP project cost projections to design and construct underwater settler sludge sampling equipment are estimated to be $2,500,000 (per A21C-PL-001 Rev0E). This cost cannot be justified for the sole purpose of personnel dose reduction. Other operational considerations that may warrant underwater sampling of settler sludge are not evaluated in this assessment.

KBC-40179 REV 0

MicroShield 7.02
DOE (7.02-0000)

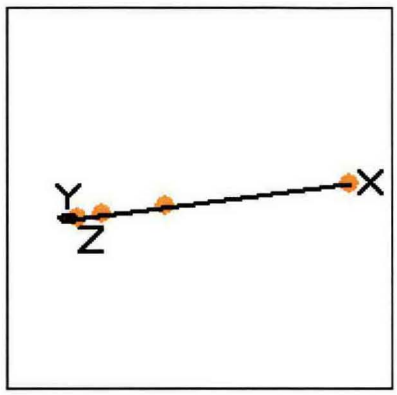
Date	By	Checked
1/30/2009	L. NELSEN	PER TELECON B. ELDER

Filename	Run Date	Run Time	Duration
KBC40179_1.ms7	January 30, 2009	10:22:46 AM	00:00:02

Project Info	
Case Title	Sample Bottle Unsh
Description	Sample Bottle from 210/220 400ml
Geometry	7 - Cylinder Volume - Side Shields

Source Dimensions	
Height	2.195 cm (0.9 in)
Radius	7.62 cm (3.0 in)

Dose Points			
A	X	Y	Z
#1	10.643 cm (4.2 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#2	38.583 cm (1 ft 3.2 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#3	108.1 cm (3 ft 6.6 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#4	312.903 cm (10 ft 3.2 in)	1.244 cm (0.5 in)	0.0 cm (0.0 in)



Shields			
Shield N	Dimension	Material	Density
Source	400.4 cm³	Water	1.59
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	.48 cm	Water	1
Top Clad	.48 cm	Water	1

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

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Am-241	2.7027e-002	1.0000e+009	6.7500e+001	2.4975e+006
Ba-137m	4.8448e-001	1.7926e+010	1.2100e+003	4.4770e+007
Co-60	4.4044e-004	1.6296e+007	1.1000e+000	4.0700e+004
Cs-134	1.0050e-003	3.7185e+007	2.5100e+000	9.2870e+004
Cs-137	5.1251e-001	1.8963e+010	1.2800e+003	4.7360e+007
Eu-154	3.7518e-003	1.3881e+008	9.3700e+000	3.4669e+005
Eu-155	1.1171e-003	4.1333e+007	2.7900e+000	1.0323e+005
Np-237	2.8869e-006	1.0681e+005	7.2100e-003	2.6677e+002
Pu-238	4.6446e-003	1.7185e+008	1.1600e+001	4.2920e+005
Pu-239	1.6496e-002	6.1037e+008	4.1200e+001	1.5244e+006

KBC-40179
REV0

Pu-240	1.0010e-002	3.7037e+008	2.5000e+001	9.2500e+005
Pu-241	4.1642e-001	1.5407e+010	1.0400e+003	3.8480e+007
Pu-242	4.0440e-006	1.4963e+005	1.0100e-002	3.7370e+002
Sm-151	1.0130e-003	3.7481e+007	2.5300e+000	9.3610e+004
Sr-90	5.0450e-001	1.8667e+010	1.2600e+003	4.6620e+007
Tc-99	1.3173e-004	4.8741e+006	3.2900e-001	1.2173e+004
Y-90	5.0450e-001	1.8667e+010	1.2600e+003	4.6620e+007

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

Results - Dose Point # 1 - (10.6426,1.2446,0) 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
0.0306	2.450e+09	1.512e+04	3.467e+04	1.408e+02	3.230e+02
0.114	7.973e+07	3.376e+03	1.226e+04	5.230e+00	1.898e+01
0.1881	3.174e+05	2.457e+01	6.775e+01	4.276e-02	1.179e-01
0.2479	9.165e+06	9.920e+02	2.334e+03	1.827e+00	4.300e+00
0.2769	1.316e+04	1.630e+00	3.608e+00	3.057e-03	6.768e-03
0.4318	9.904e+05	2.111e+02	3.866e+02	4.130e-01	7.563e-01
0.4764	8.435e+05	2.027e+02	3.578e+02	3.978e-01	7.020e-01
0.5668	9.209e+06	2.737e+03	4.554e+03	5.357e+00	8.915e+00
0.6024	4.459e+07	1.427e+04	2.330e+04	2.785e+01	4.547e+01
0.6617	1.613e+10	5.790e+06	9.179e+06	1.122e+04	1.779e+04
0.7281	3.580e+07	1.444e+04	2.224e+04	2.774e+01	4.273e+01
0.7968	3.565e+07	1.604e+04	2.410e+04	3.052e+01	4.585e+01
0.8723	1.769e+07	8.883e+03	1.305e+04	1.671e+01	2.455e+01
0.904	1.143e+06	5.995e+02	8.734e+02	1.123e+00	1.635e+00
1.0017	3.912e+07	2.323e+04	3.307e+04	4.281e+01	6.094e+01
1.0416	5.689e+05	3.542e+02	4.998e+02	6.482e-01	9.146e-01
1.1313	8.130e+05	5.592e+02	7.744e+02	1.007e+00	1.395e+00
1.173	1.697e+07	1.219e+04	1.675e+04	2.178e+01	2.993e+01
1.2737	5.070e+07	4.022e+04	5.427e+04	7.054e+01	9.519e+01
1.3325	1.630e+07	1.365e+04	1.824e+04	2.368e+01	3.165e+01
1.3652	1.130e+06	9.745e+02	1.296e+03	1.680e+00	2.235e+00
1.4944	9.017e+05	8.660e+02	1.132e+03	1.459e+00	1.906e+00
1.5952	3.991e+06	4.143e+03	5.350e+03	6.853e+00	8.850e+00
Totals	**1.895e+10**	**5.963e+06**	**9.449e+06**	**1.165e+04**	**1.854e+04**

Results - Dose Point # 2 - (38.5826,1.2446,0) 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

KBC-40179
REVO

0.0306	2.450e+09	5.646e+02	1.410e+03	5.260e+00	1.313e+01
0.114	7.973e+07	1.448e+02	6.804e+02	2.243e-01	1.054e+00
0.1881	3.174e+05	1.083e+00	3.748e+00	1.884e-03	6.523e-03
0.2479	9.165e+06	4.442e+01	1.279e+02	8.183e-02	2.356e-01
0.2769	1.316e+04	7.345e-02	1.967e-01	1.378e-04	3.690e-04
0.4318	9.904e+05	9.779e+00	2.085e+01	1.913e-02	4.079e-02
0.4764	8.435e+05	9.449e+00	1.926e+01	1.854e-02	3.779e-02
0.5668	9.209e+06	1.289e+02	2.446e+02	2.524e-01	4.788e-01
0.6024	4.459e+07	6.750e+02	1.251e+03	1.317e+00	2.440e+00
0.6617	1.613e+10	2.754e+05	4.922e+05	5.339e+02	9.542e+02
0.7281	3.580e+07	6.907e+02	1.191e+03	1.327e+00	2.290e+00
0.7968	3.565e+07	7.716e+02	1.290e+03	1.468e+00	2.455e+00
0.8723	1.769e+07	4.297e+02	6.986e+02	8.086e-01	1.315e+00
0.904	1.143e+06	2.907e+01	4.676e+01	5.442e-02	8.755e-02
1.0017	3.912e+07	1.133e+03	1.771e+03	2.088e+00	3.263e+00
1.0416	5.689e+05	1.732e+01	2.676e+01	3.169e-02	4.898e-02
1.1313	8.130e+05	2.747e+01	4.148e+01	4.947e-02	7.470e-02
1.173	1.697e+07	6.001e+02	8.970e+02	1.072e+00	1.603e+00
1.2737	5.070e+07	1.989e+03	2.908e+03	3.489e+00	5.100e+00
1.3325	1.630e+07	6.767e+02	9.774e+02	1.174e+00	1.696e+00
1.3652	1.130e+06	4.839e+01	6.945e+01	8.345e-02	1.198e-01
1.4944	9.017e+05	4.322e+01	6.066e+01	7.279e-02	1.022e-01
1.5952	3.991e+06	2.075e+02	2.869e+02	3.432e-01	4.746e-01
Totals	**1.895e+10**	**2.836e+05**	**5.062e+05**	**5.531e+02**	**9.902e+02**

Results - Dose Point # 3 - (108.1,1.2446,0) 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
0.0306	2.450e+09	6.386e+01	1.638e+02	5.949e-01	1.526e+00
0.114	7.973e+07	1.703e+01	8.478e+01	2.638e-02	1.313e-01
0.1881	3.174e+05	1.282e-01	4.671e-01	2.232e-04	8.130e-04
0.2479	9.165e+06	5.281e+00	1.592e+01	9.729e-03	2.932e-02
0.2769	1.316e+04	8.747e-03	2.446e-02	1.641e-05	4.588e-05
0.4318	9.904e+05	1.172e+00	2.588e+00	2.294e-03	5.063e-03
0.4764	8.435e+05	1.134e+00	2.390e+00	2.226e-03	4.689e-03
0.5668	9.209e+06	1.552e+01	3.033e+01	3.038e-02	5.937e-02
0.6024	4.459e+07	8.132e+01	1.551e+02	1.587e-01	3.026e-01
0.6617	1.613e+10	3.323e+04	6.102e+04	6.441e+01	1.183e+02
0.7281	3.580e+07	8.345e+01	1.477e+02	1.604e-01	2.838e-01
0.7968	3.565e+07	9.335e+01	1.599e+02	1.776e-01	3.044e-01
0.8723	1.769e+07	5.206e+01	8.660e+01	9.795e-02	1.629e-01
0.904	1.143e+06	3.523e+00	5.796e+00	6.596e-03	1.085e-02
1.0017	3.912e+07	1.375e+02	2.195e+02	2.534e-01	4.045e-01
1.0416	5.689e+05	2.103e+00	3.318e+00	3.849e-03	6.072e-03
1.1313	8.130e+05	3.340e+00	5.142e+00	6.014e-03	9.261e-03

KBC-40179
Rev 0

1.173	1.697e+07	7.299e+01	1.112e+02	1.304e-01	1.987e-01
1.2737	5.070e+07	2.422e+02	3.605e+02	4.249e-01	6.323e-01
1.3325	1.630e+07	8.245e+01	1.212e+02	1.431e-01	2.103e-01
1.3652	1.130e+06	5.898e+00	8.612e+00	1.017e-02	1.485e-02
1.4944	9.017e+05	5.274e+00	7.523e+00	8.882e-03	1.267e-02
1.5952	3.991e+06	2.534e+01	3.559e+01	4.192e-02	5.887e-02
Totals	**1.895e+10**	**3.422e+04**	**6.275e+04**	**6.670e+01**	**1.227e+02**

Results - Dose Point # 4 - (312.9026,1.243584,0) 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
0.0306	2.450e+09	6.848e+00	1.831e+01	6.380e-02	1.706e-01
0.114	7.973e+07	1.922e+00	1.007e+01	2.976e-03	1.560e-02
0.1881	3.174e+05	1.456e-02	5.545e-02	2.535e-05	9.651e-05
0.2479	9.165e+06	6.022e-01	1.887e+00	1.109e-03	3.477e-03
0.2769	1.316e+04	9.989e-04	2.898e-03	1.874e-06	5.436e-06
0.4318	9.904e+05	1.347e-01	3.061e-01	2.635e-04	5.988e-04
0.4764	8.435e+05	1.305e-01	2.826e-01	2.561e-04	5.544e-04
0.5668	9.209e+06	1.790e+00	3.585e+00	3.504e-03	7.018e-03
0.6024	4.459e+07	9.386e+00	1.833e+01	1.832e-02	3.577e-02
0.6617	1.613e+10	3.840e+03	7.211e+03	7.444e+00	1.398e+01
0.7281	3.580e+07	9.655e+00	1.745e+01	1.855e-02	3.354e-02
0.7968	3.565e+07	1.081e+01	1.890e+01	2.058e-02	3.596e-02
0.8723	1.769e+07	6.036e+00	1.023e+01	1.136e-02	1.925e-02
0.904	1.143e+06	4.086e-01	6.848e-01	7.651e-04	1.282e-03
1.0017	3.912e+07	1.597e+01	2.594e+01	2.944e-02	4.780e-02
1.0416	5.689e+05	2.444e-01	3.920e-01	4.472e-04	7.174e-04
1.1313	8.130e+05	3.885e-01	6.077e-01	6.996e-04	1.094e-03
1.173	1.697e+07	8.493e+00	1.314e+01	1.518e-02	2.349e-02
1.2737	5.070e+07	2.821e+01	4.260e+01	4.949e-02	7.473e-02
1.3325	1.630e+07	9.608e+00	1.432e+01	1.667e-02	2.485e-02
1.3652	1.130e+06	6.874e-01	1.018e+00	1.185e-03	1.755e-03
1.4944	9.017e+05	6.153e-01	8.892e-01	1.036e-03	1.498e-03
1.5952	3.991e+06	2.958e+00	4.207e+00	4.894e-03	6.959e-03
Totals	**1.895e+10**	**3.955e+03**	**7.415e+03**	**7.704e+00**	**1.449e+01**

KBC-40179
REV 0

MicroShield 7.02
DOE (7.02-0000)

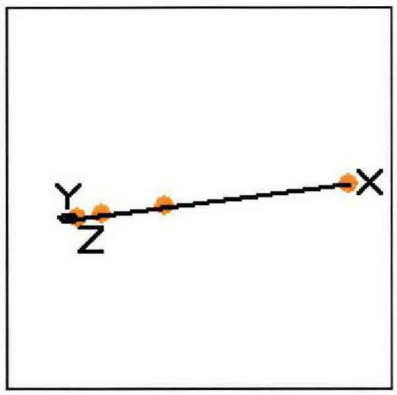
Date	By	Checked
1/30/2009	L. NELSON	PER TELECON B. ELDER

Filename	Run Date	Run Time	Duration
KBC40179_2.ms7	January 30, 2009	10:23:25 AM	00:00:02

Project Info	
Case Title	Sample Bottle Unsh
Description	Sample Bottle 240/250/260 400ml
Geometry	7 - Cylinder Volume - Side Shields

Source Dimensions	
Height	2.195 cm (0.9 in)
Radius	7.62 cm (3.0 in)

Dose Points			
A	X	Y	Z
#1	10.643 cm (4.2 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#2	38.583 cm (1 ft 3.2 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#3	108.1 cm (3 ft 6.6 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#4	312.903 cm (10 ft 3.2 in)	1.244 cm (0.5 in)	0.0 cm (0.0 in)



Shields			
Shield N	Dimension	Material	Density
Source	400.4 cm³	Water	1.43
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	.48 cm	Water	1
Top Clad	.48 cm	Water	1

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

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Am-241	7.7277e-003	2.8593e+008	1.9300e+001	7.1410e+005
Ba-137m	1.1572e-001	4.2815e+009	2.8900e+002	1.0693e+007
Co-60	3.9800e-004	1.4726e+007	9.9400e-001	3.6778e+004
Cs-134	3.0470e-005	1.1274e+006	7.6100e-002	2.8157e+003
Cs-137	1.2252e-001	4.5333e+009	3.0600e+002	1.1322e+007
Eu-154	1.1091e-003	4.1037e+007	2.7700e+000	1.0249e+005
Eu-155	5.7658e-004	2.1333e+007	1.4400e+000	5.3280e+004
Np-237	1.8018e-006	6.6667e+004	4.5000e-003	1.6650e+002
Pu-238	1.4174e-003	5.2444e+007	3.5400e+000	1.3098e+005
Pu-239	5.6056e-005	2.0741e+006	1.4000e-001	5.1800e+003

KBC-40179
REV 0

Pu-240	3.0711e-003	1.1363e+008	7.6700e+000	2.8379e+005
Pu-241	1.6537e-001	6.1185e+009	4.1300e+002	1.5281e+007
Pu-242	1.4815e-006	5.4815e+004	3.7000e-003	1.3690e+002
Sm-151	3.0470e-005	1.1274e+006	7.6100e-002	2.8157e+003
Sr-90	1.2132e-001	4.4889e+009	3.0300e+002	1.1211e+007
Tc-99	5.3654e-005	1.9852e+006	1.3400e-001	4.9580e+003
Y-90	1.2132e-001	4.4889e+009	3.0300e+002	1.1211e+007

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

Results - Dose Point # 1 - (10.6426,1.2446,0) 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
0.031	6.276e+08	4.300e+03	9.900e+03	3.875e+01	8.922e+01
0.1106	2.821e+07	1.228e+03	4.307e+03	1.894e+00	6.644e+00
0.1879	9.451e+04	7.748e+00	2.038e+01	1.348e-02	3.546e-02
0.2479	2.709e+06	3.102e+02	6.984e+02	5.714e-01	1.287e+00
0.2769	3.991e+02	5.220e-02	1.108e-01	9.792e-05	2.079e-04
0.4318	2.928e+05	6.560e+01	1.160e+02	1.283e-01	2.270e-01
0.4778	1.053e+05	2.667e+01	4.547e+01	5.234e-02	8.923e-02
0.5645	3.733e+05	1.157e+02	1.868e+02	2.264e-01	3.658e-01
0.596	3.553e+06	1.176e+03	1.868e+03	2.296e+00	3.648e+00
0.6617	3.853e+09	1.446e+06	2.227e+06	2.803e+03	4.318e+03
0.7281	1.058e+07	4.457e+03	6.678e+03	8.565e+00	1.283e+01
0.7993	1.252e+06	5.899e+02	8.624e+02	1.122e+00	1.641e+00
0.8723	5.229e+06	2.736e+03	3.919e+03	5.149e+00	7.374e+00
0.904	3.379e+05	1.846e+02	2.623e+02	3.456e-01	4.911e-01
1.0017	1.157e+07	7.143e+03	9.929e+03	1.316e+01	1.830e+01
1.046	6.954e+04	4.522e+01	6.229e+01	8.270e-02	1.139e-01
1.1313	2.403e+05	1.716e+02	2.325e+02	3.091e-01	4.187e-01
1.1732	1.475e+07	1.100e+04	1.478e+04	1.965e+01	2.642e+01
1.2737	1.499e+07	1.233e+04	1.629e+04	2.162e+01	2.857e+01
1.3325	1.473e+07	1.278e+04	1.673e+04	2.216e+01	2.903e+01
1.3652	3.427e+04	3.060e+01	3.989e+01	5.277e-02	6.879e-02
1.4944	2.666e+05	2.648e+02	3.395e+02	4.460e-01	5.718e-01
1.5952	1.180e+06	1.266e+03	1.605e+03	2.094e+00	2.655e+00
Totals	**4.591e+09**	**1.506e+06**	**2.316e+06**	**2.942e+03**	**4.548e+03**

Results - Dose Point # 2 - (38.5826,1.2446,0) 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

KBC-40179
REV 0

0.031	6.276e+08	1.641e+02	4.140e+02	1.479e+00	3.731e+00
0.1106	2.821e+07	5.358e+01	2.421e+02	8.264e-02	3.735e-01
0.1879	9.451e+04	3.476e-01	1.139e+00	6.050e-04	1.982e-03
0.2479	2.709e+06	1.413e+01	3.860e+01	2.604e-02	7.111e-02
0.2769	3.991e+02	2.393e-03	6.092e-03	4.489e-06	1.143e-05
0.4318	2.928e+05	3.087e+00	6.302e+00	6.040e-03	1.233e-02
0.4778	1.053e+05	1.263e+00	2.465e+00	2.478e-03	4.837e-03
0.5645	3.733e+05	5.529e+00	1.010e+01	1.082e-02	1.978e-02
0.596	3.553e+06	5.637e+01	1.009e+02	1.101e-01	1.971e-01
0.6617	3.853e+09	6.976e+04	1.202e+05	1.352e+02	2.330e+02
0.7281	1.058e+07	2.162e+02	3.600e+02	4.155e-01	6.919e-01
0.7993	1.252e+06	2.877e+01	4.646e+01	5.472e-02	8.838e-02
0.8723	5.229e+06	1.341e+02	2.111e+02	2.523e-01	3.971e-01
0.904	3.379e+05	9.063e+00	1.413e+01	1.697e-02	2.645e-02
1.0017	1.157e+07	3.527e+02	5.347e+02	6.500e-01	9.854e-01
1.046	6.954e+04	2.239e+00	3.355e+00	4.094e-03	6.135e-03
1.1313	2.403e+05	8.532e+00	1.252e+01	1.536e-02	2.255e-02
1.1732	1.475e+07	5.477e+02	7.961e+02	9.788e-01	1.423e+00
1.2737	1.499e+07	6.165e+02	8.773e+02	1.081e+00	1.539e+00
1.3325	1.473e+07	6.406e+02	9.013e+02	1.111e+00	1.564e+00
1.3652	3.427e+04	1.536e+00	2.149e+00	2.649e-03	3.705e-03
1.4944	2.666e+05	1.336e+01	1.829e+01	2.249e-02	3.081e-02
1.5952	1.180e+06	6.405e+01	8.650e+01	1.059e-01	1.431e-01
Totals	**4.591e+09**	**7.269e+04**	**1.249e+05**	**1.417e+02**	**2.443e+02**

Results - Dose Point # 3 - (108.1,1.2446,0) 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
0.031	6.276e+08	1.864e+01	4.837e+01	1.680e-01	4.359e-01
0.1106	2.821e+07	6.322e+00	3.027e+01	9.751e-03	4.669e-02
0.1879	9.451e+04	4.131e-02	1.423e-01	7.189e-05	2.476e-04
0.2479	2.709e+06	1.686e+00	4.814e+00	3.106e-03	8.869e-03
0.2769	3.991e+02	2.859e-04	7.590e-04	5.364e-07	1.424e-06
0.4318	2.928e+05	3.712e-01	7.834e-01	7.262e-04	1.533e-03
0.4778	1.053e+05	1.520e-01	3.063e-01	2.984e-04	6.010e-04
0.5645	3.733e+05	6.673e-01	1.255e+00	1.306e-03	2.456e-03
0.596	3.553e+06	6.810e+00	1.253e+01	1.330e-02	2.448e-02
0.6617	3.853e+09	8.439e+03	1.492e+04	1.636e+01	2.893e+01
0.7281	1.058e+07	2.619e+01	4.469e+01	5.033e-02	8.588e-02
0.7993	1.252e+06	3.489e+00	5.767e+00	6.637e-03	1.097e-02
0.8723	5.229e+06	1.628e+01	2.619e+01	3.064e-02	4.929e-02
0.904	3.379e+05	1.101e+00	1.753e+00	2.062e-03	3.282e-03
1.0017	1.157e+07	4.291e+01	6.637e+01	7.907e-02	1.223e-01
1.046	6.954e+04	2.725e-01	4.164e-01	4.983e-04	7.614e-04
1.1313	2.403e+05	1.040e+00	1.554e+00	1.872e-03	2.799e-03

KBC-40179
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1.1732	1.475e+07	6.677e+01	9.882e+01	1.193e-01	1.766e-01
1.2737	1.499e+07	7.524e+01	1.089e+02	1.320e-01	1.910e-01
1.3325	1.473e+07	7.821e+01	1.119e+02	1.357e-01	1.941e-01
1.3652	3.427e+04	1.876e-01	2.667e-01	3.235e-04	4.599e-04
1.4944	2.666e+05	1.633e+00	2.271e+00	2.750e-03	3.824e-03
1.5952	1.180e+06	7.837e+00	1.074e+01	1.296e-02	1.776e-02
Totals	**4.591e+09**	**8.795e+03**	**1.550e+04**	**1.713e+01**	**3.031e+01**

Results - Dose Point # 4 - (312.9026,1.243584,0) 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**
0.031	6.276e+08	2.003e+00	5.424e+00	1.805e-02	4.889e-02
0.1106	2.821e+07	7.139e-01	3.603e+00	1.101e-03	5.557e-03
0.1879	9.451e+04	4.698e-03	1.692e-02	8.176e-06	2.944e-05
0.2479	2.709e+06	1.925e-01	5.715e-01	3.546e-04	1.053e-03
0.2769	3.991e+02	3.269e-05	9.003e-05	6.133e-08	1.689e-07
0.4318	2.928e+05	4.270e-02	9.274e-02	8.354e-05	1.814e-04
0.4778	1.053e+05	1.751e-02	3.625e-02	3.437e-05	7.113e-05
0.5645	3.733e+05	7.703e-02	1.484e-01	1.508e-04	2.905e-04
0.596	3.553e+06	7.867e-01	1.483e+00	1.536e-03	2.895e-03
0.6617	3.853e+09	9.761e+02	1.765e+03	1.892e+00	3.421e+00
0.7281	1.058e+07	3.033e+00	5.284e+00	5.828e-03	1.016e-02
0.7993	1.252e+06	4.045e-01	6.818e-01	7.695e-04	1.297e-03
0.8723	5.229e+06	1.890e+00	3.097e+00	3.556e-03	5.827e-03
0.904	3.379e+05	1.278e-01	2.073e-01	2.394e-04	3.881e-04
1.0017	1.157e+07	4.988e+00	7.847e+00	9.192e-03	1.446e-02
1.046	6.954e+04	3.169e-02	4.923e-02	5.795e-05	9.002e-05
1.1313	2.403e+05	1.210e-01	1.837e-01	2.179e-04	3.309e-04
1.1732	1.475e+07	7.775e+00	1.168e+01	1.390e-02	2.088e-02
1.2737	1.499e+07	8.769e+00	1.288e+01	1.538e-02	2.258e-02
1.3325	1.473e+07	9.120e+00	1.323e+01	1.582e-02	2.295e-02
1.3652	3.427e+04	2.188e-02	3.154e-02	3.774e-05	5.438e-05
1.4944	2.666e+05	1.907e-01	2.685e-01	3.211e-04	4.522e-04
1.5952	1.180e+06	9.156e-01	1.270e+00	1.515e-03	2.101e-03
Totals	**4.591e+09**	**1.017e+03**	**1.833e+03**	**1.981e+00**	**3.582e+00**

KBC-40179
REVD

MicroShield 7.02
DOE (7.02-0000)

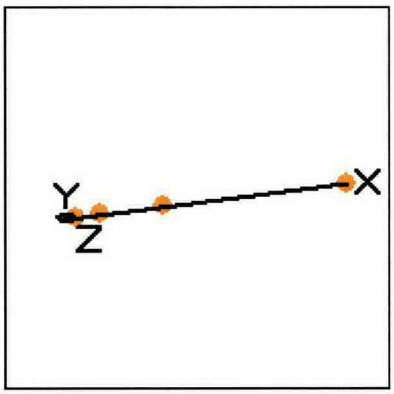
Date	By	Checked
1-30-2009	L. NELSON	PER FALCON B. ELDER

Filename	Run Date	Run Time	Duration
KBC40179_3.ms7	January 30, 2009	10:23:42 AM	00:00:03

Project Info	
Case Title	Sample Bottle Unsh
Description	Sample Bottle Settler 400ml
Geometry	7 - Cylinder Volume - Side Shields

Source Dimensions	
Height	2.195 cm (0.9 in)
Radius	7.62 cm (3.0 in)

Dose Points			
A	X	Y	Z
#1	10.643 cm (4.2 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#2	38.583 cm (1 ft 3.2 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#3	108.1 cm (3 ft 6.6 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#4	312.903 cm (10 ft 3.2 in)	1.244 cm (0.5 in)	0.0 cm (0.0 in)



Shields			
Shield N	Dimension	Material	Density
Source	400.4 cm³	Concrete	3
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	.48 cm	Water	1
Top Clad	.48 cm	Water	1

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

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Am-241	1.9139e-001	7.0815e+009	4.7800e+002	1.7686e+007
Ba-137m	2.8148e+000	1.0415e+011	7.0300e+003	2.6011e+008
Co-60	3.1071e-004	1.1496e+007	7.7600e-001	2.8712e+004
Cs-134	1.1411e-003	4.2222e+007	2.8500e+000	1.0545e+005
Cs-137	3.1271e+000	1.1570e+011	7.8100e+003	2.8897e+008
Eu-154	1.3493e-002	4.9926e+008	3.3700e+001	1.2469e+006
Eu-155	4.7247e-003	1.7481e+008	1.1800e+001	4.3660e+005
Np-237	1.1451e-005	4.2370e+005	2.8600e-002	1.0582e+003
Pu-238	2.7227e-002	1.0074e+009	6.8000e+001	2.5160e+006
Pu-239	1.1491e-001	4.2519e+009	2.8700e+002	1.0619e+007

KBC-40179
REV 0

Pu-240	6.9269e-002	2.5630e+009	1.7300e+002	6.4010e+006
Pu-241	2.3704e+000	8.7704e+010	5.9200e+003	2.1904e+008
Pu-242	2.5065e-005	9.2741e+005	6.2600e-002	2.3162e+003
Sm-151	1.1411e-003	4.2222e+007	2.8500e+000	1.0545e+005
Sr-90	3.4995e+000	1.2948e+011	8.7400e+003	3.2338e+008
Tc-99	8.4484e-004	3.1259e+007	2.1100e+000	7.8070e+004
Y-90	3.4995e+000	1.2948e+011	8.7400e+003	3.2338e+008

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

Results - Dose Point # 1 - (10.6426,1.2446,0) 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
0.0308	1.522e+10	2.017e+04	2.461e+04	1.854e+02	2.262e+02
0.1122	3.076e+08	8.416e+03	2.157e+04	1.300e+01	3.334e+01
0.1881	1.142e+06	6.229e+01	1.526e+02	1.084e-01	2.655e-01
0.2479	3.296e+07	2.565e+03	5.891e+03	4.725e+00	1.085e+01
0.2769	1.495e+04	1.339e+00	2.986e+00	2.512e-03	5.601e-03
0.4318	3.562e+06	5.641e+02	1.105e+03	1.104e+00	2.162e+00
0.4772	1.697e+06	3.056e+02	5.821e+02	5.997e-01	1.142e+00
0.5661	1.133e+07	2.540e+03	4.598e+03	4.972e+00	9.001e+00
0.5994	7.105e+07	1.714e+04	3.051e+04	3.346e+01	5.955e+01
0.6617	9.372e+10	2.567e+07	4.439e+07	4.976e+04	8.607e+04
0.7281	1.288e+08	3.987e+04	6.718e+04	7.662e+01	1.291e+02
0.7975	4.207e+07	1.464e+04	2.409e+04	2.786e+01	4.583e+01
0.8723	6.362e+07	2.484e+04	3.996e+04	4.674e+01	7.518e+01
0.904	4.111e+06	1.681e+03	2.680e+03	3.147e+00	5.017e+00
1.0017	1.407e+08	6.559e+04	1.020e+05	1.209e+02	1.880e+02
1.0441	1.131e+06	5.560e+02	8.558e+02	1.017e+00	1.566e+00
1.1313	2.924e+06	1.593e+03	2.404e+03	2.868e+00	4.329e+00
1.1729	1.226e+07	6.991e+03	1.046e+04	1.249e+01	1.869e+01
1.2737	1.824e+08	1.155e+05	1.696e+05	2.027e+02	2.974e+02
1.3325	1.150e+07	7.714e+03	1.121e+04	1.338e+01	1.944e+01
1.3652	1.284e+06	8.882e+02	1.283e+03	1.532e+00	2.213e+00
1.4944	3.243e+06	2.516e+03	3.567e+03	4.238e+00	6.007e+00
1.5952	1.435e+07	1.209e+04	1.693e+04	2.000e+01	2.800e+01
Totals	**1.100e+11**	**2.601e+07**	**4.494e+07**	**5.054e+04**	**8.723e+04**

Results - Dose Point # 2 - (38.5826,1.2446,0) 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

KBC-40179
REV0

0.0308	1.522e+10	6.209e+02	7.621e+02	5.707e+00	7.006e+00
0.1122	3.076e+08	3.217e+02	9.465e+02	4.972e-01	1.463e+00
0.1881	1.142e+06	2.480e+00	7.156e+00	4.317e-03	1.246e-02
0.2479	3.296e+07	1.041e+02	2.821e+02	1.919e-01	5.196e-01
0.2769	1.495e+04	5.482e-02	1.439e-01	1.028e-04	2.699e-04
0.4318	3.562e+06	2.386e+01	5.439e+01	4.668e-02	1.064e-01
0.4772	1.697e+06	1.303e+01	2.875e+01	2.556e-02	5.641e-02
0.5661	1.133e+07	1.097e+02	2.283e+02	2.147e-01	4.470e-01
0.5994	7.105e+07	7.437e+02	1.518e+03	1.452e+00	2.963e+00
0.6617	9.372e+10	1.122e+06	2.216e+06	2.176e+03	4.296e+03
0.7281	1.288e+08	1.757e+03	3.363e+03	3.376e+00	6.463e+00
0.7975	4.207e+07	6.498e+02	1.209e+03	1.236e+00	2.301e+00
0.8723	6.362e+07	1.111e+03	2.011e+03	2.090e+00	3.784e+00
0.904	4.111e+06	7.535e+01	1.350e+02	1.411e-01	2.528e-01
1.0017	1.407e+08	2.966e+03	5.155e+03	5.465e+00	9.499e+00
1.0441	1.131e+06	2.522e+01	4.331e+01	4.614e-02	7.922e-02
1.1313	2.924e+06	7.272e+01	1.219e+02	1.310e-01	2.196e-01
1.1729	1.226e+07	3.201e+02	5.312e+02	5.721e-01	9.494e-01
1.2737	1.824e+08	5.326e+03	8.633e+03	9.341e+00	1.514e+01
1.3325	1.150e+07	3.569e+02	5.713e+02	6.191e-01	9.912e-01
1.3652	1.284e+06	4.117e+01	6.547e+01	7.099e-02	1.129e-01
1.4944	3.243e+06	1.174e+02	1.825e+02	1.978e-01	3.073e-01
1.5952	1.435e+07	5.673e+02	8.675e+02	9.383e-01	1.435e+00
Totals	**1.100e+11**	**1.138e+06**	**2.243e+06**	**2.208e+03**	**4.350e+03**

Results - Dose Point # 3 - (108.1,1.2446,0) 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**
0.0308	1.522e+10	6.775e+01	8.347e+01	6.227e-01	7.673e-01
0.1122	3.076e+08	3.708e+01	1.125e+02	5.730e-02	1.738e-01
0.1881	1.142e+06	2.884e-01	8.616e-01	5.020e-04	1.500e-03
0.2479	3.296e+07	1.216e+01	3.410e+01	2.241e-02	6.283e-02
0.2769	1.495e+04	6.413e-03	1.743e-02	1.203e-05	3.269e-05
0.4318	3.562e+06	2.812e+00	6.619e+00	5.502e-03	1.295e-02
0.4772	1.697e+06	1.538e+00	3.501e+00	3.018e-03	6.870e-03
0.5661	1.133e+07	1.299e+01	2.785e+01	2.543e-02	5.451e-02
0.5994	7.105e+07	8.816e+01	1.852e+02	1.721e-01	3.615e-01
0.6617	9.372e+10	1.333e+05	2.706e+05	2.584e+02	5.246e+02
0.7281	1.288e+08	2.090e+02	4.110e+02	4.016e-01	7.898e-01
0.7975	4.207e+07	7.742e+01	1.478e+02	1.473e-01	2.813e-01
0.8723	6.362e+07	1.325e+02	2.461e+02	2.494e-01	4.630e-01
0.904	4.111e+06	8.998e+00	1.652e+01	1.685e-02	3.094e-02
1.0017	1.407e+08	3.548e+02	6.313e+02	6.538e-01	1.163e+00
1.0441	1.131e+06	3.020e+00	5.306e+00	5.524e-03	9.706e-03
1.1313	2.924e+06	8.719e+00	1.495e+01	1.570e-02	2.692e-02

KBC-40179
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1.1729	1.226e+07	3.841e+01	6.514e+01	6.864e-02	1.164e-01
1.2737	1.824e+08	6.399e+02	1.059e+03	1.122e+00	1.858e+00
1.3325	1.150e+07	4.291e+01	7.011e+01	7.445e-02	1.216e-01
1.3652	1.284e+06	4.952e+00	8.037e+00	8.540e-03	1.386e-02
1.4944	3.243e+06	1.415e+01	2.241e+01	2.383e-02	3.774e-02
1.5952	1.435e+07	6.842e+01	1.066e+02	1.132e-01	1.763e-01
Totals	**1.100e+11**	**1.351e+05**	**2.738e+05**	**2.622e+02**	**5.311e+02**

Results - Dose Point # 4 - (312.9026,1.243584,0) 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
0.0308	1.522e+10	7.197e+00	8.958e+00	6.616e-02	8.235e-02
0.1122	3.076e+08	4.154e+00	1.299e+01	6.420e-03	2.007e-02
0.1881	1.142e+06	3.256e-02	1.003e-01	5.666e-05	1.745e-04
0.2479	3.296e+07	1.378e+00	3.979e+00	2.539e-03	7.330e-03
0.2769	1.495e+04	7.280e-04	2.034e-03	1.366e-06	3.816e-06
0.4318	3.562e+06	3.212e-01	7.747e-01	6.284e-04	1.516e-03
0.4772	1.697e+06	1.759e-01	4.100e-01	3.452e-04	8.045e-04
0.5661	1.133e+07	1.489e+00	3.264e+00	2.916e-03	6.389e-03
0.5994	7.105e+07	1.012e+01	2.171e+01	1.975e-02	4.238e-02
0.6617	9.372e+10	1.532e+04	3.173e+04	2.969e+01	6.152e+01
0.7281	1.288e+08	2.405e+01	4.821e+01	4.621e-02	9.265e-02
0.7975	4.207e+07	8.919e+00	1.735e+01	1.697e-02	3.302e-02
0.8723	6.362e+07	1.529e+01	2.889e+01	2.876e-02	5.436e-02
0.904	4.111e+06	1.038e+00	1.940e+00	1.944e-03	3.633e-03
1.0017	1.407e+08	4.100e+01	7.416e+01	7.555e-02	1.367e-01
1.0441	1.131e+06	3.492e-01	6.234e-01	6.387e-04	1.140e-03
1.1313	2.924e+06	1.009e+00	1.757e+00	1.817e-03	3.164e-03
1.1729	1.226e+07	4.447e+00	7.657e+00	7.948e-03	1.368e-02
1.2737	1.824e+08	7.417e+01	1.245e+02	1.301e-01	2.185e-01
1.3325	1.150e+07	4.977e+00	8.246e+00	8.634e-03	1.431e-02
1.3652	1.284e+06	5.745e-01	9.453e-01	9.907e-04	1.630e-03
1.4944	3.243e+06	1.643e+00	2.637e+00	2.768e-03	4.441e-03
1.5952	1.435e+07	7.952e+00	1.255e+01	1.315e-02	2.075e-02
Totals	**1.100e+11**	**1.553e+04**	**3.211e+04**	**3.012e+01**	**6.227e+01**

KBC-40179
REV 0

MicroShield 7.02
DOE (7.02-0000)

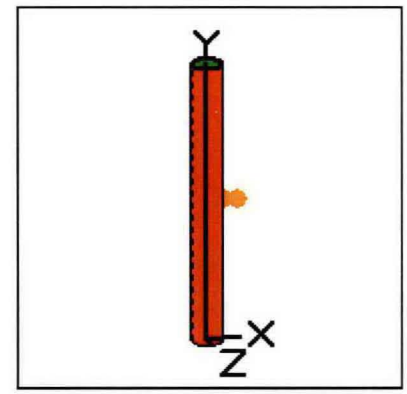
Date	By	Checked
1-30-2009	L. NELSON	PER TELECON B. ELDER

Filename	Run Date	Run Time	Duration
KBC40179_4.ms7	January 30, 2009	10:23:59 AM	00:00:02

Project Info	
Case Title	Settler Sludge Tank
Description	Settler Tanks 54% Full of Sludge, Max Dose DRF
Geometry	7 - Cylinder Volume - Side Shields

Source Dimensions	
Height	487.68 cm (16 ft)
Radius	25.4 cm (10.0 in)

Dose Points			
A	X	Y	Z
#1	28.575 cm (11.3 in)	243.84 cm (8 ft)	0.0 cm (0.0 in)
#2	31.115 cm (1 ft 0.2 in)	243.84 cm (8 ft)	0.0 cm (0.0 in)
#3	56.515 cm (1 ft 10.3 in)	243.84 cm (8 ft)	0.0 cm (0.0 in)



Shields			
Shield N	Dimension	Material	Density
Source	9.88e+05 cm³	Concrete	3
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	.635 cm	Iron	7.86

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

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Am-241	2.5502e+002	9.4357e+012	2.5800e+002	9.5460e+006
Ba-137m	3.9366e+003	1.4566e+014	3.9827e+003	1.4736e+008
Co-60	4.1416e-001	1.5324e+010	4.1900e-001	1.5503e+004
Cs-134	1.5222e+000	5.6322e+010	1.5400e+000	5.6980e+004
Cs-137	4.1614e+003	1.5397e+014	4.2100e+003	1.5577e+008
Eu-154	1.8187e+001	6.7293e+011	1.8400e+001	6.8080e+005
Eu-155	6.3260e+000	2.3406e+011	6.4000e+000	2.3680e+005
Np-237	1.5222e-002	5.6322e+008	1.5400e-002	5.6980e+002
Pu-238	3.6276e+001	1.3422e+012	3.6700e+001	1.3579e+006
Pu-239	1.5321e+002	5.6687e+012	1.5500e+002	5.7350e+006
Pu-240	9.1925e+001	3.4012e+012	9.3000e+001	3.4410e+006
Pu-241	3.1630e+003	1.1703e+014	3.2000e+003	1.1840e+008

KBC-40179
REV 0

Pu-242	3.3409e-002	1.2361e+009	3.3800e-002	1.2506e+003
Sm-151	1.4332e+000	5.3030e+010	1.4500e+000	5.3650e+004
Sr-90	4.6655e+003	1.7262e+014	4.7200e+003	1.7464e+008
Tc-99	1.1268e+000	4.1693e+010	1.1400e+000	4.2180e+004
Y-90	4.6655e+003	1.7262e+014	4.7200e+003	1.7464e+008

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

Results - Dose Point # 1 - (28.575,243.84,0) 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
0.0045	1.512e+12	9.593e-166	1.277e-21	6.575e-166	8.752e-22
0.0061	7.016e+10	6.034e-167	8.032e-23	3.051e-167	4.061e-23
0.0139	4.810e+12	9.455e-165	1.259e-20	1.042e-165	1.387e-21
0.0215	1.568e+07	1.055e-62	7.836e-26	2.896e-64	2.150e-27
0.0263	2.272e+11	7.029e-32	1.624e-21	1.032e-33	2.384e-23
0.0329	1.061e+13	5.368e-14	1.314e-13	4.060e-16	9.936e-16
0.0428	1.824e+11	5.107e-06	2.036e-05	1.910e-08	7.615e-08
0.049	4.799e+10	8.841e-04	4.541e-03	2.451e-06	1.259e-05
0.0596	3.407e+12	2.438e+01	1.678e+02	4.885e-02	3.363e-01
0.0865	7.277e+10	1.248e+02	9.938e+02	1.931e-01	1.538e+00
0.1057	5.111e+10	3.549e+02	2.658e+03	5.447e-01	4.080e+00
0.1231	2.723e+11	3.904e+03	2.710e+04	6.131e+00	4.256e+01
0.1882	1.535e+09	7.947e+01	4.449e+02	1.383e-01	7.744e-01
0.2026	2.086e+06	1.275e-01	6.894e-01	2.257e-04	1.220e-03
0.248	4.445e+10	4.111e+03	2.022e+04	7.574e+00	3.725e+01
0.4464	7.080e+09	1.885e+03	7.079e+03	3.693e+00	1.387e+01
0.5942	1.082e+11	4.707e+04	1.550e+05	9.193e+01	3.028e+02
0.6617	1.312e+14	6.860e+07	2.153e+08	1.330e+05	4.175e+05
0.8934	2.167e+11	1.893e+05	5.239e+05	3.551e+02	9.827e+02
1.0381	1.491e+11	1.686e+05	4.394e+05	3.088e+02	8.045e+02
1.3039	2.796e+11	4.678e+05	1.116e+06	8.159e+02	1.947e+03
Totals	**1.533e+14**	**6.948e+07**	**2.176e+08**	**1.346e+05**	**4.216e+05**

Results - Dose Point # 2 - (31.115,243.84,0) 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
0.0045	1.512e+12	7.378e-140	1.123e-21	5.057e-140	7.694e-22
0.0061	7.016e+10	4.641e-141	7.061e-23	2.347e-141	3.570e-23
0.0139	4.810e+12	7.272e-139	1.106e-20	8.015e-140	1.219e-21
0.0215	1.568e+07	5.486e-54	6.889e-26	1.505e-55	1.890e-27

KBC-40179
REV0

0.0263	2.272e+11	3.064e-27	1.428e-21	4.498e-29	2.096e-23
0.0329	1.061e+13	9.589e-12	2.294e-11	7.253e-14	1.735e-13
0.0428	1.824e+11	4.363e-05	1.642e-04	1.632e-07	6.142e-07
0.049	4.799e+10	3.406e-03	1.623e-02	9.442e-06	4.501e-05
0.0596	3.407e+12	4.629e+01	2.886e+02	9.277e-02	5.783e-01
0.0865	7.277e+10	1.306e+02	9.366e+02	2.021e-01	1.449e+00
0.1057	5.111e+10	3.320e+02	2.289e+03	5.095e-01	3.513e+00
0.1231	2.723e+11	3.499e+03	2.289e+04	5.495e+00	3.594e+01
0.1882	1.535e+09	6.831e+01	3.758e+02	1.189e-01	6.542e-01
0.2026	2.086e+06	1.093e-01	5.836e-01	1.935e-04	1.033e-03
0.248	4.445e+10	3.509e+03	1.720e+04	6.465e+00	3.169e+01
0.4464	7.080e+09	1.605e+03	6.085e+03	3.145e+00	1.192e+01
0.5942	1.082e+11	4.013e+04	1.337e+05	7.838e+01	2.611e+02
0.6617	1.312e+14	5.853e+07	1.859e+08	1.135e+05	3.604e+05
0.8934	2.167e+11	1.620e+05	4.534e+05	3.038e+02	8.503e+02
1.0381	1.491e+11	1.445e+05	3.805e+05	2.645e+02	6.969e+02
1.3039	2.796e+11	4.017e+05	9.684e+05	7.007e+02	1.689e+03
Totals	**1.533e+14**	**5.929e+07**	**1.879e+08**	**1.148e+05**	**3.639e+05**

Results - Dose Point # 3 - (56.515,243.84,0) 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**
0.0045	1.512e+12	6.409e-124	5.260e-22	4.393e-124	3.605e-22
0.0061	7.016e+10	4.031e-125	3.309e-23	2.038e-125	1.673e-23
0.0139	4.810e+12	6.316e-123	5.184e-21	6.961e-124	5.714e-22
0.0215	1.568e+07	4.858e-49	3.228e-26	1.333e-50	8.856e-28
0.0263	2.272e+11	6.156e-25	6.694e-22	9.037e-27	9.826e-24
0.0329	1.061e+13	5.837e-11	1.364e-10	4.414e-13	1.032e-12
0.0428	1.824e+11	4.248e-05	1.545e-04	1.589e-07	5.778e-07
0.049	4.799e+10	2.174e-03	9.993e-03	6.028e-06	2.770e-05
0.0596	3.407e+12	2.240e+01	1.359e+02	4.488e-02	2.724e-01
0.0865	7.277e+10	5.915e+01	4.315e+02	9.152e-02	6.676e-01
0.1057	5.111e+10	1.537e+02	1.095e+03	2.358e-01	1.681e+00
0.1231	2.723e+11	1.643e+03	1.114e+04	2.581e+00	1.749e+01
0.1882	1.535e+09	3.278e+01	1.856e+02	5.706e-02	3.230e-01
0.2026	2.086e+06	5.259e-02	2.883e-01	9.308e-05	5.102e-04
0.248	4.445e+10	1.695e+03	8.501e+03	3.123e+00	1.566e+01
0.4464	7.080e+09	7.825e+02	3.005e+03	1.533e+00	5.886e+00
0.5942	1.082e+11	1.962e+04	6.598e+04	3.832e+01	1.289e+02
0.6617	1.312e+14	2.865e+07	9.172e+07	5.553e+04	1.778e+05
0.8934	2.167e+11	7.945e+04	2.236e+05	1.490e+02	4.194e+02
1.0381	1.491e+11	7.093e+04	1.877e+05	1.299e+02	3.437e+02
1.3039	2.796e+11	1.975e+05	4.777e+05	3.444e+02	8.331e+02
Totals	**1.533e+14**	**2.902e+07**	**9.270e+07**	**5.620e+04**	**1.796e+05**

KBC-40179
REV 0

MicroShield 7.02
DOE (7.02-0000)

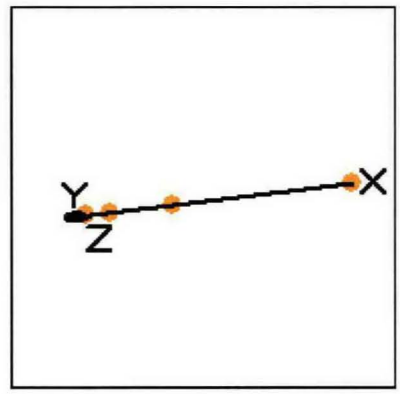
Date	By	Checked
1-30-2009	L.A NELSEN	PER TELECON B. ELDER

Filename	Run Date	Run Time	Duration
KBC40179_5.ms7	January 30, 2009	10:24:15 AM	00:00:03

Project Info	
Case Title	Sample Bottle Shield
Description	Sample Bottle Settler 400ml in cart shield (1.4in Pb)
Geometry	7 - Cylinder Volume - Side Shields

Source Dimensions	
Height	2.195 cm (0.9 in)
Radius	7.62 cm (3.0 in)

Dose Points			
A	X	Y	Z
#1	12.656 cm (5.0 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#2	41.66 cm (1 ft 4.4 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#3	111.7 cm (3 ft 8.0 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)
#4	316.382 cm (10 ft 4.6 in)	1.245 cm (0.5 in)	0.0 cm (0.0 in)



Shields			
Shield N	Dimension	Material	Density
Source	400.4 cm³	Concrete	3
Shield 1	3.556 cm	Lead	11.34
Transition		Air	0.00122
Air Gap		Air	0.00122
Wall Clad	.48 cm	Water	1
Top Clad	.48 cm	Water	1

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

Nuclide	Ci	Bq	µCi/cm³	Bq/cm³
Am-241	1.9139e-001	7.0815e+009	4.7800e+002	1.7686e+007
Ba-137m	2.8148e+000	1.0415e+011	7.0300e+003	2.6011e+008
Co-60	3.1071e-004	1.1496e+007	7.7600e-001	2.8712e+004
Cs-134	1.1411e-003	4.2222e+007	2.8500e+000	1.0545e+005
Cs-137	3.1271e+000	1.1570e+011	7.8100e+003	2.8897e+008
Eu-154	1.3493e-002	4.9926e+008	3.3700e+001	1.2469e+006
Eu-155	4.7247e-003	1.7481e+008	1.1800e+001	4.3660e+005
Np-237	1.1451e-005	4.2370e+005	2.8600e-002	1.0582e+003
Pu-238	2.7227e-002	1.0074e+009	6.8000e+001	2.5160e+006

KBC-40179 Rev 0

Pu-239	1.1491e-001	4.2519e+009	2.8700e+002	1.0619e+007
Pu-240	6.9269e-002	2.5630e+009	1.7300e+002	6.4010e+006
Pu-241	2.3704e+000	8.7704e+010	5.9200e+003	2.1904e+008
Pu-242	2.5065e-005	9.2741e+005	6.2600e-002	2.3162e+003
Sm-151	1.1411e-003	4.2222e+007	2.8500e+000	1.0545e+005
Sr-90	3.4995e+000	1.2948e+011	8.7400e+003	3.2338e+008
Tc-99	8.4484e-004	3.1259e+007	2.1100e+000	7.8070e+004
Y-90	3.4995e+000	1.2948e+011	8.7400e+003	3.2338e+008

Buildup: The material reference is Shield 1 Integration Parameters	
Radial	20
Circumferential	20
Y Direction (axial)	20

Results - Dose Point # 1 - (12.656,1.2446,0) 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
0.0045	1.081e+09	0.000e+00	2.598e-23	0.000e+00	1.781e-23
0.0061	5.215e+07	0.000e+00	1.699e-24	0.000e+00	8.589e-25
0.0139	3.611e+09	0.000e+00	2.688e-22	0.000e+00	2.963e-23
0.0215	1.248e+04	0.000e+00	1.449e-27	0.000e+00	3.977e-29
0.0263	1.705e+08	0.000e+00	2.454e-23	0.000e+00	3.602e-25
0.0329	7.590e+09	0.000e+00	1.391e-21	0.000e+00	1.052e-23
0.0428	1.356e+08	4.409e-197	3.320e-23	1.649e-199	1.242e-25
0.049	3.568e+07	2.294e-137	1.020e-23	6.358e-140	2.829e-26
0.0596	2.557e+09	3.322e-79	9.334e-22	6.658e-82	1.871e-24
0.0865	5.435e+07	5.382e-29	3.356e-23	8.328e-32	5.193e-26
0.1057	3.818e+07	1.363e-80	4.232e-08	2.091e-83	6.495e-11
0.1231	2.020e+08	1.393e-53	5.092e-12	2.188e-56	7.998e-15
0.1882	1.139e+06	5.165e-19	7.984e-19	8.991e-22	1.390e-21
0.2026	1.570e+03	1.221e-18	1.824e-18	2.160e-21	3.229e-21
0.248	3.298e+07	4.655e-08	6.766e-08	8.575e-11	1.247e-10
0.4465	5.259e+06	1.875e-01	3.426e-01	3.674e-04	6.711e-04
0.5943	8.084e+07	5.768e+01	1.134e+02	1.127e-01	2.214e-01
0.6617	9.385e+10	1.464e+05	2.938e+05	2.838e+02	5.696e+02
0.8931	1.612e+08	1.291e+03	2.711e+03	2.421e+00	5.085e+00
1.0383	1.108e+08	1.654e+03	3.482e+03	3.030e+00	6.376e+00
1.3039	2.076e+08	6.683e+03	1.369e+04	1.166e+01	2.388e+01
Totals	**1.100e+11**	**1.561e+05**	**3.138e+05**	**3.010e+02**	**6.052e+02**

Results - Dose Point # 2 - (41.66,1.2446,0) 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
0.0045	1.081e+09	0.000e+00	1.973e-24	0.000e+00	1.352e-24

KBC-40179
REV 0

0.0061	5.215e+07	0.000e+00	1.290e-25	0.000e+00	6.524e-26
0.0139	3.611e+09	0.000e+00	2.042e-23	0.000e+00	2.250e-24
0.0215	1.248e+04	0.000e+00	1.101e-28	0.000e+00	3.020e-30
0.0263	1.705e+08	0.000e+00	1.864e-24	0.000e+00	2.736e-26
0.0329	7.590e+09	0.000e+00	1.057e-22	0.000e+00	7.992e-25
0.0428	1.356e+08	5.591e-198	2.522e-24	2.091e-200	9.431e-27
0.049	3.568e+07	2.742e-138	7.750e-25	7.602e-141	2.148e-27
0.0596	2.557e+09	3.469e-80	7.090e-23	6.952e-83	1.421e-25
0.0865	5.435e+07	4.049e-30	2.549e-24	6.266e-33	3.944e-27
0.1057	3.818e+07	1.426e-81	3.214e-09	2.189e-84	4.933e-12
0.1231	2.020e+08	1.278e-54	3.868e-13	2.008e-57	6.075e-16
0.1882	1.139e+06	3.657e-20	5.651e-20	6.365e-23	9.838e-23
0.2026	1.570e+03	8.436e-20	1.261e-19	1.493e-22	2.231e-22
0.248	3.298e+07	3.076e-09	4.473e-09	5.668e-12	8.241e-12
0.4465	5.259e+06	1.198e-02	2.197e-02	2.348e-05	4.304e-05
0.5943	8.084e+07	3.711e+00	7.344e+00	7.247e-03	1.434e-02
0.6617	9.385e+10	9.455e+03	1.913e+04	1.833e+01	3.709e+01
0.8931	1.612e+08	8.450e+01	1.796e+02	1.585e-01	3.368e-01
1.0383	1.108e+08	1.091e+02	2.329e+02	1.998e-01	4.264e-01
1.3039	2.076e+08	4.462e+02	9.293e+02	7.783e-01	1.621e+00
Totals	**1.100e+11**	**1.010e+04**	**2.048e+04**	**1.947e+01**	**3.949e+01**

Results - Dose Point # 3 - (111.7,1.2446,0) 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
0.0045	1.081e+09	0.000e+00	2.705e-25	0.000e+00	1.854e-25
0.0061	5.215e+07	0.000e+00	1.769e-26	0.000e+00	8.944e-27
0.0139	3.611e+09	0.000e+00	2.800e-24	0.000e+00	3.085e-25
0.0215	1.248e+04	0.000e+00	1.509e-29	0.000e+00	4.141e-31
0.0263	1.705e+08	0.000e+00	2.556e-25	0.000e+00	3.752e-27
0.0329	7.590e+09	0.000e+00	1.449e-23	0.000e+00	1.096e-25
0.0428	1.356e+08	7.344e-199	3.457e-25	2.747e-201	1.293e-27
0.049	3.568e+07	3.549e-139	1.063e-25	9.838e-142	2.946e-28
0.0596	2.557e+09	4.383e-81	9.721e-24	8.783e-84	1.948e-26
0.0865	5.435e+07	5.091e-31	3.495e-25	7.878e-34	5.408e-28
0.1057	3.818e+07	1.829e-82	4.407e-10	2.807e-85	6.764e-13
0.1231	2.020e+08	1.630e-55	5.303e-14	2.559e-58	8.329e-17
0.1882	1.139e+06	4.651e-21	7.189e-21	8.096e-24	1.251e-23
0.2026	1.570e+03	1.073e-20	1.604e-20	1.900e-23	2.840e-23
0.248	3.298e+07	3.924e-10	5.707e-10	7.229e-13	1.051e-12
0.4465	5.259e+06	1.546e-03	2.839e-03	3.029e-06	5.561e-06
0.5943	8.084e+07	4.817e-01	9.557e-01	9.407e-04	1.866e-03
0.6617	9.385e+10	1.230e+03	2.497e+03	2.385e+00	4.840e+00
0.8931	1.612e+08	1.106e+01	2.360e+01	2.075e-02	4.426e-02
1.0383	1.108e+08	1.433e+01	3.071e+01	2.624e-02	5.623e-02

KBC-40179
REV0

1.3039	2.076e+08	5.884e+01	1.232e+02	1.026e-01	2.148e-01
Totals	**1.100e+11**	**1.315e+03**	**2.675e+03**	**2.535e+00**	**5.157e+00**

Results - Dose Point # 4 - (316.382,1.2446,0) 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**
0.0045	1.081e+09	0.000e+00	3.365e-26	0.000e+00	2.307e-26
0.0061	5.215e+07	0.000e+00	2.201e-27	0.000e+00	1.113e-27
0.0139	3.611e+09	0.000e+00	3.483e-25	0.000e+00	3.838e-26
0.0215	1.248e+04	0.000e+00	1.878e-30	0.000e+00	5.152e-32
0.0263	1.705e+08	0.000e+00	3.179e-26	0.000e+00	4.667e-28
0.0329	7.590e+09	0.000e+00	1.802e-24	0.000e+00	1.363e-26
0.0428	1.356e+08	8.421e-200	4.301e-26	3.150e-202	1.609e-28
0.049	3.568e+07	4.075e-140	1.322e-26	1.130e-142	3.664e-29
0.0596	2.557e+09	5.037e-82	1.209e-24	1.010e-84	2.423e-27
0.0865	5.435e+07	5.899e-32	4.348e-26	9.128e-35	6.727e-29
0.1057	3.818e+07	2.129e-83	5.483e-11	3.267e-86	8.414e-14
0.1231	2.020e+08	1.901e-56	6.597e-15	2.985e-59	1.036e-17
0.1882	1.139e+06	5.457e-22	8.435e-22	9.500e-25	1.468e-24
0.2026	1.570e+03	1.261e-21	1.885e-21	2.232e-24	3.336e-24
0.248	3.298e+07	4.625e-11	6.726e-11	8.520e-14	1.239e-13
0.4465	5.259e+06	1.841e-04	3.384e-04	3.606e-07	6.629e-07
0.5943	8.084e+07	5.763e-02	1.146e-01	1.125e-04	2.237e-04
0.6617	9.385e+10	1.474e+02	2.999e+02	2.858e-01	5.814e-01
0.8931	1.612e+08	1.332e+00	2.850e+00	2.498e-03	5.346e-03
1.0383	1.108e+08	1.729e+00	3.718e+00	3.166e-03	6.809e-03
1.3039	2.076e+08	7.123e+00	1.497e+01	1.242e-02	2.611e-02
Totals	**1.100e+11**	**1.577e+02**	**3.216e+02**	**3.040e-01**	**6.199e-01**

MICROSHIELD 7.02 VALIDATION COMPLETED ON COMPUTER WC95262 ON 12/23/08

KBC-40179 REV 0

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*** Comparison Results ***
File 1: C:\Program Files\MicroShield 7\Validation\Base\ANSI_II.MS7
File 2: C:\Program Files\MicroShield 7\Validation\Test\ANSI_II.MS7
--------------------------

File 1: Line 2:  Licensed To: AREVA
File 2: Line 2:  Licensed To: DOE
File 1: Line 6:  This case was run on Tuesday, October 31, 2006 at 9:12:58 AM
File 2: Line 6:  This case was run on Tuesday, December 23, 2008 at 2:19:28 PM
File 1: Line 868:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Exampl
File 2: Line 868:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Valida


*** Comparison Results ***
File 1: C:\Program Files\MicroShield 7\Validation\Base\ESIS_D2.MS7
File 2: C:\Program Files\MicroShield 7\Validation\Test\ESIS_D2.MS7
--------------------------

File 1: Line 2:  Licensed To: AREVA
File 2: Line 2:  Licensed To: DOE
File 1: Line 5:  The execution time was: 00:00:01
File 2: Line 5:  The execution time was: 00:00:00
File 1: Line 6:  This case was run on Tuesday, October 31, 2006 at 9:13:20 AM
File 2: Line 6:  This case was run on Tuesday, December 23, 2008 at 2:19:29 PM
File 1: Line 347:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Exampl
File 2: Line 347:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Valida


*** Comparison Results ***
File 1: C:\Program Files\MicroShield 7\Validation\Base\ESIS_D3.MS7
File 2: C:\Program Files\MicroShield 7\Validation\Test\ESIS_D3.MS7
--------------------------

File 1: Line 2:  Licensed To: AREVA
File 2: Line 2:  Licensed To: DOE
File 1: Line 6:  This case was run on Tuesday, October 31, 2006 at 9:13:36 AM
File 2: Line 6:  This case was run on Tuesday, December 23, 2008 at 2:19:29 PM
File 1: Line 347:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Exampl
File 2: Line 347:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Valida


*** Comparison Results ***
File 1: C:\Program Files\MicroShield 7\Validation\Base\ESIS_D5.MS7
File 2: C:\Program Files\MicroShield 7\Validation\Test\ESIS_D5.MS7
--------------------------

File 1: Line 2:  Licensed To: AREVA
File 2: Line 2:  Licensed To: DOE
File 1: Line 6:  This case was run on Tuesday, October 31, 2006 at 9:14:02 AM
File 2: Line 6:  This case was run on Tuesday, December 23, 2008 at 2:19:29 PM
File 1: Line 347:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Exampl
File 2: Line 347:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Valida


*** Comparison Results ***
File 1: C:\Program Files\MicroShield 7\Validation\Base\ESIS_D6.MS7
File 2: C:\Program Files\MicroShield 7\Validation\Test\ESIS_D6.MS7
--------------------------

File 1: Line 2:  Licensed To: AREVA
File 2: Line 2:  Licensed To: DOE
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File 1: Line 6:  This case was run on Tuesday, October 31, 2006 at 9:15:10 AM
File 2: Line 6:  This case was run on Tuesday, December 23, 2008 at 2:19:30 PM
File 1: Line 347:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Exampl
File 2: Line 347:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Valida


*** Comparison Results ***
File 1: C:\Program Files\MicroShield 7\Validation\Base\EXAMP#6E.MS7
File 2: C:\Program Files\MicroShield 7\Validation\Test\EXAMP#6E.MS7
--------------------------

File 1: Line 1:  MicroShield v6.00
File 2: Line 1:  MicroShield 7.02
File 1: Line 2:  Licensed To: Grove Engineering
File 2: Line 2:  Licensed To: DOE
File 1: Line 5:  The execution time was: 00:00:02
File 2: Line 5:  The execution time was: 00:00:00
File 1: Line 6:  This case was run on Saturday, March 29, 2003 at 10:19:48 AM
File 2: Line 6:  This case was run on Tuesday, December 23, 2008 at 2:19:30 PM
File 1: Line 307:  1.04637743015851E-86
File 2: Line 307:  1.04635899473695E-86
File 1: Line 308:  1.58099596565155E-41
File 2: Line 308:  1.58096949344362E-41
File 1: Line 312:  6.09109304862984E-11
File 2: Line 312:  6.0911259363398E-11
File 1: Line 313:  1.38328890733527E-08
File 2: Line 313:  1.38329736405916E-08
File 1: Line 314:  5.20590963872562E-06
File 2: Line 314:  5.20594082107324E-06
File 1: Line 315:  5.33269428829795E-06
File 2: Line 315:  5.33272342182793E-06
File 1: Line 316:  2.6259667716229E-03
File 2: Line 316:  2.6259797721751E-03
File 1: Line 317:  2.10261768381861E-02
File 2: Line 317:  2.10262715693327E-02
File 1: Line 318:  1.16778364703763
File 2: Line 318:  1.16778846243353
File 1: Line 319:  1.45009555184066
File 2: Line 319:  1.45010063531212
File 1: Line 320:  4.90926045633015
File 2: Line 320:  4.90927533269773
File 1: Line 321:  36.9196123118051
File 2: Line 321:  36.9196946072309
File 1: Line 337:  7.00076197727756E-09
File 2: Line 337:  7.0008005429736E-09
File 1: Line 338:  2.67153259920516E-06
File 2: Line 338:  2.67154840320609E-06
File 1: Line 339:  1.0590324555401E-03
File 2: Line 339:  1.05903837144253E-03
File 1: Line 340:  7.7875239280746E-04
File 2: Line 340:  7.78756189711177E-04
File 1: Line 341:  0.25865820096431
File 2: Line 341:  0.258659316140114
File 1: Line 342:  1.46630247558309
File 2: Line 342:  1.46630812426147
File 1: Line 343:  60.6612769111141
File 2: Line 343:  60.6614878066736
File 1: Line 344:  47.325672683076
File 2: Line 344:  47.3258094839488
File 1: Line 345:  113.014608327532
File 2: Line 345:  113.014886452268
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KBC-40179
REV 0

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File 1: Line 346:  473.638763561892
File 2: Line 346:  473.639600475543
File 1: Line 355:  End of MicroShield 5 Case File: C:\MS6 TEST CASES\CASE FILES\EXAMPLES
File 2: Line 355:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Valida


*** Comparison Results ***
File 1: C:\Program Files\MicroShield 7\Validation\Base\EXAMP#6F.MS7
File 2: C:\Program Files\MicroShield 7\Validation\Test\EXAMP#6F.MS7
--------------------------

File 1: Line 2:  Licensed To: AREVA
File 2: Line 2:  Licensed To: DOE
File 1: Line 5:  The execution time was: 00:00:01
File 2: Line 5:  The execution time was: 00:00:00
File 1: Line 6:  This case was run on Tuesday, October 31, 2006 at 9:32:44 AM
File 2: Line 6:  This case was run on Tuesday, December 23, 2008 at 2:19:30 PM
File 1: Line 355:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Exampl
File 2: Line 355:  End of MicroShield 7 Case File: C:\Program Files\MicroShield 7\Valida
```