SEP 08 2000

ENGINEERING DATA TRANSMITTAL

Page 1 of 1
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(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	RPP-6549	N/A	0	Dose Rate Calculations for Rotary Mode Core Sampling Exhauster	N/A	3	1	

16. KEY			
Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)
E, S, Q, D OR N/A (See WHC-CM-3-5, Sec. 12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority	N/A			4	4	Peer Review RM Pierson	<i>R.M. Pierson</i>	9/6/00	57-75
		Design Agent	N/A								
1	1	Cog. Eng.	DJ Foust	<i>David Foust</i>	8/3/00						
1	1	Cog. Mgr.	JS Schofield	<i>John Schofield</i>	9/6/00						
		QA	N/A								
		Safety	N/A								
		Env.	N/A								

18. <i>David Foust</i> D. J. Foust Signature of EDT Originator Date 8/3/00		19. N/A Authorized Representative for Receiving Organization Date		20. <i>John Schofield</i> JS Schofield Design Authority/Cognizant Manager Date 9/6/00		21. DOE APPROVAL (if required) Ctrl No. N/A ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
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Dose Rate Calculations for Rotary Mode Core Sampling Exhauster

D. J. Foust

CH2M Hill Hanford Group Inc.

Richland, WA 99352

U.S. Department of Energy Contract DE-AC06-99RL14047

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Abstract:

This document provides calculated estimated dose rates for three external locations on the rotary mode core sampling exhauster HEPA filter housing.

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9/8/00
Release Approval Date

Approved For Public Release

Purpose

This document provides the calculated estimated dose rates for three external locations on the Rotary Mode Core Sampling (RMCS) exhauster HEPA filter housing, per the request of Characterization Field Engineering.¹

Calculations

Dose rates for nine cases, as described in table 2, were calculated utilizing the MicroShield² computer-modeling program. The geometry utilized is shown in figures 1 and 2 below. The isotopic concentration utilized in the source term is shown in table 1.

Because of limitations in the MicroShield computer-model, it was not possible to model the filters as rectangular solids in cases 2, 3, 4, 6, 7 and 8. For these cases, it was necessary to model the filters as rectangular plane sources, and thus, the results for these cases are estimates only, and may not be directly comparable to the results for cases 1, 5 and 9. Because of the lack of self shielding in the planar model, the calculated dose rates for these cases is likely to be higher than actual measurements.

References

- Interoffice Memo # 74910-00-010, "Dose Rate Calculations for Rotary Mode Core Sampling Exhauster, June 6, 2000

Table 1 SST Solids Radionuclide Concentrations To Use for RMCS Exhauster Housing Dose Rate Calculations		
Isotope	Concentration	
	Bq/L	Ci/L
⁶⁰ Co	4.2 x 10 ⁸	0.011
⁹⁰ Sr	1.6 x 10 ¹²	43.2
⁹⁰ Y	1.6 x 10 ¹²	43.2
¹³⁷ Cs	1.0 x 10 ¹¹	2.7
^{137m} Ba	9.5 x 10 ¹⁰	2.6
¹⁵⁴ Eu	5.8 x 10 ⁹	0.16

¹ Interoffice Memo # 74910-00-010, "Dose Rate Calculations for Rotary Mode Core Sampling Exhauster, June 6, 2000

² MicroShield is a registered trademark of Grove Engineering Inc.

Table 2		
Case Number	Description	Dose Rate (mR/hr)
1	Dose rate at point A with 1 L of waste distributed evenly throughout the pre-filter.	5,129
2	Dose rate at point B with 1 L of waste distributed evenly throughout the pre-filter.	729 ¹
3	Dose rate at point C with 1 L of waste distributed evenly throughout the pre-filter.	245 ¹
4	Dose rate at point A with 1 L of waste distributed evenly throughout the 1 st HEPA.	729 ¹
5	Dose rate at point B with 1 L of waste distributed evenly throughout the 1 st HEPA.	5,085
6	Dose rate at point C with 1 L of waste distributed evenly throughout the 1 st HEPA.	364 ¹
7	Dose rate at point A with 1 L of waste distributed evenly throughout the 2 nd HEPA.	245 ¹
8	Dose rate at point B with 1 L of waste distributed evenly throughout the 2 nd HEPA.	364 ¹
9	Dose rate at point C with 1 L of waste distributed evenly throughout the 2 nd HEPA.	5,085
¹ Because of limitations of the MicroShield Model, the results for these cases should be considered estimates, and may not be directly comparable with the results for cases 1, 5 & 9.		

Table 3 Shield Materials¹					
Component	Dimension (inches)	Material	Density (gm/cm³)	Elemental Component	% by Weight
HEPA Filter	11.2	Al	0.03	Al	100
		SiO ₂	0.02	Si	47
				O	53
HEPA Frame	0.075	Fe	7.86	Fe	100
Air Gap	4.25		0.00122		100
Duct Wall	0.25	Fe	7.86	Fe	100
Foam Insulation	1.13	C	0.20	C	100
¹ Interoffice Memo # 74910-00-010, "Dose Rate Calculations for Rotary Mode Core Sampling Exhauster, June 6, 2000					

Figure 1:

Figure 2:

Page : 1
DOS File: RMCSEXH1.MS5
Run Date: June 8, 2000
Run Time: 8:36:30 AM
Duration: 00:00:06

File Ref: _____
Date: 8/2/2000
By: DH
Checked: /m/s 2/10/00

Case Title: RMCSExh1
Description: RMCS Exhauster - Case 1
Geometry: 13 - Rectangular Volume

Source Dimensions		
Length	56.896 cm	1 ft 10.4 in
Width	5.08 cm	2.0 in
Height	56.896 cm	1 ft 10.4 in

Dose Points			
#	X	Y	Z
# 1	72.39 cm 2 ft 4.5 in	28.448 cm 11.2 in	2.54 cm 1.0 in

Shields			
Shield Name	Dimension	Material	Density
Source	1.64e+04 cm ³	HEPA	0.05
Shield 1	.191 cm	Iron	7.86
Shield 2	10.795 cm	Air	0.00122
Shield 3	.635 cm	Iron	7.86
Shield 4	2.87 cm	Carbon	0.29
Air Gap		Air	0.00122

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

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	2.6000e+000	9.6200e+010	1.5811e+002	5.8499e+006
Co-60	1.1000e-002	4.0700e+008	6.6891e-001	2.4750e+004
Cs-137	2.7000e+000	9.9900e+010	1.6419e+002	6.0749e+006
Eu-154	1.6000e-001	5.9200e+009	9.7296e+000	3.5999e+005
Sr-90	4.3200e+001	1.5984e+012	2.6270e+003	9.7198e+007
Y-90	4.3200e+001	1.5984e+012	2.6270e+003	9.7198e+007

Buildup
The material reference is : Shield 3

Integration Parameters	
X Direction	10
Y Direction	20
Z Direction	20

Results					
Energy	Activity	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
MeV	photons/sec	MeV/cm ² /sec	MeV/cm ² /sec	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	5.666e+09	3.281e-20	3.579e-20	3.252e-22	3.547e-22
0.04	2.542e+09	1.576e-07	1.856e-07	6.971e-10	8.207e-10
0.05	3.060e+08	1.407e-03	1.808e-03	3.748e-06	4.815e-06
0.1	2.395e+09	8.182e+02	1.416e+03	1.252e+00	2.167e+00

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Duration: 00:00:06

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<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
0.2	4.043e+08	1.265e+03	2.569e+03	2.233e+00	4.534e+00
0.4	4.224e+07	3.889e+02	7.162e+02	7.578e-01	1.395e+00
0.5	1.282e+07	1.601e+02	2.781e+02	3.143e-01	5.458e-01
0.6	8.704e+10	1.387e+06	2.290e+06	2.707e+03	4.469e+03
0.8	2.309e+09	5.357e+04	8.196e+04	1.019e+02	1.559e+02
1.0	2.228e+09	6.885e+04	9.988e+04	1.269e+02	1.841e+02
1.5	2.717e+09	1.394e+05	1.851e+05	2.345e+02	3.113e+02
TOTALS:	1.057e+11	1.651e+06	2.662e+06	3.174e+03	5.129e+03

DOS File: RMDSEXH2.M55

Run Date: August 3, 2000

Run Time: 8:08:32 AM

Duration: 00:00:01

Case Title: RCMSExh2
 Description: RCMS Exhauster - Case 2
 Geometry: 5 - Rectangular Area - Horizontal

Length	56.896 cm	1 ft 10.4 in
Width	56.896 cm	1 ft 10.4 in

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	72.387 cm 2 ft 4.5 in	33.655 cm 1 ft 1.3 in	28.448 cm 11.2 in

Shields			
Shield Name	Dimension	Material	Density
Shield 1	.191 cm	Iron	7.86
Shield 2	10.795 cm	Air	0.00122
Shield 3	.635 cm	Iron	7.86
Shield 4	2.87 cm	Carbon	0.2
Air Gap		Air	0.00122
Immersion		Air	0.00122

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

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2
Ba-137m	2.6000e+000	9.6200e+010	8.0317e+002	2.9717e+007
Co-60	1.1000e-002	4.0700e+008	3.3980e+000	1.2573e+005
Cs-137	2.7000e+000	9.9900e+010	8.3407e+002	3.0860e+007
Eu-154	1.6000e-001	5.9200e+009	4.9426e+001	1.8288e+006
Sr-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008
Y-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008

Buildup
 The material reference is : Shield 3

Integration Parameters	
Z Direction	20
X Direction	20

Results					
Energy	Activity	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
MeV	photons/sec	$\text{MeV}/\text{cm}^2/\text{sec}$	$\text{MeV}/\text{cm}^2/\text{sec}$	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	5.666e+09	1.723e-21	1.878e-21	1.708e-23	1.861e-23
0.04	2.542e+09	2.042e-08	2.406e-08	9.030e-11	1.064e-10
0.05	3.060e+08	2.386e-04	3.067e-04	6.355e-07	8.170e-07
0.1	2.395e+09	1.428e+02	2.424e+02	2.185e-01	3.708e-01
0.2	4.043e+08	2.050e+02	3.907e+02	3.619e-01	6.896e-01
0.4	4.224e+07	6.042e+01	1.031e+02	1.177e-01	2.010e-01
0.5	1.282e+07	2.459e+01	3.975e+01	4.827e-02	7.802e-02
0.6	8.704e+10	2.110e+05	3.259e+05	4.119e+02	6.361e+02
0.8	2.309e+09	8.044e+03	1.162e+04	1.530e+01	2.210e+01

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
1.0	2.228e+09	1.024e+04	1.408e+04	1.887e+01	2.595e+01
1.5	2.717e+09	2.039e+04	2.588e+04	3.431e+01	4.354e+01
TOTALS:	1.057e+11	2.501e+05	3.783e+05	4.811e+02	7.291e+02

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DOS File: RMDSEXH3.MS5
Run Date: June 14, 2000
Run Time: 8:05:24 AM
Duration: 00:00:01

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File Ref:
Date: 8/2/2000
By: R5
Checked: RMP 8/10/00

Case Title: RCMSExh3
Description: RCMS Exhauster - Case 3
Geometry: 5 - Rectangular Area - Horizontal

Source Dimensions
Length 56.896 cm 1 ft 10.4 in
Width 56.896 cm 1 ft 10.4 in

Dose Points
1 X 72.387 cm 2 ft 4.5 in
Y 133.35 cm 4 ft 4.5 in
Z 28.448 cm 11.2 in

Shield Name	Dimension	Material	Density
Shield 1	.075 in	Iron	7.86
Shield 2	4.25 in	Air	0.00122
Shield 3	.25 in	Iron	7.86
Shield 4	1.13 in	Carbon	0.2
Air Gap		Air	0.00122
Immersion		Air	0.00122

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

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2
Ba-137m	2.6000e+000	9.6200e+010	8.0317e+002	2.9717e+007
Co-60	1.1000e-002	4.0700e+008	3.3980e+000	1.2573e+005
Cs-137	2.7000e+000	9.9900e+010	8.3407e+002	3.0860e+007
Eu-154	1.6000e-001	5.9200e+009	4.9426e+001	1.8288e+006
Sr-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008
Y-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008

Buildup
The material reference is : Shield 3

Integration Parameters
Z Direction 20
X Direction 20

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	5.666e+09	1.035e-31	4.594e-24	1.026e-33	4.553e-26
0.04	2.542e+09	1.717e-13	2.056e-13	7.594e-16	9.093e-16
0.05	3.060e+08	1.840e-07	2.431e-07	4.901e-10	6.477e-10
0.1	2.395e+09	1.351e+01	2.584e+01	2.067e-02	3.954e-02
0.2	4.043e+08	4.291e+01	1.008e+02	7.573e-02	1.779e-01
0.4	4.224e+07	1.539e+01	3.307e+01	3.000e-02	6.443e-02

<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.5	1.282e+07	6.526e+00	1.311e+01	1.281e-02	2.573e-02
0.6	8.704e+10	5.771e+04	1.092e+05	1.126e+02	2.132e+02
0.8	2.309e+09	2.298e+03	3.954e+03	4.370e+00	7.521e+00
1.0	2.228e+09	3.016e+03	4.849e+03	5.560e+00	8.939e+00
1.5	2.717e+09	6.317e+03	9.119e+03	1.063e+01	1.534e+01
TOTALS:	1.057e+11	6.942e+04	1.273e+05	1.333e+02	2.453e+02

DOS File: RMDSEX4.MS5

Run Date: June 14, 2000

Run Time: 8:22:34 AM

Duration: 00:00:01

Case Title: RCMSEx4

Description: RCMS Exhauster - Case 4

Geometry: 5 - Rectangular Area - Horizontal

Length	56.896 cm	1 ft 10.4 in
Width	56.896 cm	1 ft 10.4 in

Source Dimensions

	<u>X</u>	<u>Y</u>	<u>Z</u>
# 1	72.387 cm 2 ft 4.5 in	33.655 cm 1 ft 1.3 in	28.448 cm 11.2 in

Dose Points

Shield Name	Dimension	Material	Density
Shield 1	.075 in	Iron	7.86
Shield 2	4.25 in	Air	0.00122
Shield 3	.25 in	Iron	7.86
Shield 4	1.13 in	Carbon	0.2
Air Gap		Air	0.00122
Immersion		Air	0.00122

Shields

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

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2
Ba-137m	2.6000e+000	9.6200e+010	8.0317e+002	2.9717e+007
Co-60	1.1000e-002	4.0700e+008	3.3980e+000	1.2573e+005
Cs-137	2.7000e+000	9.9900e+010	8.3407e+002	3.0860e+007
Eu-154	1.6000e-001	5.9200e+009	4.9426e+001	1.8288e+006
Sr-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008
Y-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008

Buildup

The material reference is : Shield 3

Integration Parameters

Z Direction	20
X Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm ² /sec No Buildup	Fluence Rate MeV/cm ² /sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	5.666e+09	1.723e-21	1.878e-21	1.708e-23	1.861e-23
0.04	2.542e+09	2.042e-08	2.406e-08	9.030e-11	1.064e-10
0.05	3.060e+08	2.386e-04	3.067e-04	6.355e-07	8.170e-07
0.1	2.395e+09	1.428e+02	2.424e+02	2.185e-01	3.708e-01
0.2	4.043e+08	2.050e+02	3.907e+02	3.619e-01	6.896e-01
0.4	4.224e+07	6.042e+01	1.031e+02	1.177e-01	2.010e-01

<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.5	1.282e+07	2.459e+01	3.975e+01	4.827e-02	7.802e-02
0.6	8.704e+10	2.110e+05	3.259e+05	4.119e+02	6.361e+02
0.8	2.309e+09	8.044e+03	1.162e+04	1.530e+01	2.210e+01
1.0	2.228e+09	1.024e+04	1.408e+04	1.887e+01	2.595e+01
1.5	2.717e+09	2.039e+04	2.588e+04	3.431e+01	4.354e+01
TOTALS:	1.057e+11	2.501e+05	3.783e+05	4.811e+02	7.291e+02

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Run Date: June 14, 2000
Run Time: 7:14:01 AM
Duration: 00:00:06

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File Ref:
Date: 8/2/2000
By: PH
Checked: 1.1.1

Case Title: RMCSExh5
Description: RMCS Exhauster - Case 5
Geometry: 13 - Rectangular Volume

Source Dimensions		
Length	56.896 cm	1 ft 10.4 in
Width	10.16 cm	4.0 in
Height	56.896 cm	1 ft 10.4 in

Dose Points			
#	X	Y	Z
# 1	72.39 cm 2 ft 4.5 in	28.448 cm 11.2 in	5.08 cm 2.0 in

Shields			
Shield Name	Dimension	Material	Density
Source	2007.04 in ³	HEPA	0.05
Shield 1	.075 in	Iron	7.86
Shield 2	4.25 in	Air	0.00122
Shield 3	.25 in	Iron	7.86
Shield 4	1.13 in	Carbon	0.29
Air Gap		Air	0.00122

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

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	2.6000e+000	9.6200e+010	7.9053e+001	2.9249e+006
Co-60	1.1000e-002	4.0700e+008	3.3445e-001	1.2375e+004
Cs-137	2.7000e+000	9.9900e+010	8.2093e+001	3.0374e+006
Eu-154	1.6000e-001	5.9200e+009	4.8648e+000	1.8000e+005
Sr-90	4.3200e+001	1.5984e+012	1.3135e+003	4.8599e+007
Y-90	4.3200e+001	1.5984e+012	1.3135e+003	4.8599e+007

Buildup
The material reference is : Shield 3

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy	Activity	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
MeV	photons/sec	$\text{MeV}/\text{cm}^2/\text{sec}$	$\text{MeV}/\text{cm}^2/\text{sec}$	mR/hr	mR/hr
		No Buildup	With Buildup	No Buildup	With Buildup
0.03	5.666e+09	2.588e-20	2.823e-20	2.565e-22	2.798e-22
0.04	2.542e+09	1.413e-07	1.663e-07	6.247e-10	7.356e-10
0.05	3.060e+08	1.322e-03	1.699e-03	3.522e-06	4.526e-06
0.1	2.395e+09	8.029e+02	1.391e+03	1.228e+00	2.129e+00

<u>Energy</u>	<u>Activity</u>	<u>Fluence Rate</u>	<u>Fluence Rate</u>	<u>Exposure Rate</u>	<u>Exposure Rate</u>
<u>MeV</u>	<u>photons/sec</u>	<u>MeV/cm²/sec</u>	<u>MeV/cm²/sec</u>	<u>mR/hr</u>	<u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.2	4.043e+08	1.249e+03	2.542e+03	2.205e+00	4.486e+00
0.4	4.224e+07	3.846e+02	7.097e+02	7.494e-01	1.383e+00
0.5	1.282e+07	1.584e+02	2.756e+02	3.110e-01	5.410e-01
0.6	8.704e+10	1.372e+06	2.270e+06	2.678e+03	4.431e+03
0.8	2.309e+09	5.303e+04	8.125e+04	1.009e+02	1.546e+02
1.0	2.228e+09	6.817e+04	9.904e+04	1.257e+02	1.826e+02
1.5	2.717e+09	1.381e+05	1.835e+05	2.323e+02	3.088e+02
TOTALS:	1.057e+11	1.634e+06	2.639e+06	3.142e+03	5.085e+03

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Duration : 00:00:01

Case Title: RCMSExh6
Description: RCMS Exhauster - Case 6
Geometry: 5 - Rectangular Area - Horizontal

Source Dimensions
Length 56.896 cm 1 ft 10.4 in
Width 56.896 cm 1 ft 10.4 in

Dose Points
1 X 72.387 cm 2 ft 4.5 in
Y 99.695 cm 3 ft 3.3 in
Z 28.448 cm 11.2 in

Shield Name	Dimension	Material	Density
Shield 1	.075 in	Iron	7.86
Shield 2	4.25 in	Air	0.00122
Shield 3	.25 in	Iron	7.86
Shield 4	1.13 in	Carbon	0.2
Air Gap		Air	0.00122
Immersion		Air	0.00122

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

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2
Ba-137m	2.6000e+000	9.6200e+010	8.0317e+002	2.9717e+007
Co-60	1.1000e-002	4.0700e+008	3.3980e+000	1.2573e+005
Cs-137	2.7000e+000	9.9900e+010	8.3407e+002	3.0860e+007
Eu-154	1.6000e-001	5.9200e+009	4.9426e+001	1.8288e+006
Sr-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008
Y-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008

Buildup
The material reference is : Shield 3

Integration Parameters
Z Direction 20
X Direction 20

Energy MeV	Activity photons/sec	Fluence Rate No Buildup $\text{MeV}/\text{cm}^2/\text{sec}$	Fluence Rate With Buildup $\text{MeV}/\text{cm}^2/\text{sec}$	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	5.666e+09	1.580e-27	6.419e-24	1.566e-29	6.361e-26
0.04	2.542e+09	1.717e-11	2.043e-11	7.595e-14	9.034e-14
0.05	3.060e+08	2.903e-06	3.799e-06	7.735e-09	1.012e-08
0.1	2.395e+09	3.311e+01	6.066e+01	5.066e-02	9.280e-02
0.2	4.043e+08	7.686e+01	1.674e+02	1.357e-01	2.954e-01
0.4	4.224e+07	2.549e+01	5.015e+01	4.966e-02	9.772e-02

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Duration: 00:00:01

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<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
0.5	1.282e+07	1.063e+01	1.963e+01	2.086e-02	3.852e-02
0.6	8.704e+10	9.286e+04	1.623e+05	1.813e+02	3.168e+02
0.8	2.309e+09	3.633e+03	5.831e+03	6.910e+00	1.109e+01
1.0	2.228e+09	4.710e+03	7.125e+03	8.681e+00	1.313e+01
1.5	2.717e+09	9.666e+03	1.330e+04	1.626e+01	2.238e+01
TOTALS:	1.057e+11	1.110e+05	1.888e+05	2.134e+02	3.639e+02

Case Title: RCMSExh7

Description: RCMS Exhauster - Case 7

Geometry: 5 - Rectangular Area - Horizontal

Source Dimensions		
Length	56.896 cm	1 ft 10.4 in
Width	56.896 cm	1 ft 10.4 in

Dose Points			
	X	Y	Z
# 1	72.387 cm 2 ft 4.5 in	133.35 cm 4 ft 4.5 in	28.448 cm 11.2 in

Shields			
Shield Name	Dimension	Material	Density
Shield 1	.075 in	Iron	7.86
Shield 2	4.25 in	Air	0.00122
Shield 3	.25 in	Iron	7.86
Shield 4	1.13 in	Carbon	0.2
Air Gap		Air	0.00122
Immersion		Air	0.00122

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : Grove

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2
Ba-137m	2.6000e+000	9.6200e+010	8.0317e+002	2.9717e+007
Co-60	1.1000e-002	4.0700e+008	3.3980e+000	1.2573e+005
Cs-137	2.7000e+000	9.9900e+010	8.3407e+002	3.0860e+007
Eu-154	1.6000e-001	5.9200e+009	4.9426e+001	1.8288e+006
Sr-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008
Y-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008

Buildup

The material reference is : Shield 3

Integration Parameters

Z Direction	20
X Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		$\text{MeV}/\text{cm}^2/\text{sec}$ No Buildup	$\text{MeV}/\text{cm}^2/\text{sec}$ With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	5.666e+09	1.035e-31	4.594e-24	1.026e-33	4.553e-26
0.04	2.542e+09	1.717e-13	2.056e-13	7.594e-16	9.093e-16
0.05	3.060e+08	1.840e-07	2.431e-07	4.901e-10	6.477e-10
0.1	2.395e+09	1.351e+01	2.584e+01	2.067e-02	3.954e-02
0.2	4.043e+08	4.291e+01	1.008e+02	7.573e-02	1.779e-01
0.4	4.224e+07	1.539e+01	3.307e+01	3.000e-02	6.443e-02

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<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
0.5	1.282e+07	6.526e+00	1.311e+01	1.281e-02	2.573e-02
0.6	8.704e+10	5.771e+04	1.092e+05	1.126e+02	2.132e+02
0.8	2.309e+09	2.298e+03	3.954e+03	4.370e+00	7.521e+00
1.0	2.228e+09	3.016e+03	4.849e+03	5.560e+00	8.939e+00
1.5	2.717e+09	6.317e+03	9.119e+03	1.063e+01	1.534e+01
TOTALS:	1.057e+11	6.942e+04	1.273e+05	1.333e+02	2.453e+02

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File Ref:
Date: 8/2/2000
By: [Signature]
Checked: RNP 8/16/00

Case Title: RCMSExh8
Description: RCMS Exhauster - Case 8
Geometry: 5 - Rectangular Area - Horizontal

Source Dimensions
Length 56.896 cm 1 ft 10.4 in
Width 56.896 cm 1 ft 10.4 in

Dose Points
1 X 72.387 cm 2 ft 4.5 in
Y 99.695 cm 3 ft 3.3 in
Z 28.448 cm 11.2 in

Shield Name	Dimension	Material	Density
Shield 1	.075 in	Iron	7.86
Shield 2	4.25 in	Air	0.00122
Shield 3	.25 in	Iron	7.86
Shield 4	1.13 in	Carbon	0.2
Air Gap		Air	0.00122
Immersion		Air	0.00122

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

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^2$	Bq/cm^2
Ba-137m	2.6000e+000	9.6200e+010	8.0317e+002	2.9717e+007
Co-60	1.1000e-002	4.0700e+008	3.3980e+000	1.2573e+005
Cs-137	2.7000e+000	9.9900e+010	8.3407e+002	3.0860e+007
Eu-154	1.6000e-001	5.9200e+009	4.9426e+001	1.8288e+006
Sr-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008
Y-90	4.3200e+001	1.5984e+012	1.3345e+004	4.9377e+008

Buildup
The material reference is : Shield 3

Integration Parameters
Z Direction 20
X Direction 20

Energy MeV	Activity photons/sec	Fluence Rate		Exposure Rate	
		No Buildup MeV/cm ² /sec	With Buildup MeV/cm ² /sec	mR/hr No Buildup	mR/hr With Buildup
0.03	5.666e+09	1.580e-27	6.419e-24	1.566e-29	6.361e-26
0.04	2.542e+09	1.717e-11	2.043e-11	7.595e-14	9.034e-14
0.05	3.060e+08	2.903e-06	3.799e-06	7.735e-09	1.012e-08
0.1	2.395e+09	3.311e+01	6.066e+01	5.066e-02	9.280e-02
0.2	4.043e+08	7.686e+01	1.674e+02	1.357e-01	2.954e-01
0.4	4.224e+07	2.549e+01	5.015e+01	4.966e-02	9.772e-02

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Duration: 00:00:01

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<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>No Buildup</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u> <u>With Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>No Buildup</u>	<u>Exposure Rate</u> <u>mR/hr</u> <u>With Buildup</u>
0.5	1.282e+07	1.063e+01	1.963e+01	2.086e-02	3.852e-02
0.6	8.704e+10	9.286e+04	1.623e+05	1.813e+02	3.168e+02
0.8	2.309e+09	3.633e+03	5.831e+03	6.910e+00	1.109e+01
1.0	2.228e+09	4.710e+03	7.125e+03	8.681e+00	1.313e+01
1.5	2.717e+09	9.666e+03	1.330e+04	1.626e+01	2.238e+01
TOTALS:	1.057e+11	1.110e+05	1.888e+05	2.134e+02	3.639e+02

Case Title: RMCSExh9

Description: RMCS Exhauster - Case 9

Geometry: 13 - Rectangular Volume

Source Dimensions			
Length	56.896 cm	1 ft 10.4 in	
Width	10.16 cm	4.0 in	
Height	56.896 cm	1 ft 10.4 in	

Dose Points			
	X	Y	Z
# 1	72.39 cm 2 ft 4.5 in	28.448 cm 11.2 in	5.08 cm 2.0 in

Shields			
Shield Name	Dimension	Material	Density
Source	2007.04 in ³	HEPA	0.05
Shield 1	.075 in	Iron	7.86
Shield 2	4.25 in	Air	0.00122
Shield 3	.25 in	Iron	7.86
Shield 4	1.13 in	Carbon	0.29
Air Gap		Air	0.00122

Source Input

Grouping Method : Standard Indices

Number of Groups : 25

Lower Energy Cutoff : 0.015

Photons < 0.015 : Excluded

Library : Grove

Nuclide	curies	becquerels	$\mu\text{Ci}/\text{cm}^3$	Bq/cm^3
Ba-137m	2.6000e+000	9.6200e+010	7.9053e+001	2.9249e+006
Co-60	1.1000e-002	4.0700e+008	3.3445e-001	1.2375e+004
Cs-137	2.7000e+000	9.9900e+010	8.2093e+001	3.0374e+006
Eu-154	1.6000e-001	5.9200e+009	4.8648e+000	1.8000e+005
Sr-90	4.3200e+001	1.5984e+012	1.3135e+003	4.8599e+007
Y-90	4.3200e+001	1.5984e+012	1.3135e+003	4.8599e+007

Buildup

The material reference is : Shield 3

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
		$\text{MeV}/\text{cm}^2/\text{sec}$ No Buildup	$\text{MeV}/\text{cm}^2/\text{sec}$ With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.03	5.666e+09	2.588e-20	2.823e-20	2.565e-22	2.798e-22
0.04	2.542e+09	1.413e-07	1.663e-07	6.247e-10	7.356e-10
0.05	3.060e+08	1.322e-03	1.699e-03	3.522e-06	4.526e-06
0.1	2.395e+09	8.029e+02	1.391e+03	1.228e+00	2.129e+00

<u>Energy</u> <u>MeV</u>	<u>Activity</u> <u>photons/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u>	<u>Fluence Rate</u> <u>MeV/cm²/sec</u>	<u>Exposure Rate</u> <u>mR/hr</u>	<u>Exposure Rate</u> <u>mR/hr</u>
		<u>No Buildup</u>	<u>With Buildup</u>	<u>No Buildup</u>	<u>With Buildup</u>
0.2	4.043e+08	1.249e+03	2.542e+03	2.205e+00	4.486e+00
0.4	4.224e+07	3.846e+02	7.097e+02	7.494e-01	1.383e+00
0.5	1.282e+07	1.584e+02	2.756e+02	3.110e-01	5.410e-01
0.6	8.704e+10	1.372e+06	2.270e+06	2.678e+03	4.431e+03
0.8	2.309e+09	5.303e+04	8.125e+04	1.009e+02	1.546e+02
1.0	2.228e+09	6.817e+04	9.904e+04	1.257e+02	1.826e+02
1.5	2.717e+09	1.381e+05	1.835e+05	2.323e+02	3.088e+02
TOTALS:	1.057e+11	1.634e+06	2.639e+06	3.142e+03	5.085e+03