

ATTACHMENT 8

Important Notice

For best results in the application of Flanders/CSC[®] products, it is recommended that the buyer supply complete information about the operating conditions of the ventilation system to Flanders/CSC[®] for prior evaluation. Flanders/CSC[®] does not guarantee that its equipment will operate at the performance levels given on the identification labels or in the catalog specifications under all conditions of installation and use, nor does Flanders/CSC[®] guarantee the suitability of its product for the particular end use which may be contemplated by the buyer. When the system components are supplied to the buyer or his agent for final installation and assembly in the field, it should be under the supervision of factory trained personnel who are equipped to test the installation and certify its performance and conformance to industry accepted specifications. Failure to follow these procedures may result in a compromised installation.



FLANDERS/CSC CORPORATION
7013 Hwy 92E - PO Box 3
Bath, NC 27808

Representatives of Flanders/CSC[®] products are located throughout the world.

Your closest representative's office may be found by contacting our manufacturing and sales department.

Represented by:

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Web site: www.flanders-csc.com

FLANDERS/CSC[®]

Printed in USA 11/2003

MicroShield 8.02	
Nathan Hogue (8.00-0000)	

Date	By	Checked
6-9-15	N. Hogue	

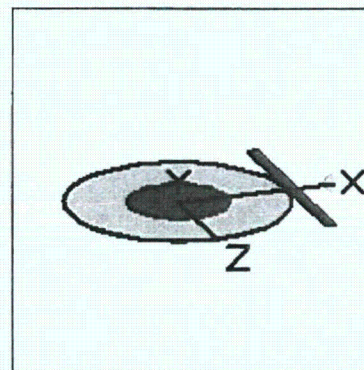
Filename	Run Date	Run Time	Duration
Case1	June 9, 2015	4:36:02 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (4 of 4 DF 1000 filters)-Filter No.1
Geometry	12 - Annular Cylinder - External Dose Point

Source Dimensions	
Height	1.0 cm (0.4 in)
Inner Cyl Radius	40.0 cm (1 ft 3.7 in)
Inner Cyl Thickness	0.1 cm (0.0 in)
Outer Cyl Thickness	0.1 cm (0.0 in)
Source	50.0 cm (1 ft 7.7 in)

Dose Points			
A	X	Y	Z
#1	130.2 cm (4 ft 3.3 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Cyl. Radius	40.0 cm	Air	0.00122
Shield 1	.1 cm	Iron	7.85
Source	2.05e+04 cm ³	Carbon	2.1
Shield 3	.1 cm	Iron	7.85
Transition		Air	0.00122
Shield 5	10.0 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	1.4985e+002	5.5445e+012	7.3270e+003	2.7110e+008

Buildup: The material reference is Shield 5	
Integration Parameters	
Radial	10
Circumferential	20
Y Direction (axial)	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
0.0041	3.050e+10	0.000e+00	7.407e-24	0.000e+00	5.521e-24

0.0295	7.467e+10	0.000e+00	1.334e-22	0.000e+00	1.396e-24
0.0298	1.385e+11	0.000e+00	2.505e-22	0.000e+00	2.538e-24
0.0336	4.925e+10	0.000e+00	1.016e-22	0.000e+00	7.226e-25
0.0802	1.452e+11	9.194e-103	8.815e-22	1.454e-105	1.394e-24
0.1772	1.468e+10	5.184e-61	2.461e-22	8.897e-64	4.224e-25
0.2843	3.356e+11	1.775e-17	3.070e-17	3.343e-20	5.781e-20
0.3258	1.390e+10	1.279e-13	2.406e-13	2.450e-16	4.608e-16
0.3294	1.277e+10	2.638e-13	5.001e-13	5.058e-16	9.590e-16
0.3645	4.500e+12	6.112e-08	1.256e-07	1.183e-10	2.432e-10
0.503	1.999e+10	1.006e-04	2.596e-04	1.974e-07	5.096e-07
0.637	4.026e+11	3.292e-01	9.351e-01	6.400e-04	1.818e-03
0.6427	1.217e+10	1.158e-02	3.302e-02	2.250e-05	6.416e-05
0.7229	9.994e+10	5.655e-01	1.696e+00	1.088e-03	3.262e-03
Totals	5.850e+12	9.063e-01	2.665e+00	1.750e-03	5.145e-03

MicroShield 8.02 Nathan Hogue (8.00-0000)	
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Date	By	Checked
6-9-15	<i>N. Hogue</i>	<i>N. Hogue</i>

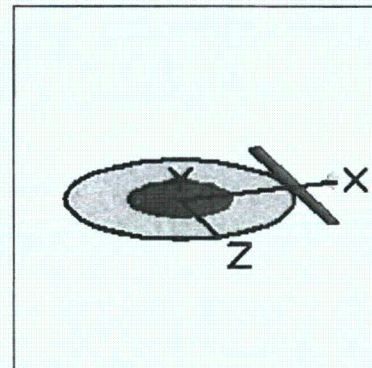
Filename	Run Date	Run Time	Duration
Case1	June 9, 2015	4:37:03 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (4 of 4 DF 100 filters)-Filter No.1
Geometry	12 - Annular Cylinder - External Dose Point

Source Dimensions	
Height	1.0 cm (0.4 in)
Inner Cyl Radius	40.0 cm (1 ft 3.7 in)
Inner Cyl Thickness	0.1 cm (0.0 in)
Outer Cyl Thickness	0.1 cm (0.0 in)
Source	50.0 cm (1 ft 7.7 in)

Dose Points			
A	X	Y	Z
#1	130.2 cm (4 ft 3.3 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Cyl. Radius	40.0 cm	Air	0.00122
Shield 1	.1 cm	Iron	7.85
Source	2.05e+04 cm ³	Carbon	2.1
Shield 3	.1 cm	Iron	7.85
Transition		Air	0.00122
Shield 5	10.0 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	$\mu\text{Ci/cm}^3$	Bq/cm^3
I-131	1.4850e+002	5.4945e+012	7.2610e+003	2.6866e+008

Buildup: The material reference is Shield 5	
Integration Parameters	
Radial	10
Circumferential	20
Y Direction (axial)	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
0.0041	3.022e+10	0.000e+00	7.340e-24	0.000e+00	5.472e-24

0.0295	7.400e+10	0.000e+00	1.322e-22	0.000e+00	1.384e-24
0.0298	1.373e+11	0.000e+00	2.482e-22	0.000e+00	2.515e-24
0.0336	4.881e+10	0.000e+00	1.007e-22	0.000e+00	7.161e-25
0.0802	1.439e+11	9.111e-103	8.736e-22	1.441e-105	1.381e-24
0.1772	1.455e+10	5.137e-61	2.439e-22	8.816e-64	4.186e-25
0.2843	3.325e+11	1.759e-17	3.042e-17	3.312e-20	5.729e-20
0.3258	1.378e+10	1.268e-13	2.384e-13	2.428e-16	4.566e-16
0.3294	1.266e+10	2.614e-13	4.956e-13	5.012e-16	9.504e-16
0.3645	4.460e+12	6.057e-08	1.245e-07	1.172e-10	2.410e-10
0.503	1.981e+10	9.965e-05	2.573e-04	1.956e-07	5.050e-07
0.637	3.989e+11	3.262e-01	9.266e-01	6.343e-04	1.802e-03
0.6427	1.206e+10	1.147e-02	3.272e-02	2.230e-05	6.358e-05
0.7229	9.904e+10	5.604e-01	1.681e+00	1.078e-03	3.233e-03
Totals	5.797e+12	8.982e-01	2.641e+00	1.734e-03	5.099e-03

MicroShield 8.02 Nathan Hogue (8.00-0000)	
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Date	By	Checked
6-9-15	N. Hogue	76

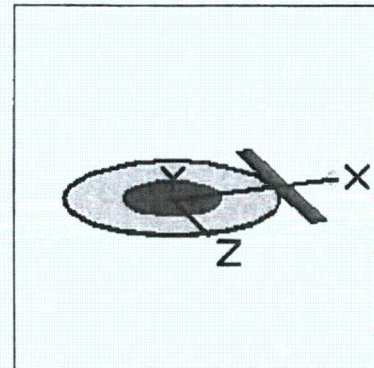
Filename	Run Date	Run Time	Duration
Case1	June 9, 2015	3:58:31 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (4 of 4 DF 1000 filters)-Filter No.2
Geometry	12 - Annular Cylinder - External Dose Point

Source Dimensions	
Height	1.0 cm (0.4 in)
Inner Cyl Radius	29.0 cm (11.4 in)
Inner Cyl Thickness	0.1 cm (0.0 in)
Outer Cyl Thickness	0.1 cm (0.0 in)
Source	36.0 cm (1 ft 2.2 in)

Dose Points			
A	X	Y	Z
#1	105.2 cm (3 ft 5.4 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Cyl. Radius	29.0 cm	Air	0.00122
Shield 1	.1 cm	Iron	7.85
Source	1.07e+04 cm ³	Carbon	2.1
Shield 3	.1 cm	Iron	7.85
Transition		Air	0.00122
Shield 5	10.0 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	1.4985e-001	5.5445e+009	1.4065e+001	5.2042e+005

Buildup: The material reference is Shield 5	
Integration Parameters	
Radial	10
Circumferential	20
Y Direction (axial)	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
0.0041	3.050e+07	0.000e+00	1.038e-26	0.000e+00	7.740e-27

ATTACHMENT 9

0.0295	7.467e+07	0.000e+00	1.870e-25	0.000e+00	1.957e-27
0.0298	1.385e+08	0.000e+00	3.511e-25	0.000e+00	3.557e-27
0.0336	4.925e+07	0.000e+00	1.424e-25	0.000e+00	1.013e-27
0.0802	1.452e+08	1.557e-105	1.236e-24	2.463e-108	1.954e-27
0.1772	1.468e+07	9.682e-64	3.450e-25	1.662e-66	5.922e-28
0.2843	3.356e+08	3.431e-20	5.933e-20	6.462e-23	1.117e-22
0.3258	1.390e+07	2.450e-16	4.608e-16	4.693e-19	8.826e-19
0.3294	1.277e+07	5.050e-16	9.574e-16	9.685e-19	1.836e-18
0.3645	4.500e+09	1.167e-10	2.398e-10	2.259e-13	4.642e-13
0.503	1.999e+07	1.914e-07	4.940e-07	3.756e-10	9.697e-10
0.637	4.026e+08	6.238e-04	1.771e-03	1.213e-06	3.444e-06
0.6427	1.217e+07	2.194e-05	6.253e-05	4.263e-08	1.215e-07
0.7229	9.994e+07	1.068e-03	3.202e-03	2.055e-06	6.158e-06
Totals	5.850e+09	1.714e-03	5.036e-03	3.311e-06	9.724e-06

MicroShield 8.02 Nathan Hogue (8.00-0000)	
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Date	By	Checked
6-9-15	N. Hogue	N. Hogue

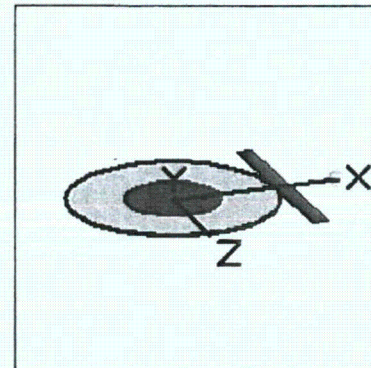
Filename	Run Date	Run Time	Duration
Case1	June 9, 2015	4:22:16 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (3 of 4 DF 1000 filters)-Filter No.2
Geometry	12 - Annular Cylinder - External Dose Point

Source Dimensions	
Height	1.0 cm (0.4 in)
Inner Cyl Radius	29.0 cm (11.4 in)
Inner Cyl Thickness	0.1 cm (0.0 in)
Outer Cyl Thickness	0.1 cm (0.0 in)
Source	36.0 cm (1 ft 2.2 in)

Dose Points			
A	X	Y	Z
#1	105.2 cm (3 ft 5.4 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Cyl. Radius	29.0 cm	Air	0.00122
Shield 1	.1 cm	Iron	7.85
Source	1.07e+04 cm ³	Carbon	2.1
Shield 3	.1 cm	Iron	7.85
Transition		Air	0.00122
Shield 5	10.0 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	1.4985e+002	5.5445e+012	1.4065e+004	5.2042e+008

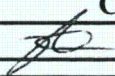
Buildup: The material reference is Shield 5 Integration Parameters	
Radial	10
Circumferential	20
Y Direction (axial)	20

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
0.0041	3.050e+10	0.000e+00	1.038e-23	0.000e+00	7.740e-24

ATTACHMENT 9

0.0295	7.467e+10	0.000e+00	1.870e-22	0.000e+00	1.957e-24
0.0298	1.385e+11	0.000e+00	3.511e-22	0.000e+00	3.557e-24
0.0336	4.925e+10	0.000e+00	1.424e-22	0.000e+00	1.013e-24
0.0802	1.452e+11	1.557e-102	1.236e-21	2.463e-105	1.954e-24
0.1772	1.468e+10	9.682e-61	3.450e-22	1.662e-63	5.922e-25
0.2843	3.356e+11	3.431e-17	5.933e-17	6.462e-20	1.117e-19
0.3258	1.390e+10	2.450e-13	4.608e-13	4.693e-16	8.826e-16
0.3294	1.277e+10	5.050e-13	9.574e-13	9.685e-16	1.836e-15
0.3645	4.500e+12	1.167e-07	2.398e-07	2.259e-10	4.642e-10
0.503	1.999e+10	1.914e-04	4.940e-04	3.756e-07	9.697e-07
0.637	4.026e+11	6.238e-01	1.771e+00	1.213e-03	3.444e-03
0.6427	1.217e+10	2.194e-02	6.253e-02	4.263e-05	1.215e-04
0.7229	9.994e+10	1.068e+00	3.202e+00	2.055e-03	6.158e-03
Totals	5.850e+12	1.714e+00	5.036e+00	3.311e-03	9.724e-03

MicroShield 8.02 Nathan Hogue (8.00-0000)	
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Date	By	Checked
6-9-15	N. Hogue	

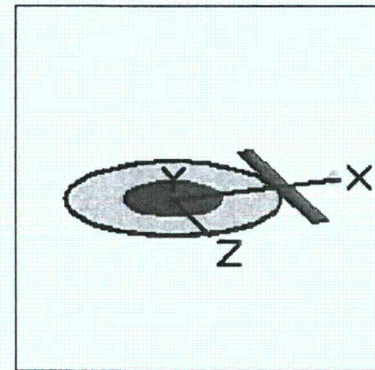
Filename	Run Date	Run Time	Duration
Case1	June 9, 2015	4:06:54 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (4 of 4 DF 100 filters)-Filter No.2
Geometry	12 - Annular Cylinder - External Dose Point

Source Dimensions	
Height	1.0 cm (0.4 in)
Inner Cyl Radius	29.0 cm (11.4 in)
Inner Cyl Thickness	0.1 cm (0.0 in)
Outer Cyl Thickness	0.1 cm (0.0 in)
Source	36.0 cm (1 ft 2.2 in)

Dose Points			
A	X	Y	Z
#1	105.2 cm (3 ft 5.4 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Cyl. Radius	29.0 cm	Air	0.00122
Shield 1	.1 cm	Iron	7.85
Source	1.07e+04 cm ³	Carbon	2.1
Shield 3	.1 cm	Iron	7.85
Transition		Air	0.00122
Shield 5	10.0 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	1.4850e+000	5.4945e+010	1.3939e+002	5.1573e+006

Buildup: The material reference is Shield 5	
Integration Parameters	
Radial	10
Circumferential	20
Y Direction (axial)	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
0.0041	3.022e+08	0.000e+00	1.029e-25	0.000e+00	7.670e-26

ATTACHMENT 9

0.0295	7.400e+08	0.000e+00	1.853e-24	0.000e+00	1.940e-26
0.0298	1.373e+09	0.000e+00	3.479e-24	0.000e+00	3.525e-26
0.0336	4.881e+08	0.000e+00	1.411e-24	0.000e+00	1.004e-26
0.0802	1.439e+09	1.543e-104	1.225e-23	2.440e-107	1.936e-26
0.1772	1.455e+08	9.595e-63	3.419e-24	1.647e-65	5.868e-27
0.2843	3.325e+09	3.400e-19	5.880e-19	6.403e-22	1.107e-21
0.3258	1.378e+08	2.428e-15	4.566e-15	4.651e-18	8.746e-18
0.3294	1.266e+08	5.005e-15	9.488e-15	9.597e-18	1.819e-17
0.3645	4.460e+10	1.156e-09	2.377e-09	2.238e-12	4.601e-12
0.503	1.981e+08	1.896e-06	4.896e-06	3.722e-09	9.609e-09
0.637	3.989e+09	6.182e-03	1.755e-02	1.202e-05	3.413e-05
0.6427	1.206e+08	2.174e-04	6.197e-04	4.224e-07	1.204e-06
0.7229	9.904e+08	1.059e-02	3.173e-02	2.036e-05	6.102e-05
Totals	5.797e+10	1.699e-02	4.991e-02	3.281e-05	9.636e-05

MicroShield 8.02 Nathan Hogue (8.00-0000)	
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Date	By	Checked
6-9-15	N. Hogue	TH

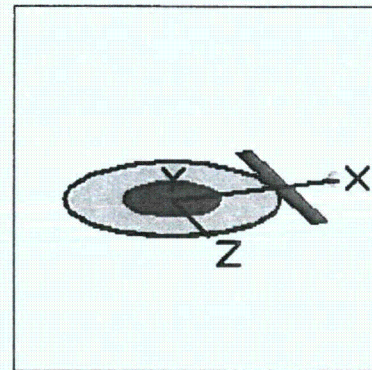
Filename	Run Date	Run Time	Duration
Case1	June 9, 2015	4:08:24 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (3 of 4 DF 100 filters)-Filter No.2
Geometry	12 - Annular Cylinder - External Dose Point

Source Dimensions	
Height	1.0 cm (0.4 in)
Inner Cyl Radius	29.0 cm (11.4 in)
Inner Cyl Thickness	0.1 cm (0.0 in)
Outer Cyl Thickness	0.1 cm (0.0 in)
Source	36.0 cm (1 ft 2.2 in)

Dose Points			
A	X	Y	Z
#1	105.2 cm (3 ft 5.4 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Cyl. Radius	29.0 cm	Air	0.00122
Shield 1	.1 cm	Iron	7.85
Source	1.07e+04 cm ³	Carbon	2.1
Shield 3	.1 cm	Iron	7.85
Transition		Air	0.00122
Shield 5	10.0 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	1.4850e+002	5.4945e+012	1.3939e+004	5.1573e+008

Buildup: The material reference is Shield 5	
Integration Parameters	
Radial	10
Circumferential	20
Y Direction (axial)	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
0.0041	3.022e+10	0.000e+00	1.029e-23	0.000e+00	7.670e-24

0.0295	7.400e+10	0.000e+00	1.853e-22	0.000e+00	1.940e-24
0.0298	1.373e+11	0.000e+00	3.479e-22	0.000e+00	3.525e-24
0.0336	4.881e+10	0.000e+00	1.411e-22	0.000e+00	1.004e-24
0.0802	1.439e+11	1.543e-102	1.225e-21	2.440e-105	1.936e-24
0.1772	1.455e+10	9.595e-61	3.419e-22	1.647e-63	5.868e-25
0.2843	3.325e+11	3.400e-17	5.880e-17	6.403e-20	1.107e-19
0.3258	1.378e+10	2.428e-13	4.566e-13	4.651e-16	8.746e-16
0.3294	1.266e+10	5.005e-13	9.488e-13	9.597e-16	1.819e-15
0.3645	4.460e+12	1.156e-07	2.377e-07	2.238e-10	4.601e-10
0.503	1.981e+10	1.896e-04	4.896e-04	3.722e-07	9.609e-07
0.637	3.989e+11	6.182e-01	1.755e+00	1.202e-03	3.413e-03
0.6427	1.206e+10	2.174e-02	6.197e-02	4.224e-05	1.204e-04
0.7229	9.904e+10	1.059e+00	3.173e+00	2.036e-03	6.102e-03
Totals	5.797e+12	1.699e+00	4.991e+00	3.281e-03	9.636e-03

MicroShield 8.02 Nathan Hogue (8.00-0000)	
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Date	By	Checked
6-10-15	N. Hogue	<i>[Signature]</i>

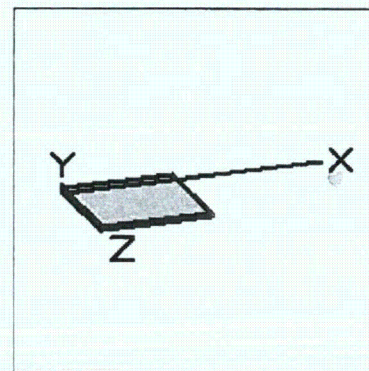
Filename	Run Date	Run Time	Duration
Case1	June 10, 2015	12:39:43 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (4 of 4 DF 1000 filters)Filter No.4
Geometry	13 - Rectangular Volume

Source Dimensions	
Length	23.5 cm (9.3 in)
Width	23.5 cm (9.3 in)
Height	1.0 cm (0.4 in)

Dose Points			
A	X	Y	Z
#1	55.0 cm (1 ft 9.7 in)	0.5 cm (0.2 in)	12.0 cm (4.7 in)

Shields			
Shield N	Dimension	Material	Density
Source	552.25 cm ³	Carbon	2.1
Shield 2	.635 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	1.4985e-007	5.5445e+003	2.7134e-004	1.0040e+001

Buildup: The material reference is Shield 2 Integration Parameters	
X Direction	10
Y Direction	20
Z 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
0.0041	3.050e+01	0.000e+00	4.900e-32	0.000e+00	3.653e-32
0.0295	7.467e+01	1.651e-101	8.827e-31	1.728e-103	9.238e-33
0.0298	1.385e+02	1.597e-98	1.657e-30	1.618e-100	1.679e-32
0.0336	4.925e+01	2.058e-73	6.722e-31	1.464e-75	4.781e-33
0.0802	1.452e+02	1.694e-11	2.001e-11	2.679e-14	3.164e-14
0.1772	1.468e+01	2.376e-09	3.485e-09	4.077e-12	5.981e-12
0.2843	3.356e+02	4.875e-05	6.194e-05	9.180e-08	1.166e-07

0.3258	1.390e+01	5.147e-06	6.674e-06	9.859e-09	1.278e-08
0.3294	1.277e+01	5.047e-06	6.553e-06	9.678e-09	1.257e-08
0.3645	4.500e+03	3.041e-03	3.997e-03	5.886e-06	7.737e-06
0.503	1.999e+01	4.522e-05	6.201e-05	8.877e-08	1.217e-07
0.637	4.026e+02	1.681e-03	2.348e-03	3.268e-06	4.565e-06
0.6427	1.217e+01	5.187e-05	7.253e-05	1.008e-07	1.409e-07
0.7229	9.994e+01	5.510e-04	7.781e-04	1.060e-06	1.496e-06
Totals	5.850e+03	5.429e-03	7.333e-03	1.051e-05	1.420e-05

MicroShield 8.02 Nathan Hogue (8.00-0000)	
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Date	By	Checked
6-10-15	N. Hogue	<i>[Signature]</i>

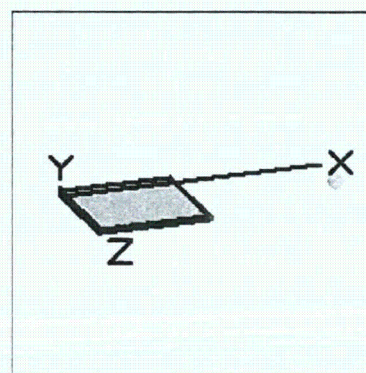
Filename	Run Date	Run Time	Duration
Case1	June 10, 2015	12:40:53 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (3 of 4 DF 1000 filters)Filter No.4
Geometry	13 - Rectangular Volume

Source Dimensions	
Length	23.5 cm (9.3 in)
Width	23.5 cm (9.3 in)
Height	1.0 cm (0.4 in)

Dose Points			
A	X	Y	Z
#1	55.0 cm (1 ft 9.7 in)	0.5 cm (0.2 in)	12.0 cm (4.7 in)

Shields			
Shield N	Dimension	Material	Density
Source	552.25 cm ³	Carbon	2.1
Shield 2	.635 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	1.4985e-004	5.5445e+006	2.7134e-001	1.0040e+004

Buildup: The material reference is Shield 2	
Integration Parameters	
X Direction	10
Y Direction	20
Z 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
0.0041	3.050e+04	0.000e+00	4.900e-29	0.000e+00	3.653e-29
0.0295	7.467e+04	1.651e-98	8.827e-28	1.728e-100	9.238e-30
0.0298	1.385e+05	1.597e-95	1.657e-27	1.618e-97	1.679e-29
0.0336	4.925e+04	2.058e-70	6.722e-28	1.464e-72	4.781e-30
0.0802	1.452e+05	1.694e-08	2.001e-08	2.679e-11	3.164e-11
0.1772	1.468e+04	2.376e-06	3.485e-06	4.077e-09	5.981e-09
0.2843	3.356e+05	4.875e-02	6.194e-02	9.180e-05	1.166e-04

0.3258	1.390e+04	5.147e-03	6.674e-03	9.859e-06	1.278e-05
0.3294	1.277e+04	5.047e-03	6.553e-03	9.678e-06	1.257e-05
0.3645	4.500e+06	3.041e+00	3.997e+00	5.886e-03	7.737e-03
0.503	1.999e+04	4.522e-02	6.201e-02	8.877e-05	1.217e-04
0.637	4.026e+05	1.681e+00	2.348e+00	3.268e-03	4.565e-03
0.6427	1.217e+04	5.187e-02	7.253e-02	1.008e-04	1.409e-04
0.7229	9.994e+04	5.510e-01	7.781e-01	1.060e-03	1.496e-03
Totals	5.850e+06	5.429e+00	7.333e+00	1.051e-02	1.420e-02

MicroShield 8.02
Nathan Hogue (8.00-0000)

Date	By	Checked
6-10-15	N. Hogue	70

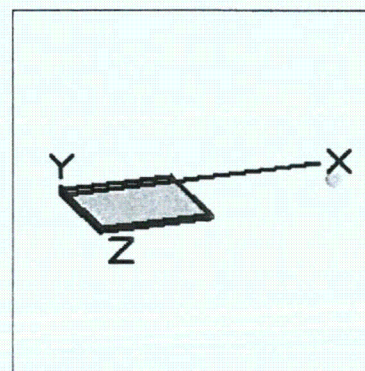
Filename	Run Date	Run Time	Duration
Case1	June 10, 2015	12:42:38 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (4 of 4 DF 100 filters)Filter No.4
Geometry	13 - Rectangular Volume

Source Dimensions	
Length	23.5 cm (9.3 in)
Width	23.5 cm (9.3 in)
Height	1.0 cm (0.4 in)

Dose Points			
A	X	Y	Z
#1	55.0 cm (1 ft 9.7 in)	0.5 cm (0.2 in)	12.0 cm (4.7 in)

Shields			
Shield N	Dimension	Material	Density
Source	552.25 cm ³	Carbon	2.1
Shield 2	.635 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	1.4850e-004	5.4945e+006	2.6890e-001	9.9493e+003

Buildup: The material reference is Shield 2	
Integration Parameters	
X Direction	10
Y Direction	20
Z 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
0.0041	3.022e+04	0.000e+00	4.856e-29	0.000e+00	3.620e-29
0.0295	7.400e+04	1.636e-98	8.747e-28	1.712e-100	9.154e-30
0.0298	1.373e+05	1.582e-95	1.642e-27	1.603e-97	1.664e-29
0.0336	4.881e+04	2.039e-70	6.661e-28	1.450e-72	4.738e-30
0.0802	1.439e+05	1.679e-08	1.983e-08	2.654e-11	3.135e-11
0.1772	1.455e+04	2.354e-06	3.454e-06	4.041e-09	5.928e-09
0.2843	3.325e+05	4.831e-02	6.138e-02	9.097e-05	1.156e-04

0.3258	1.378e+04	5.101e-03	6.614e-03	9.771e-06	1.267e-05
0.3294	1.266e+04	5.001e-03	6.494e-03	9.591e-06	1.245e-05
0.3645	4.460e+06	3.013e+00	3.961e+00	5.833e-03	7.668e-03
0.503	1.981e+04	4.482e-02	6.145e-02	8.797e-05	1.206e-04
0.637	3.989e+05	1.665e+00	2.327e+00	3.238e-03	4.524e-03
0.6427	1.206e+04	5.141e-02	7.187e-02	9.988e-05	1.397e-04
0.7229	9.904e+04	5.461e-01	7.711e-01	1.050e-03	1.483e-03
Totals	5.797e+06	5.380e+00	7.267e+00	1.042e-02	1.408e-02

MicroShield 8.02
Nathan Hogue (8.00-0000)

Date	By	Checked
6-10-15	N. Hogue	<i>[Signature]</i>

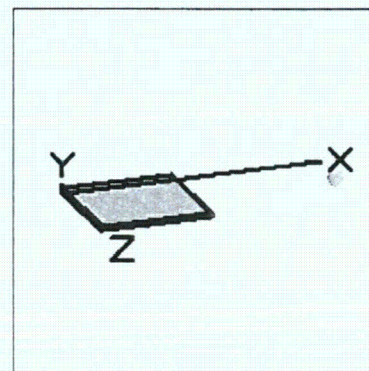
Filename	Run Date	Run Time	Duration
Case1	June 10, 2015	12:43:40 PM	00:00:00

Project Info	
Case Title	Case 1
Description	150 Ci Target-Mitigated (3 of 4 DF 100 filters)Filter No.4
Geometry	13 - Rectangular Volume

Source Dimensions	
Length	23.5 cm (9.3 in)
Width	23.5 cm (9.3 in)
Height	1.0 cm (0.4 in)

Dose Points			
A	X	Y	Z
#1	55.0 cm (1 ft 9.7 in)	0.5 cm (0.2 in)	12.0 cm (4.7 in)

Shields			
Shield N	Dimension	Material	Density
Source	552.25 cm ³	Carbon	2.1
Shield 2	.635 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	1.4850e-002	5.4945e+008	2.6890e+001	9.9493e+005

Buildup: The material reference is Shield 2	
Integration Parameters	
X Direction	10
Y Direction	20
Z 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
0.0041	3.022e+06	0.000e+00	4.856e-27	0.000e+00	3.620e-27
0.0295	7.400e+06	1.636e-96	8.747e-26	1.712e-98	9.154e-28
0.0298	1.373e+07	1.582e-93	1.642e-25	1.603e-95	1.664e-27
0.0336	4.881e+06	2.039e-68	6.661e-26	1.450e-70	4.738e-28
0.0802	1.439e+07	1.679e-06	1.983e-06	2.654e-09	3.135e-09
0.1772	1.455e+06	2.354e-04	3.454e-04	4.041e-07	5.928e-07
0.2843	3.325e+07	4.831e+00	6.138e+00	9.097e-03	1.156e-02

0.3258	1.378e+06	5.101e-01	6.614e-01	9.771e-04	1.267e-03
0.3294	1.266e+06	5.001e-01	6.494e-01	9.591e-04	1.245e-03
0.3645	4.460e+08	3.013e+02	3.961e+02	5.833e-01	7.668e-01
0.503	1.981e+06	4.482e+00	6.145e+00	8.797e-03	1.206e-02
0.637	3.989e+07	1.665e+02	2.327e+02	3.238e-01	4.524e-01
0.6427	1.206e+06	5.141e+00	7.187e+00	9.988e-03	1.397e-02
0.7229	9.904e+06	5.461e+01	7.711e+01	1.050e-01	1.483e-01
Totals	5.797e+08	5.380e+02	7.267e+02	1.042e+00	1.408e+00

MicroShield 8.02 Nathan Hogue (8.00-0000)
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Date	By	Checked
6-9-15	N. Hogue	<i>[Signature]</i>

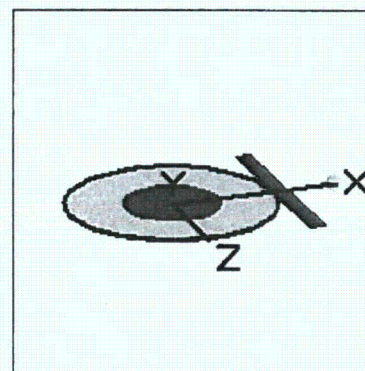
Filename	Run Date	Run Time	Duration
Case1	June 9, 2015	4:12:23 PM	00:00:00

Project Info	
Case Title	Case 1
Description	88 Ci Target-Mitigated (4 of 4 DF 1000 filters)-Filter No.2
Geometry	12 - Annular Cylinder - External Dose Point

Source Dimensions	
Height	1.0 cm (0.4 in)
Inner Cyl Radius	29.0 cm (11.4 in)
Inner Cyl Thickness	0.1 cm (0.0 in)
Outer Cyl Thickness	0.1 cm (0.0 in)
Source	36.0 cm (1 ft 2.2 in)

Dose Points			
A	X	Y	Z
#1	105.2 cm (3 ft 5.4 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Cyl. Radius	29.0 cm	Air	0.00122
Shield 1	.1 cm	Iron	7.85
Source	1.07e+04 cm ³	Carbon	2.1
Shield 3	.1 cm	Iron	7.85
Transition		Air	0.00122
Shield 5	10.0 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	8.7912e-002	3.2527e+009	8.2517e+000	3.0531e+005

Buildup: The material reference is Shield 5	
Integration Parameters	
Radial	10
Circumferential	20
Y Direction (axial)	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
0.0041	1.789e+07	0.000e+00	6.091e-27	0.000e+00	4.541e-27

0.0295	4.381e+07	0.000e+00	1.097e-25	0.000e+00	1.148e-27
0.0298	8.128e+07	0.000e+00	2.060e-25	0.000e+00	2.087e-27
0.0336	2.889e+07	0.000e+00	8.355e-26	0.000e+00	5.943e-28
0.0802	8.516e+07	9.137e-106	7.250e-25	1.445e-108	1.146e-27
0.1772	8.615e+06	5.680e-64	2.024e-25	9.749e-67	3.474e-28
0.2843	1.969e+08	2.013e-20	3.481e-20	3.791e-23	6.555e-23
0.3258	8.156e+06	1.438e-16	2.703e-16	2.753e-19	5.178e-19
0.3294	7.494e+06	2.963e-16	5.617e-16	5.682e-19	1.077e-18
0.3645	2.640e+09	6.846e-11	1.407e-10	1.325e-13	2.724e-13
0.503	1.173e+07	1.123e-07	2.898e-07	2.204e-10	5.689e-10
0.637	2.362e+08	3.660e-04	1.039e-03	7.116e-07	2.020e-06
0.6427	7.141e+06	1.287e-05	3.669e-05	2.501e-08	7.128e-08
0.7229	5.863e+07	6.268e-04	1.878e-03	1.205e-06	3.613e-06
Totals	3.432e+09	1.006e-03	2.955e-03	1.942e-06	5.705e-06

MicroShield 8.02
Nathan Hogue (8.00-0000)

Date	By	Checked
6-9-15	N. Hogue	<i>[Signature]</i>

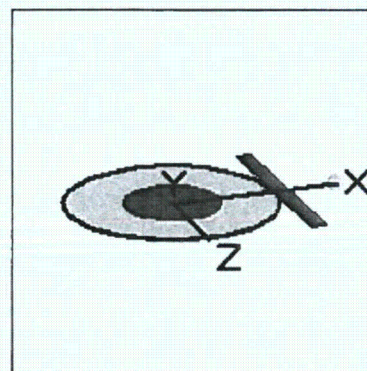
Filename	Run Date	Run Time	Duration
Case1	June 9, 2015	4:16:23 PM	00:00:00

Project Info	
Case Title	Case 1
Description	55 Ci Target-Mitigated (4 of 4 DF 1000 filters)-Filter No.2
Geometry	12 - Annular Cylinder - External Dose Point

Source Dimensions	
Height	1.0 cm (0.4 in)
Inner Cyl Radius	29.0 cm (11.4 in)
Inner Cyl Thickness	0.1 cm (0.0 in)
Outer Cyl Thickness	0.1 cm (0.0 in)
Source	36.0 cm (1 ft 2.2 in)

Dose Points			
A	X	Y	Z
#1	105.2 cm (3 ft 5.4 in)	0.0 cm (0 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Cyl. Radius	29.0 cm	Air	0.00122
Shield 1	.1 cm	Iron	7.85
Source	1.07e+04 cm ³	Carbon	2.1
Shield 3	.1 cm	Iron	7.85
Transition		Air	0.00122
Shield 5	10.0 cm	Lead	11.35
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm ³	Bq/cm ³
I-131	5.4945e-002	2.0330e+009	5.1573e+000	1.9082e+005

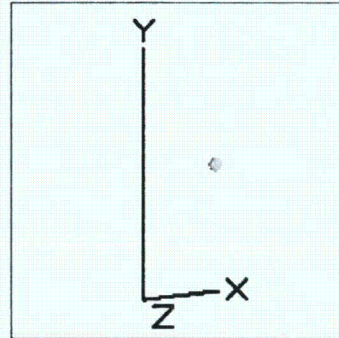
Buildup: The material reference is Shield 5	
Integration Parameters	
Radial	10
Circumferential	20
Y Direction (axial)	20

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
0.0041	1.118e+07	0.000e+00	3.807e-27	0.000e+00	2.838e-27

ATTACHMENT 9

0.0295	2.738e+07	0.000e+00	6.857e-26	0.000e+00	7.176e-28
0.0298	5.080e+07	0.000e+00	1.287e-25	0.000e+00	1.304e-27
0.0336	1.806e+07	0.000e+00	5.222e-26	0.000e+00	3.714e-28
0.0802	5.323e+07	5.711e-106	4.531e-25	9.030e-109	7.164e-28
0.1772	5.384e+06	3.550e-64	1.265e-25	6.093e-67	2.171e-28
0.2843	1.230e+08	1.258e-20	2.176e-20	2.369e-23	4.097e-23
0.3258	5.097e+06	8.985e-17	1.689e-16	1.721e-19	3.236e-19
0.3294	4.684e+06	1.852e-16	3.511e-16	3.551e-19	6.732e-19
0.3645	1.650e+09	4.279e-11	8.794e-11	8.282e-14	1.702e-13
0.503	7.329e+06	7.017e-08	1.811e-07	1.377e-10	3.555e-10
0.637	1.476e+08	2.287e-04	6.494e-04	4.447e-07	1.263e-06
0.6427	4.463e+06	8.044e-06	2.293e-05	1.563e-08	4.455e-08
0.7229	3.664e+07	3.917e-04	1.174e-03	7.533e-07	2.258e-06
Totals	2.145e+09	6.286e-04	1.847e-03	1.214e-06	3.566e-06

MicroShield 8.02 Nathan Hogue (8.00-0000)					
Date		By		Checked	
7-2-15		NH		[Signature]	
Filename		Run Date		Run Time	
Case2		July 2, 2015		8:24:16 AM	
Duration		00:00:00			
Project Info					
Case Title		Case 2			
Description		150 Ci Target-Shine from HC ductwork at 1 ft unmitigated			
Geometry		2 - Line			
Source Dimensions					
Length		100.0 cm (3 ft 3.4 in)			
Angle		90.0 °			
Dose Points					
A	X	Y	Z		
#1	30.0 cm (11.8 in)	50.0 cm (1 ft 7.7 in)	0.0 cm (0 in)		
Shields					
Shield N	Dimension	Material	Density		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Actual Photon Energies					
Nuclide	Ci	Bq	μCi/cm	Bq/cm	
I-131	1.0574e-002	3.9124e+008	1.0574e+002	3.9124e+006	
Buildup: The material reference is Air Gap					
Integration Parameters					
Length Segments					20
Results					
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
0.0041	2.152e+06	4.510e-01	4.582e-01	3.362e-01	3.415e-01
0.0295	5.269e+06	8.357e+00	8.498e+00	8.745e-02	8.893e-02
0.0298	9.776e+06	1.568e+01	1.594e+01	1.588e-01	1.615e-01
0.0336	3.475e+06	6.303e+00	6.409e+00	4.483e-02	4.558e-02
0.0802	1.024e+07	4.457e+01	4.518e+01	7.047e-02	7.143e-02
0.1772	1.036e+06	9.979e+00	1.006e+01	1.713e-02	1.727e-02
0.2843	2.368e+07	3.662e+02	3.682e+02	6.895e-01	6.934e-01
0.3258	9.810e+05	1.739e+01	1.748e+01	3.330e-02	3.348e-02
0.3294	9.014e+05	1.615e+01	1.624e+01	3.098e-02	3.114e-02
0.3645	3.175e+08	6.298e+03	6.328e+03	1.219e+01	1.225e+01
0.503	1.410e+06	3.863e+01	3.877e+01	7.582e-02	7.610e-02
0.637	2.841e+07	9.855e+02	9.886e+02	1.916e+00	1.922e+00
0.6427	8.589e+05	3.007e+01	3.016e+01	5.842e-02	5.860e-02
0.7229	7.052e+06	2.777e+02	2.785e+02	5.341e-01	5.356e-01
Totals	4.128e+08	8.115e+03	8.153e+03	1.624e+01	1.633e+01



MicroShield 8.02 Nathan Hogue (8.00-0000)	
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Date	By	Checked
7-2-15	NH	JH

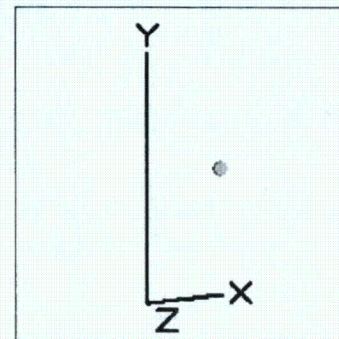
Filename	Run Date	Run Time	Duration
Case2	July 2, 2015	8:26:44 AM	00:00:00

Project Info	
Case Title	Case 2
Description	150 Ci Target-Shine from 6" ductwork at 1 ft unmitigated
Geometry	2 - Line

Source Dimensions	
Length	100.0 cm (3 ft 3.4 in)
Angle	90.0 °

Dose Points			
A	X	Y	Z
#1	30.0 cm (11.8 in)	50.0 cm (1 ft 7.7 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm	Bq/cm
I-131	2.4762e-003	9.1619e+007	2.4762e+001	9.1619e+005

Buildup: The material reference is Air Gap Integration Parameters	
Length Segments	20

Results					
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
0.0041	5.039e+05	1.056e-01	1.073e-01	7.874e-02	7.998e-02
0.0295	1.234e+06	1.957e+00	1.990e+00	2.048e-02	2.083e-02
0.0298	2.289e+06	3.671e+00	3.733e+00	3.720e-02	3.782e-02
0.0336	8.139e+05	1.476e+00	1.501e+00	1.050e-02	1.067e-02
0.0802	2.399e+06	1.044e+01	1.058e+01	1.650e-02	1.673e-02
0.1772	2.426e+05	2.337e+00	2.356e+00	4.011e-03	4.043e-03
0.2843	5.545e+06	8.575e+01	8.623e+01	1.615e-01	1.624e-01
0.3258	2.297e+05	4.072e+00	4.093e+00	7.799e-03	7.839e-03
0.3294	2.111e+05	3.783e+00	3.802e+00	7.254e-03	7.291e-03
0.3645	7.436e+07	1.475e+03	1.482e+03	2.855e+00	2.868e+00
0.503	3.303e+05	9.046e+00	9.079e+00	1.776e-02	1.782e-02
0.637	6.652e+06	2.308e+02	2.315e+02	4.487e-01	4.501e-01
0.6427	2.011e+05	7.041e+00	7.063e+00	1.368e-02	1.372e-02
0.7229	1.651e+06	6.504e+01	6.522e+01	1.251e-01	1.254e-01
Totals	9.666e+07	1.900e+03	1.909e+03	3.804e+00	3.823e+00

MicroShield 8.02 Nathan Hogue (8.00-0000)	
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Date	By	Checked
7-2-15	NH	JH

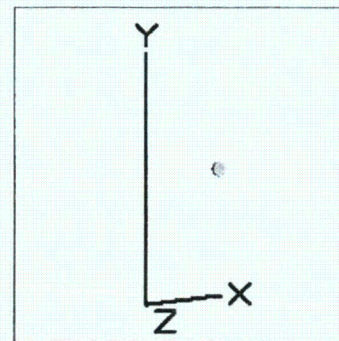
Filename	Run Date	Run Time	Duration
Case2	July 2, 2015	8:27:51 AM	00:00:00

Project Info	
Case Title	Case 2
Description	150 Ci Target-Shine from 16" ductwork at 1 ft unmitigated
Geometry	2 - Line

Source Dimensions	
Length	100.0 cm (3 ft 3.4 in)
Angle	90.0 °

Dose Points			
A	X	Y	Z
#1	30.0 cm (11.8 in)	50.0 cm (1 ft 7.7 in)	0.0 cm (0 in)

Shields			
Shield N	Dimension	Material	Density
Air Gap		Air	0.00122



Source Input: Grouping Method - Actual Photon Energies				
Nuclide	Ci	Bq	μCi/cm	Bq/cm
I-131	1.1632e-004	4.3038e+006	1.1632e+000	4.3038e+004

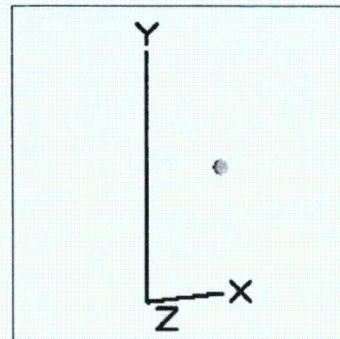
Buildup: The material reference is Air Gap Integration Parameters	
Length Segments	20

Results					
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
0.0041	2.367e+04	4.961e-03	5.040e-03	3.699e-03	3.757e-03
0.0295	5.796e+04	9.193e-02	9.348e-02	9.621e-04	9.783e-04
0.0298	1.075e+05	1.725e-01	1.754e-01	1.747e-03	1.777e-03
0.0336	3.823e+04	6.933e-02	7.050e-02	4.931e-04	5.015e-04
0.0802	1.127e+05	4.903e-01	4.970e-01	7.752e-04	7.858e-04
0.1772	1.140e+04	1.098e-01	1.107e-01	1.884e-04	1.899e-04
0.2843	2.605e+05	4.028e+00	4.051e+00	7.585e-03	7.628e-03
0.3258	1.079e+04	1.913e-01	1.923e-01	3.664e-04	3.683e-04
0.3294	9.916e+03	1.777e-01	1.786e-01	3.408e-04	3.425e-04
0.3645	3.493e+06	6.928e+01	6.961e+01	1.341e-01	1.347e-01
0.503	1.552e+04	4.249e-01	4.265e-01	8.341e-04	8.372e-04
0.637	3.125e+05	1.084e+01	1.088e+01	2.108e-02	2.114e-02
0.6427	9.448e+03	3.308e-01	3.318e-01	6.427e-04	6.447e-04
0.7229	7.758e+04	3.055e+00	3.064e+00	5.875e-03	5.892e-03
Totals	4.541e+06	8.927e+01	8.968e+01	1.787e-01	1.796e-01

MicroShield 8.02 Nathan Hogue (8.00-0000)					
Date		By		Checked	
7-2-15		NH		<i>[Signature]</i>	
Filename		Run Date		Run Time	
Case2		July 2, 2015		8:30:10 AM	
Duration		00:00:00			
Project Info					
Case Title		Case 2			
Description		88 Ci Target-Shine from HC ductwork at 1 ft unmitigated			
Geometry		2 - Line			
Source Dimensions					
Length		100.0 cm (3 ft 3.4 in)			
Angle		90.0 °			
Dose Points					
A	X	Y	Z		
#1	30.0 cm (11.8 in)	50.0 cm (1 ft 7.7 in)	0.0 cm (0 in)		
Shields					
Shield N	Dimension	Material	Density		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Actual Photon Energies					
Nuclide	Ci	Bq	μCi/cm	Bq/cm	
I-131	6.2032e-003	2.2952e+008	6.2032e+001	2.2952e+006	
Buildup: The material reference is Air Gap Integration Parameters					
Length Segments				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
0.0041	1.262e+06	2.646e-01	2.688e-01	1.972e-01	2.004e-01
0.0295	3.091e+06	4.902e+00	4.985e+00	5.130e-02	5.217e-02
0.0298	5.735e+06	9.197e+00	9.352e+00	9.318e-02	9.475e-02
0.0336	2.039e+06	3.697e+00	3.760e+00	2.630e-02	2.674e-02
0.0802	6.009e+06	2.615e+01	2.650e+01	4.134e-02	4.191e-02
0.1772	6.079e+05	5.854e+00	5.902e+00	1.005e-02	1.013e-02
0.2843	1.389e+07	2.148e+02	2.160e+02	4.045e-01	4.068e-01
0.3258	5.755e+05	1.020e+01	1.025e+01	1.954e-02	1.964e-02
0.3294	5.288e+05	9.477e+00	9.525e+00	1.817e-02	1.827e-02
0.3645	1.863e+08	3.695e+03	3.712e+03	7.152e+00	7.186e+00
0.503	8.274e+05	2.266e+01	2.274e+01	4.448e-02	4.464e-02
0.637	1.666e+07	5.782e+02	5.800e+02	1.124e+00	1.128e+00
0.6427	5.039e+05	1.764e+01	1.769e+01	3.427e-02	3.438e-02
0.7229	4.137e+06	1.629e+02	1.634e+02	3.133e-01	3.142e-01
Totals	2.422e+08	4.761e+03	4.783e+03	9.530e+00	9.577e+00

MicroShield 8.02 Nathan Hogue (8.00-0000)					
Date		By		Checked	
7-2-15		NH		[Signature]	
Filename		Run Date		Run Time	
Case2		July 2, 2015		8:31:07 AM	
Duration		-01:59:6			
Project Info					
Case Title		Case 2			
Description		88 Ci Target-Shine from 6" ductwork at 1 ft unmitigated			
Geometry		2 - Line			
Source Dimensions					
Length		100.0 cm (3 ft 3.4 in)			
Angle		90.0 °			
Dose Points					
A	X	Y	Z		
#1	30.0 cm (11.8 in)	50.0 cm (1 ft 7.7 in)	0.0 cm (0 in)		
Shields					
Shield N	Dimension	Material	Density		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Actual Photon Energies					
Nuclide	Ci	Bq	μCi/cm	Bq/cm	
I-131	1.4527e-003	5.3750e+007	1.4527e+001	5.3750e+005	
Buildup: The material reference is Air Gap Integration Parameters					
Length Segments					20
Results					
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
0.0041	2.956e+05	6.196e-02	6.294e-02	4.619e-02	4.692e-02
0.0295	7.239e+05	1.148e+00	1.167e+00	1.201e-02	1.222e-02
0.0298	1.343e+06	2.154e+00	2.190e+00	2.182e-02	2.219e-02
0.0336	4.775e+05	8.659e-01	8.805e-01	6.159e-03	6.263e-03
0.0802	1.407e+06	6.123e+00	6.207e+00	9.681e-03	9.814e-03
0.1772	1.424e+05	1.371e+00	1.382e+00	2.353e-03	2.372e-03
0.2843	3.253e+06	5.030e+01	5.059e+01	9.473e-02	9.526e-02
0.3258	1.348e+05	2.389e+00	2.401e+00	4.576e-03	4.599e-03
0.3294	1.238e+05	2.219e+00	2.231e+00	4.256e-03	4.278e-03
0.3645	4.363e+07	8.653e+02	8.694e+02	1.675e+00	1.683e+00
0.503	1.938e+05	5.307e+00	5.327e+00	1.042e-02	1.046e-02
0.637	3.903e+06	1.354e+02	1.358e+02	2.633e-01	2.641e-01
0.6427	1.180e+05	4.131e+00	4.144e+00	8.026e-03	8.051e-03
0.7229	9.688e+05	3.816e+01	3.826e+01	7.338e-02	7.359e-02
Totals	5.671e+07	1.115e+03	1.120e+03	2.232e+00	2.243e+00

MicroShield 8.02 Nathan Hogue (8.00-0000)					
Date		By		Checked	
7-2-15		NHC			
Filename	Run Date		Run Time	Duration	
Case2	July 2, 2015		8:31:55 AM	00:00:00	
Project Info					
Case Title	Case 2				
Description	88 Ci Target-Shine from 16" ductwork at 1 ft unmitigated				
Geometry	2 - Line				
Source Dimensions					
Length	100.0 cm (3 ft 3.4 in)				
Angle	90.0 °				
Dose Points					
A	X	Y	Z		
#1	30.0 cm (11.8 in)	50.0 cm (1 ft 7.7 in)	0.0 cm (0 in)		
Shields					
Shield N	Dimension	Material	Density		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Actual Photon Energies					
Nuclide	Ci	Bq	μCi/cm	Bq/cm	
I-131	6.8242e-005	2.5250e+006	6.8242e-001	2.5250e+004	
Buildup: The material reference is Air Gap					
Integration Parameters					
Length Segments					20
Results					
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
0.0041	1.389e+04	2.911e-03	2.957e-03	2.170e-03	2.204e-03
0.0295	3.401e+04	5.393e-02	5.484e-02	5.644e-04	5.739e-04
0.0298	6.309e+04	1.012e-01	1.029e-01	1.025e-03	1.042e-03
0.0336	2.243e+04	4.068e-02	4.136e-02	2.893e-04	2.942e-04
0.0802	6.611e+04	2.876e-01	2.916e-01	4.548e-04	4.610e-04
0.1772	6.687e+03	6.440e-02	6.492e-02	1.105e-04	1.114e-04
0.2843	1.528e+05	2.363e+00	2.376e+00	4.450e-03	4.475e-03
0.3258	6.331e+03	1.122e-01	1.128e-01	2.149e-04	2.160e-04
0.3294	5.817e+03	1.043e-01	1.048e-01	1.999e-04	2.009e-04
0.3645	2.049e+06	4.065e+01	4.084e+01	7.868e-02	7.905e-02
0.503	9.103e+03	2.493e-01	2.502e-01	4.893e-04	4.911e-04
0.637	1.833e+05	6.360e+00	6.380e+00	1.237e-02	1.241e-02
0.6427	5.543e+03	1.940e-01	1.946e-01	3.770e-04	3.782e-04
0.7229	4.551e+04	1.792e+00	1.797e+00	3.447e-03	3.457e-03
Totals	2.664e+06	5.237e+01	5.261e+01	1.048e-01	1.054e-01



MicroShield 8.02 Nathan Hogue (8.00-0000)					
Date	By	Checked			
7-2-15	Nut	[Signature]			
Filename	Run Date	Run Time	Duration		
Case2	July 2, 2015	8:34:26 AM	00:00:00		
Project Info					
Case Title	Case 2				
Description	55 Ci Target-Shine from HC ductwork at 1 ft unmitigated				
Geometry	2 - Line				
Source Dimensions					
Length	100.0 cm (3 ft 3.4 in)				
Angle	90.0 °				
Dose Points					
A	X	Y	Z		
#1	30.0 cm (11.8 in)	50.0 cm (1 ft 7.7 in)	0.0 cm (0 in)		
Shields					
Shield N	Dimension	Material	Density		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Actual Photon Energies					
Nuclide	Ci	Bq	μCi/cm	Bq/cm	
I-131	3.8770e-003	1.4345e+008	3.8770e+001	1.4345e+006	
Buildup: The material reference is Air Gap					
Integration Parameters					
Length Segments				20	
Results					
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
0.0041	7.890e+05	1.654e-01	1.680e-01	1.233e-01	1.252e-01
0.0295	1.932e+06	3.064e+00	3.116e+00	3.207e-02	3.261e-02
0.0298	3.584e+06	5.748e+00	5.845e+00	5.824e-02	5.922e-02
0.0336	1.274e+06	2.311e+00	2.350e+00	1.644e-02	1.671e-02
0.0802	3.756e+06	1.634e+01	1.656e+01	2.584e-02	2.619e-02
0.1772	3.799e+05	3.659e+00	3.689e+00	6.280e-03	6.331e-03
0.2843	8.682e+06	1.343e+02	1.350e+02	2.528e-01	2.542e-01
0.3258	3.597e+05	6.375e+00	6.408e+00	1.221e-02	1.227e-02
0.3294	3.305e+05	5.923e+00	5.953e+00	1.136e-02	1.142e-02
0.3645	1.164e+08	2.309e+03	2.320e+03	4.470e+00	4.491e+00
0.503	5.171e+05	1.416e+01	1.422e+01	2.780e-02	2.790e-02
0.637	1.042e+07	3.613e+02	3.625e+02	7.026e-01	7.048e-01
0.6427	3.149e+05	1.102e+01	1.106e+01	2.142e-02	2.149e-02
0.7229	2.586e+06	1.018e+02	1.021e+02	1.958e-01	1.964e-01
Totals	1.513e+08	2.975e+03	2.989e+03	5.956e+00	5.986e+00

MicroShield 8.02 Nathan Hogue (8.00-0000)					
Date		By		Checked	
7-2-15		NHG		[Signature]	
Filename		Run Date		Run Time	
Case2		July 2, 2015		8:33:37 AM	
Duration		00:00:00			
Project Info					
Case Title		Case 2			
Description		55 Ci Target-Shine from 6" ductwork at 1 ft unmitigated			
Geometry		2 - Line			
Source Dimensions					
Length		100.0 cm (3 ft 3.4 in)			
Angle		90.0 °			
Dose Points					
A	X	Y	Z		
#1	30.0 cm (11.8 in)	50.0 cm (1 ft 7.7 in)	0.0 cm (0 in)		
Shields					
Shield N	Dimension	Material	Density		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Actual Photon Energies					
Nuclide	Ci	Bq	μCi/cm	Bq/cm	
I-131	9.0796e-004	3.3595e+007	9.0796e+000	3.3595e+005	
Buildup: The material reference is Air Gap Integration Parameters					
Length Segments					20
Results					
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
0.0041	1.848e+05	3.873e-02	3.934e-02	2.887e-02	2.933e-02
0.0295	4.525e+05	7.176e-01	7.297e-01	7.509e-03	7.636e-03
0.0298	8.394e+05	1.346e+00	1.369e+00	1.364e-02	1.387e-02
0.0336	2.984e+05	5.412e-01	5.503e-01	3.849e-03	3.914e-03
0.0802	8.796e+05	3.827e+00	3.879e+00	6.051e-03	6.134e-03
0.1772	8.897e+04	8.569e-01	8.638e-01	1.471e-03	1.483e-03
0.2843	2.033e+06	3.144e+01	3.162e+01	5.921e-02	5.954e-02
0.3258	8.423e+04	1.493e+00	1.501e+00	2.860e-03	2.875e-03
0.3294	7.740e+04	1.387e+00	1.394e+00	2.660e-03	2.674e-03
0.3645	2.727e+07	5.408e+02	5.434e+02	1.047e+00	1.052e+00
0.503	1.211e+05	3.317e+00	3.329e+00	6.510e-03	6.535e-03
0.637	2.439e+06	8.462e+01	8.489e+01	1.645e-01	1.651e-01
0.6427	7.375e+04	2.582e+00	2.590e+00	5.016e-03	5.032e-03
0.7229	6.055e+05	2.385e+01	2.392e+01	4.586e-02	4.599e-02
Totals	3.544e+07	6.968e+02	7.000e+02	1.395e+00	1.402e+00

MicroShield 8.02 Nathan Hogue (8.00-0000)					
Date 7-2-15	By NHH	Checked [Signature]			
Filename Case2	Run Date July 2, 2015	Run Time 8:32:54 AM	Duration 00:00:00		
Project Info					
Case Title	Case 2				
Description	55 Ci Target-Shine from 16" ductwork at 1 ft unmitigated				
Geometry	2 - Line				
Source Dimensions					
Length	100.0 cm (3 ft 3.4 in)				
Angle	90.0 °				
Dose Points					
A	X	Y	Z		
#1	30.0 cm (11.8 in)	50.0 cm (1 ft 7.7 in)	0.0 cm (0 in)		
Shields					
Shield N	Dimension	Material	Density		
Air Gap		Air	0.00122		
Source Input: Grouping Method - Actual Photon Energies					
Nuclide	Ci	Bq	μCi/cm	Bq/cm	
I-131	4.2651e-005	1.5781e+006	4.2651e-001	1.5781e+004	
Buildup: The material reference is Air Gap					
Integration Parameters					
Length Segments				20	
Results					
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
0.0041	8.680e+03	1.819e-03	1.848e-03	1.356e-03	1.378e-03
0.0295	2.125e+04	3.371e-02	3.428e-02	3.528e-04	3.587e-04
0.0298	3.943e+04	6.323e-02	6.430e-02	6.407e-04	6.515e-04
0.0336	1.402e+04	2.542e-02	2.585e-02	1.808e-04	1.839e-04
0.0802	4.132e+04	1.798e-01	1.822e-01	2.842e-04	2.881e-04
0.1772	4.179e+03	4.025e-02	4.058e-02	6.908e-05	6.964e-05
0.2843	9.551e+04	1.477e+00	1.485e+00	2.781e-03	2.797e-03
0.3258	3.957e+03	7.013e-02	7.050e-02	1.343e-04	1.350e-04
0.3294	3.636e+03	6.516e-02	6.549e-02	1.250e-04	1.256e-04
0.3645	1.281e+06	2.540e+01	2.552e+01	4.917e-02	4.941e-02
0.503	5.689e+03	1.558e-01	1.564e-01	3.058e-04	3.070e-04
0.637	1.146e+05	3.975e+00	3.988e+00	7.729e-03	7.753e-03
0.6427	3.464e+03	1.213e-01	1.217e-01	2.356e-04	2.364e-04
0.7229	2.845e+04	1.120e+00	1.123e+00	2.154e-03	2.160e-03
Totals	1.665e+06	3.273e+01	3.288e+01	6.552e-02	6.585e-02

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TECHNICAL SPECIFICATION

UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY

Number 3.6

Page 4 of 5

Date _____

Amendment No. _____

SUBJECT: Experiments (continued)

- o. Fueled experiments containing inventories of Iodine 131 through 135 greater than 1.5 Curies or Strontium 90 greater than 5 millicuries shall be in irradiation containers that satisfy the requirements of specification 3.6.i or be vented to the exhaust stack system through HEPA and charcoal filters which are continuously monitored for an increase in radiation levels.
- p. Each non-fueled experiment shall be limited such that the inventory of Iodine 131 is not greater than 150 Curies.
- q. Non-fueled experiments that are intended to produce Iodine 131 shall be processed in hot cells that are vented to the exhaust stack system through charcoal filters which are continuously monitored for an increase in radiation levels.

Bases

- a. Specification 3.6.a restricts the generation of hazardous materials to levels that can be handled safely and easily. Analysis of fueled experiments containing a greater inventory of fission products has not been completed, and therefore their use is not permitted.
- b. Specification 3.6.b is intended to reduce the likelihood of accidental voiding in the core or water annulus surrounding the center test hole by restricting materials which could generate or accumulate gases or vapors.
- c. The limitation on experiment materials imposed by specification 3.5.c assures that the limits of Appendix B of 10 CFR 20 are not exceeded in the event of an experiment failure.
- d. Specification 3.6.d is intended to reduce the likelihood of damage to reactor or pool components resulting from detonation of explosive materials.
- e. Specification 3.6.e is intended to limit the experiments that can be moved in the center test hole while the reactor is operating, to those that will not introduce reactivity transients more severe than one that can be controlled without initiating safety system action (Ref. Add. 5 to HSR).

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Date _____

Amendment No. _____

SUBJECT: Experiments (continued)

- f. Specifications 3.6.f and 3.6.g provide guidance for experiment safety analysis to assure that anticipated transients will not result in radioactivity release and that experiments will not jeopardize the safe operation of the reactor.
- g. Specification 3.6.h is intended to reduce the likelihood of reactivity transients due to accidental voiding in the reactor or the failure of an experiment from internal or external heat generation.
- h. Specification 3.6.i is intended to reduce the likelihood of damage to the reactor and/or radioactivity releases from experiment failure.
- i. Specification 3.6.j provides assurance that no chemical reaction will take place to adversely affect the reactor or its components.
- j. Specification 3.6.k provides assurance that the integrity of the beamports will be maintained for all loop-type experiments.
- k. Specification 3.6.l assures that corrosive materials which are chemically incompatible with reactor components, highly flammable materials and toxic materials are adequately controlled and that this information is disseminated to all reactor users.
- l. The extremely low temperatures of the cryogenic liquids present structural problems which enhance the potential of an experiment failure. Specification 3.6.m provides for the proper review of proposed experiments containing or using cryogenic materials.
- m. Specifications 3.6.p and 3.6.q provide assurance that the processing of Iodine 131 can be performed safely and that equipment necessary for accident mitigation has been installed.

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TECHNICAL SPECIFICATION

UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY

Number 3.11

Page 1 of 2

Date _____

Amendment No. _____

SUBJECT: Iodine 131 Processing Hot Cells

Applicability

This specification shall apply to the limiting conditions of operation on the equipment needed to safely process Iodine 131.

Objective

The objective of this specification is to reasonably assure that the health and safety of the staff and public is not endangered as a result of processing Iodine 131.

Specification

- a. The facility ventilation exhaust system shall be operable when processing Iodine 131 in the Iodine 131 processing hot cells.
- b. The facility ventilation exhaust system shall maintain the Iodine 131 processing hot cells at a negative pressure with respect to the surrounding areas when processing Iodine 131.
- c. Processing of Iodine 131 shall not be performed in the Iodine 131 processing hot cells unless the following minimum number of radiation monitoring channels are operable.

	Radiation Monitoring Channel	Number
1.	Stack Radiation Monitor	1
2.	Iodine-131 Processing Hot Cells Radiation Monitor	1

Exception: When the required radiation monitoring channel becomes inoperable, then portable instruments may be substituted for the normally installed monitor in specification 3.11.c.2 within one (1) hour of discovery for a period not to exceed one (1) week.

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Date _____

Amendment No. _____

SUBJECT: Iodine 131 Processing Hot Cells (continued)

- d. At least three (3) charcoal filter banks having an efficiency of 99% or greater shall be operable when processing Iodine 131 in the Iodine 131 processing hot cells.

Bases

- a. Operation of the facility ventilation exhaust system when processing Iodine 131 in the Iodine 131 processing hot cells ensures proper dilution of effluents to prevent exceeding the limits of 10 CFR 20 Appendix B.
- b. Maintaining the Iodine 131 processing hot cells at a negative pressure with respect to the surrounding areas ensures safety for the facility staff.
- c. The radiation monitors provide information to operating personnel regarding routine release of radioactivity and any impending or existing danger from radiation. Their operation will provide sufficient time to take the necessary steps to prevent the spread of radioactivity to the surroundings.
- d. The potential radiation dose to staff and individuals at the Emergency Planning Zone boundary and beyond have been calculated following an accidental release of Iodine 131 activity. These calculations are based on the facility ventilation exhaust system directing all Iodine 131 processing hot cell effluents through charcoal filtration with an efficiency of 99% or greater prior to being released through the facility exhaust stack.

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TECHNICAL SPECIFICATION

UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY

Number 5.7

Page 1 of 2

Date _____

Amendment No. _____

SUBJECT: Iodine 131 Processing Hot Cells

Applicability

This specification shall apply to the surveillance of the equipment needed to safely process Iodine 131.

Objective

The objective of this specification is to reasonably assure proper operation of the equipment needed to safely process Iodine 131.

Specification

- a. An operability test of the facility ventilation exhaust system shall be performed monthly.
- b. The ability of the facility ventilation exhaust system to maintain the Iodine 131 processing hot cells at a negative pressure with respect to the surrounding areas shall be performed prior to any process (channel check).
- c. The radiation monitors as required by specification 3.11.c shall be calibrated on a semi-annual basis.
- d. The radiation monitors as required by specification 3.11.c shall be checked for operability with a radiation source at monthly intervals.
- e. The efficiency of the Iodine 131 processing hot cells charcoal filter banks shall be verified biennially. It shall be verified that the charcoal filter banks have a removal efficiency of 99% or greater for iodine.

Bases

- a. Experience has shown that monthly tests of the facility ventilation exhaust system are sufficient to assure proper operation.

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Date _____

Amendment No. _____

SUBJECT: Iodine 131 Processing Hot Cells (continued)

- b. Verifying that the Iodine 131 processing hot cells are at negative pressure with respect to the surrounding areas prior to use ensures personnel safety.
- c. Semiannual channel calibration of the radiation monitoring instrumentation will assure that long-term drift of the channels will be corrected.
- d. Experience has shown that monthly verification of operability of the radiation monitoring instrumentation is adequate assurance of proper operation over a long time period.
- e. Biennial verification of filter banks ensures that the filters will perform as analyzed.

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Date _____

Amendment No. _____

SUBJECT: Experiments (continued)

- o. Fueled experiments containing inventories of Iodine 131 through 135 greater than 1.5 Curies or Strontium 90 greater than 5 millicuries shall be in irradiation containers that satisfy the requirements of specification 3.6.i or be vented to the exhaust stack system through HEPA and charcoal filters which are continuously monitored for an increase in radiation levels.
- p. Each non-fueled experiment shall be limited such that the inventory of Iodine 131 is not greater than 150 Curies.
- q. Non-fueled experiments that are intended to produce Iodine 131 shall be processed in hot cells that are vented to the exhaust stack system through charcoal filters which are continuously monitored for an increase in radiation levels.

Bases

- a. Specification 3.6.a restricts the generation of hazardous materials to levels that can be handled safely and easily. Analysis of fueled experiments containing a greater inventory of fission products has not been completed, and therefore their use is not permitted.
- b. Specification 3.6.b is intended to reduce the likelihood of accidental voiding in the core or water annulus surrounding the center test hole by restricting materials which could generate or accumulate gases or vapors.
- c. The limitation on experiment materials imposed by specification 3.5.c assures that the limits of Appendix B of 10 CFR 20 are not exceeded in the event of an experiment failure.
- d. Specification 3.6.d is intended to reduce the likelihood of damage to reactor or pool components resulting from detonation of explosive materials.
- e. Specification 3.6.e is intended to limit the experiments that can be moved in the center test hole while the reactor is operating, to those that will not introduce reactivity transients more severe than one that can be controlled without initiating safety system action (Ref. Add. 5 to HSR).

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Amendment No. _____

SUBJECT: Experiments (continued)

- f. Specifications 3.6.f and 3.6.g provide guidance for experiment safety analysis to assure that anticipated transients will not result in radioactivity release and that experiments will not jeopardize the safe operation of the reactor.
- g. Specification 3.6.h is intended to reduce the likelihood of reactivity transients due to accidental voiding in the reactor or the failure of an experiment from internal or external heat generation.
- h. Specification 3.6.i is intended to reduce the likelihood of damage to the reactor and/or radioactivity releases from experiment failure.
- i. Specification 3.6.j provides assurance that no chemical reaction will take place to adversely affect the reactor or its components.
- j. Specification 3.6.k provides assurance that the integrity of the beamports will be maintained for all loop-type experiments.
- k. Specification 3.6.l assures that corrosive materials which are chemically incompatible with reactor components, highly flammable materials and toxic materials are adequately controlled and that this information is disseminated to all reactor users.
- l. The extremely low temperatures of the cryogenic liquids present structural problems which enhance the potential of an experiment failure. Specification 3.6.m provides for the proper review of proposed experiments containing or using cryogenic materials.
- m. Specifications 3.6.p and 3.6.q provide assurance that the processing of Iodine 131 can be performed safely and that equipment necessary for accident mitigation has been installed.

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UNIVERSITY OF MISSOURI RESEARCH REACTOR FACILITY

Number 3.11

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Date _____

Amendment No. _____

SUBJECT: Iodine 131 Processing Hot Cells

Applicability

This specification shall apply to the limiting conditions of operation on the equipment needed to safely process Iodine 131.

Objective

The objective of this specification is to reasonably assure that the health and safety of the staff and public is not endangered as a result of processing Iodine 131.

Specification

- a. The facility ventilation exhaust system shall be operable when processing Iodine 131 in the Iodine 131 processing hot cells.
- b. The facility ventilation exhaust system shall maintain the Iodine 131 processing hot cells at a negative pressure with respect to the surrounding areas when processing Iodine 131.
- c. Processing of Iodine 131 shall not be performed in the Iodine 131 processing hot cells unless the following minimum number of radiation monitoring channels are operable.

	Radiation Monitoring Channel	Number
1.	Stack Radiation Monitor	1
2.	Iodine-131 Processing Hot Cells Radiation Monitor	1

Exception: When the required radiation monitoring channel becomes inoperable, then portable instruments may be substituted for the normally installed monitor in specification 3.11.c.2 within one (1) hour of discovery for a period not to exceed one (1) week.

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SUBJECT: Iodine 131 Processing Hot Cells (continued)

- d. At least three (3) charcoal filter banks having an efficiency of 99% or greater shall be operable when processing Iodine 131 in the Iodine 131 processing hot cells.

Bases

- a. Operation of the facility ventilation exhaust system when processing Iodine 131 in the Iodine 131 processing hot cells ensures proper dilution of effluents to prevent exceeding the limits of 10 CFR 20 Appendix B.
- b. Maintaining the Iodine 131 processing hot cells at a negative pressure with respect to the surrounding areas ensures safety for the facility staff.
- c. The radiation monitors provide information to operating personnel regarding routine release of radioactivity and any impending or existing danger from radiation. Their operation will provide sufficient time to take the necessary steps to prevent the spread of radioactivity to the surroundings.
- d. The potential radiation dose to staff and individuals at the Emergency Planning Zone boundary and beyond have been calculated following an accidental release of Iodine 131 activity. These calculations are based on the facility ventilation exhaust system directing all Iodine 131 processing hot cell effluents through charcoal filtration with an efficiency of 99% or greater prior to being released through the facility exhaust stack.

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Number 5.7

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Date _____

Amendment No. _____

SUBJECT: Iodine 131 Processing Hot Cells

Applicability

This specification shall apply to the surveillance of the equipment needed to safely process Iodine 131.

Objective

The objective of this specification is to reasonably assure proper operation of the equipment needed to safely process Iodine 131.

Specification

- a. An operability test of the facility ventilation exhaust system shall be performed monthly.
- b. The ability of the facility ventilation exhaust system to maintain the Iodine 131 processing hot cells at a negative pressure with respect to the surrounding areas shall be performed prior to any process (channel check).
- c. The radiation monitors as required by specification 3.11.c shall be calibrated on a semi-annual basis.
- d. The radiation monitors as required by specification 3.11.c shall be checked for operability with a radiation source at monthly intervals.
- e. The efficiency of the Iodine 131 processing hot cells charcoal filter banks shall be verified biennially. It shall be verified that the charcoal filter banks have a removal efficiency of 99% or greater for iodine.

Bases

- a. Experience has shown that monthly tests of the facility ventilation exhaust system are sufficient to assure proper operation.

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SUBJECT: Iodine 131 Processing Hot Cells (continued)

- b. Verifying that the Iodine 131 processing hot cells are at negative pressure with respect to the surrounding areas prior to use ensures personnel safety.
- c. Semiannual channel calibration of the radiation monitoring instrumentation will assure that long-term drift of the channels will be corrected.
- d. Experience has shown that monthly verification of operability of the radiation monitoring instrumentation is adequate assurance of proper operation over a long time period.
- e. Biennial verification of filter banks ensures that the filters will perform as analyzed.