

<b>IDENTIFICATION</b>  <div style="border: 1px solid black; padding: 5px; text-align: center; font-weight: bold;">FS1-0039661</div>	<b>REVISION</b>  <div style="border: 1px solid black; padding: 5px; text-align: center; font-weight: bold;">2.0</div>	<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: left;"> <b>Framatome Fuel</b> </div> <div style="text-align: right;"> </div> </div>
<b>TOTAL NUMBER OF PAGES: 24</b>		

## TN-B1 Shielding Evaluation

**ADDITIONAL INFORMATION:**  
 TN-B1; Docket No. 71-9372; FS1-0015020

PROJECT		DISTRIBUTION TO	PURPOSE OF DISTRIBUTION
HANDLING	None		
CATEGORY	DAD - Design Analysis Documentation		
STATUS			

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**REVISIONS**

REVISION	DATE	EXPLANATORY NOTES
2.0	See 1 <sup>st</sup> page release date	Corrected typographic error in the table is Section 2.
1.0	9/4/2018	New document

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## REFERENCES

- 1 FS1-0015020 Revision 1.0, "TN-B1 Shipment of ATRIUM 11 Assemblies"
- 2 TJT 16:08 ltr Docket No. 71-9372, "AREVA TN-B1 Shipping Container, Application For Approval For Incorporation Of ATRIUM 11 Fuel Assemblies." Dated 18 November 2016
- 3 TJT 17:007 ltr Docket No. 71-9372, "AREVA TN-B1 Shipping Container, Application For Approval For Incorporation Of ATRIUM 11 Fuel Assemblies." Dated 17 February 2017
- 4 FS1-0014159 Revision 8.0, "Framatome TN-B1 Docket No. 71-9372 Safety Analysis Report"
- 5 FS1-0025122 Revision 1.0, "AREVA TN-B1 ATRIUM-11 Fuel Assembly Shipping Container Drop Analyses"

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## 1. PURPOSE

Reference (1) "TN-B1 Shipment of ATRIUM 11 Assemblies" was a shielding evaluation done to demonstrate that the ATRIUM 11 Lead Test Assembly (LTA) shipments would meet the dose rate limits of 10 CFR 71.47(a), 10 CFR 71.51(a)(2), and 49 CFR 173.441(a). This evaluation, because of the assumptions made in the evaluation, was initially considered adequate to meet the requirements when an application to modify TN-B1 CoC 9372 (USA/9372/B(U)F-96 to incorporate the ATRIUM 11 (see references (2) and (3)) was submitted.

Upon further review it was determined that the correlation in reference (1) and the allowed package content of the TN-B1 shown in reference (4) FS1-0014159 "AREVA TN-B1 Docket No. 71-9372 Safety Analysis Report" could be more specific. It was then decided to repeat the analysis of reference (1) to provide an improved analysis with a direct correlation to the defined package limits content of the TN-B1.

## 2. SUMMARY OF RESULTS

The results of these analyses show shipments of ATRIUM 11 will meet the dose rate limits of 10 CFR 71.47(a), 10 CFR 71.51(a)(2), and 49 CFR 173.441(a) for both the normal conditions of transport (NCT) and the hypothetical accident conditions (HAC).

Normal Conditions of Transport	Package surface mSv/h (mrem/h)			1 Meter from Package Surface mSv/h (mrem/h)		
	Top	Side	Bottom	Top	Side	Bottom
Radiation						
Gamma	.4591 (45.9)	.405 (40.5)	.245 (24.6)	.036 (3.51)	.02 (2.02)	.003 (.27)
10 CFR 71.47(a) limit	2 (200)	2 (200)	2 (200)	-	-	-

These results are consistent with the results of reference (1).

## 3. BACKGROUND

The allowed contents of the TN-B1 are found in section 1.2.3 "Contents" of reference (4). The content is generally described as having a maximum of two fuel assemblies which are placed in each package. The assemblies are configured either in 8x8, 9x9, 10x10 or 11x11 arrays or as loose rods contained in a cylinder. The nuclear fuel pellets are located in fuel rods and contained in the fuel assembly. The fuel pellets are either UO<sub>2</sub> or UO<sub>2</sub>-Gd<sub>2</sub>O<sub>3</sub>.

The fuel may be of either Type A or Type B content. When the contents of the packaging is commercial grade uranium or other uranium materials and the A<sub>2</sub> value is not exceeded, the packaging may be considered Type A. When the contents of the packaging includes enriched reprocessed uranium or other origin uranium not exceeding the values in Table 1-3 "Type B Quantity of Radioactive Material" of reference (4), the packaging is considered Type B. Table 1-3 "Type B Quantity of Radioactive Material" is reproduced as Appendix B of this document.

For the Hypothetical Accident Condition (HAC), reference (5) FS1-0025122 "AREVA TN-B1 ATRIUM-11 Fuel Assembly Shipping Container Drop Analyses" was reviewed. It was noted that this evaluation concluded that

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“the ATRIUM 11 Fuel Assemblies shipped within the AREVA TN-B1 shipping container deform but still maintain cladding integrity and structural stability while complying with the 10 CFR and ASME structural code requirements”. The deformation noted would not cause any significant variation that would result in a lack of conservatism as compared to the analysis.

## 4. ASSUMPTIONS AND MODEL SIMPLIFICATIONS

MicroShield® can only handle very simple geometries. Hence, it was necessary to assume a rectangular volume that would envelop the uranium portions of the assembly. These dimensions were provided in Appendix A. The uranium mass was ‘smeared’ throughout this volume, i.e. had a constant density.

It was assumed that all of the uranium in the assemblies was entirely BLEU. BLEU material is the most restrictive mixture of material processed at Framatome. This includes slightly irradiated fuel. All fuels at Framatome, other than BLEU meet ASTM C-996 standards for isotopic makeups. The isotopic make-up of BLEU varies, but was assumed to be at the limits for U-232, U-234, U-235, and U-236 shown in Table 1 of Appendix B.

Both UF<sub>6</sub> and BLEU may contain gamma radiation from fission products and alpha activity from neptunium and plutonium (see ASTM C-996 section 4.5). For gamma emitters the limiting content is shown in Table 1 of Appendix B. The dose rate from BLEU varies with time due to the build-in and decay of daughters. The principal nuclide of concern is TI-208, a constituent of the U-232 decay chain, which emits a number of gamma rays, including a 2.614 MeV gamma with a 100% yield. The peak dose rate occurs roughly 10.25 years after uranium purification. MicroShield® was used to calculate the activities of the daughters at 10.25 years of age, and these were subsequently used in the calculations.


Additional radionuclides were added based on the ASTM C-996, C-787, C-1295 standards for irradiated UF<sub>6</sub> and their subsequent analysis. These radionuclides are reflected in Table 2 of Appendix B. Feed and product fuel at Framatome meet this requirement. Calculations were performed at the limits of the feed material.

The model conservatively assumed no spacing or shielding from the TN-B1 shipping container.

Only one set of calculations were made for each dose point. Only credit was taken for shielding from Uranium, one thickness of the Zirconium Cladding. Additionally, distances between the fuel and the outer layer of the container were ignored. The calculations represent two unshielded fuel assemblies. This is extremely conservative and displays the lack of a need of additional shielding or additional accident scenario calculations. No credit was taken for any other materials present including the top and bottom nozzles. Distances were taken from RAJ-11 DWG NO. 105E3737 REV 6 and distances and densities are shown in Appendix C.

MicroShield® calculates both exposure rates and dose rates. The exposure rates are higher than the dose rates. In the comparison with DOT limits, the exposure rates were used as dose rates.

Manufacturing tolerances of both the TN-B1 and the ATRIUM 11 fuel affect the actual dose rates. However, given the conservatisms employed in the analysis and the comparison of results with regulatory limits, variations within tolerances are not a concern.

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## 5. SOFTWARE

MicroShield® Version 8.03 was used to calculate the activities of the uraniums, uranium daughters, potential transuranics and daughters and mixed fission products and daughters and the associated dose rates.

MicroShield® is a comprehensive photon/gamma ray shielding and dose assessment program that is widely used for designing shields and estimating source strength from radiation measurements.

MicroShield® is fully interactive and utilizes extensive input error checking. Integrated tools provide graphing of results, material and source file creation, source inference with decay (dose-to-Ci calculations accounting for decay and daughter buildup), and projection of exposure rate versus time as a result of decay, access to material and nuclide data.

## 6. CALCULATIONS

MicroShield® Version 8.03 was used to estimate the dose rates at midpoints of the ends, top, and side surfaces and at a distance of 1 meter from the fuel assemblies. (Midpoints should be where the dose rates are the highest.) The dose rates calculated using MicroShield® were then compared to NRC and DOT limits. If the dose rates were less than NRC and DOT dose limits, no additional shielding would be needed.

### 6.1. INPUTS

The inputs for MicroShield® are shown in Appendices A, B, C and D.

### 6.2. OUTPUTS

The outputs from each run from MicroShield® are contained in Appendix D.

## 7. RESULTS

The results of these analyses show shipments of ATRIUM 11 will meet the dose rate limits of 10 CFR 71.47(a), 10 CFR 71.51(a)(2), and 49 CFR 173.441(a) for both the normal conditions of transport (NCT) and the Hypothetical Accident Condition (HAC).

Normal Conditions of Transport	Package surface mSv/h (mrem/h)			1 Meter from Package Surface mSv/h (mrem/h)		
	Top	Side	Bottom	Top	Side	Bottom
Radiation						
Gamma	.459 (45.9)	.405 (40.5)	.246 (24.6)	.36 (3.61)	.02 (2.02)	.003 (.27)
10 CFR 71.47(a) limit	2 (200)	2 (200)	2 (200)	-	-	-
49 CFR 173.441 (a) Limit	2 (200)	2 (200)	2 (200)	-	-	-
10 CFR 71.51(a)(2) Limit	10 (1000)	10 (1000)	10 (1000)	-	-	-


Note: Since the packaging is not modelled, the NCT radiation results presented above do not result in a lack of conservatism when compared against the HAC limits.

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## ***APPENDIX A: Mechanical Design Inputs***

TN-B1 specifications came from GNF drawings (see Reference 1)

- RAJ-11 Outer/inner Container Assembly Licensing Drawing 105E3737, dated 03-26-04
- RAJ-11 Outer Container Main Body Assembly Licensing Drawing 105E3738, dated 03-26-04
- RAJ-11 Outer Container Lid Assembly Licensing Drawing 105E3743, dated 03-26-04
- RAJ-11 Inner Container Lid Assembly Licensing Drawing 105E3745, dated 03-26-04
- RAJ-11 Inner Container Parts Assembly Licensing Drawing 105E3746, dated 03-26-04
- RAJ-11 Inner Container Lid Assembly Licensing Drawing 105E3747, dated 03-26-04

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## APPENDIX B: Uranium Design Input

**Table 1 Type B Quality of Radioactive Material  
(Based in 11x11 Fuel Assembly)**

**Type B Quality of Radioactive Material (Based on 11x11 Fuel Assembly)**

Isotope	Max Content g/gU (1)	Maximum mass, g	Specific Activity (2), Tbq/g	Total Activity, Tbq	Total Activity, Ci
U-232	2.00E-09	9.92E-04	0.83	8.23E-04	2.23E-02
U-234	2.00E-03	9.92E+02	2.30E-04	2.28E-01	6.17E+00
U-235	5.00E-02	2.48E+04	8.00E-08	1.98E-03	5.36E-02
U-236	2.50E-02	1.24E+04	2.40E-06	2.98E-02	8.04E-01
U-238	9.23E-01	4.58E+05	1.20E-08	5.49E-03	1.48E-01
NP-237	1.66E-06	8.23E-01	2.60E-05	2.14E-05	5.79E-04
PU-238	6.20E-11	3.08E-05	6.30E-01	1.94E-05	5.24E-04
PU-239	3.04E-09	1.51E-03	2.30E-03	3.47E-06	9.37E-05
PU-240	3.04E-09	1.51E-03	8.40E-03	1.27E-05	3.42E-04
Gamma Emitters (3)	5.18E+05	N/A	N/A	2.57E-02	6.94E-01
			<b>Total</b>	2.92E-01	7.89E+00

(1) Based on a maximum payload of 281 kg UO<sub>2</sub> per assembly, 248 kg U (562 kg UO<sub>2</sub>, 496 kg U total)

(2) 10CFR71, Appendix A (Note: Current Part 71 values used, NP-237 & Pu-238 Specific Activities have been revised downward to two significant digits.)

(3) Assume gamma energy of 0.01 MeV(MeV-Bq/kgU)




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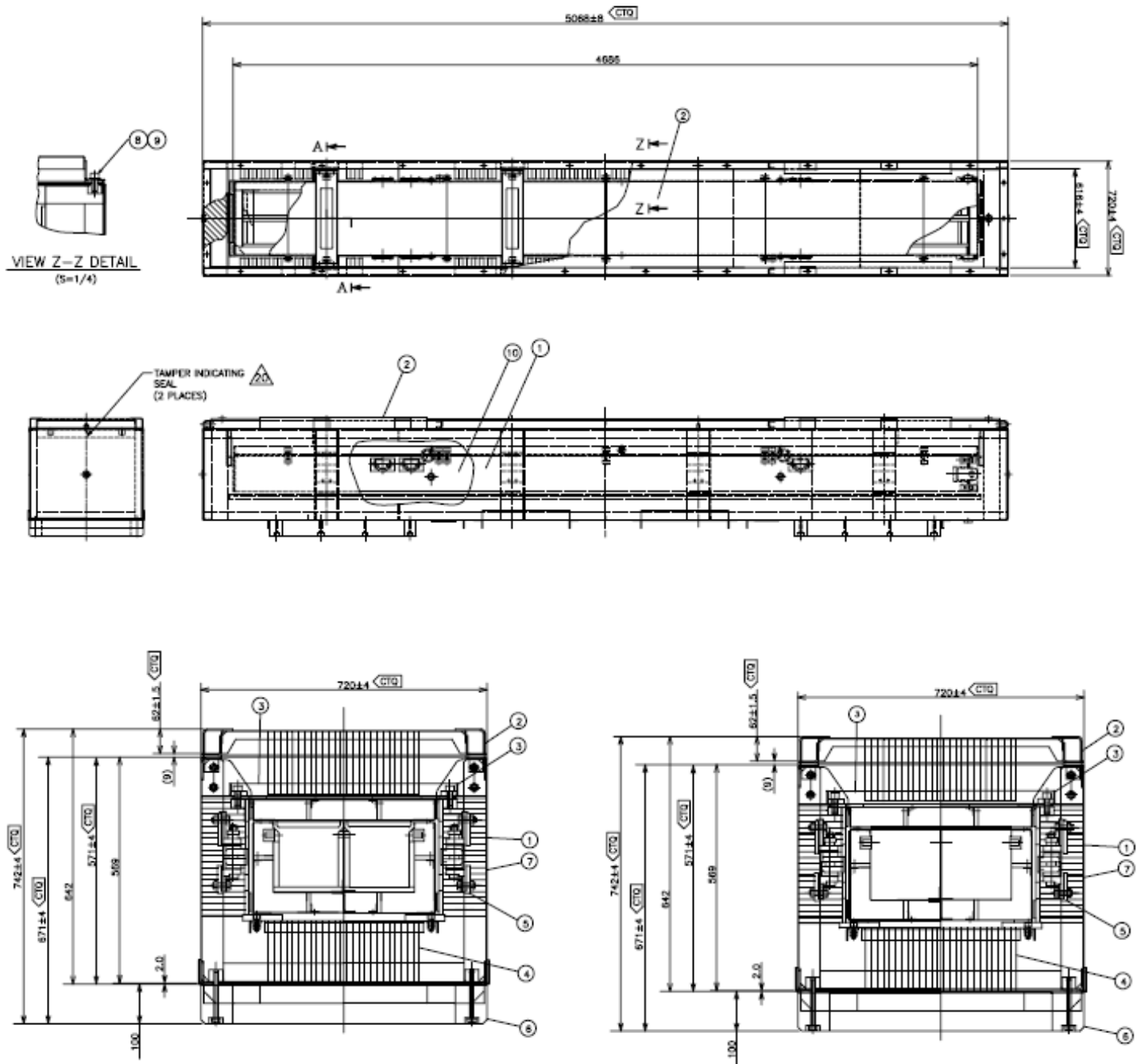
**Table 2 Type B Quantity of Target non fuel Radioactive Material  
(Based in 11x11 Fuel Assembly)**

<b>Type B Quantity of Target non fuel Radioactive Material (Based on 11x11 Fuel Assembly)</b>				
Isotope	Max Activity TBq/gU (1)	Maximum mass, g	Total Activity, Tbq	Total Activity, Ci
Ru-106	2.48E-09	4.96E+05	1.23E-03	3.32E-02
Ru-103	1.04E-09	4.96E+05	5.18E-04	1.40E-02
Ce-144	9.85E-09	4.96E+05	4.89E-03	1.32E-01
Sb-125	1.22E-09	4.96E+05	6.03E-04	1.63E-02
Cs-134	3.35E-10	4.96E+05	1.66E-04	4.49E-03
Cs-137	9.19E-10	4.96E+05	4.56E-04	1.23E-02
Zr-95	7.07E-10	4.96E+05	3.51E-04	9.48E-03
Nb-95	6.77E-10	4.96E+05	3.36E-04	9.08E-03
			<b>Total</b>	<b>2.31E-01</b>

***APPENDIX C: Conceptual Input***

Misc Data Atrium 11	Value	Units
Uranium Weight (excluding Gd)	248	kg
Assembly Length	12.761	cm
Assembly Width	12.761	cm
Assembly Height	381	cm
Zirc Clad Shielding Length	0.57	cm
Zirc Clad Shielding Density	6.49	g/cm3
Steel Wall Shielding	0.2	cm
Density of Steel Wall	7.874	g/cm3

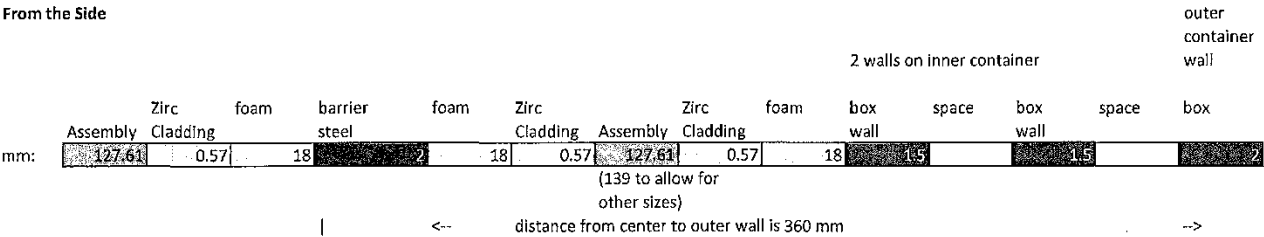
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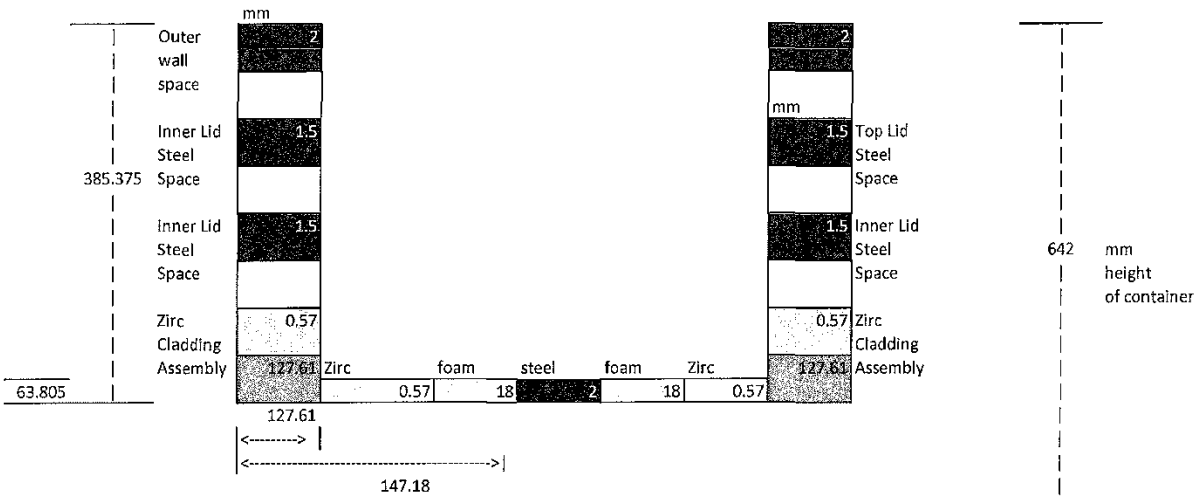
From RAJ-11 DWG NO. 105E3737 REV 6 All units in mm

Conceptual Drawings

From the Side



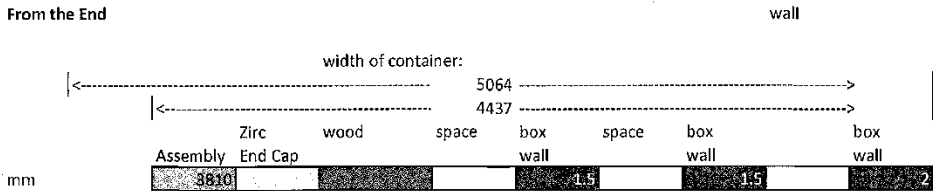
From the Top



Height of the outer container is 642 mm  
and assuming the assemblies are centered, 256.625 mm is between  
the assembly and either the top or bottom of the container.

The distance from the bottom of assembly to the top of outer container is: 385.375 mm  
The distance from the side of the assembly to surface of the outer  
container at the mid-point between the 2 assemblies is: 147.18 mm (only considers 1 axis)

From the End



Total length of outer container: 5064 mm  
if 'active' assembly is centered, 627 mm is left between fuel rods and the outer container's end  
The distance from the beginning of the assembly to the end of the box furthest away is: 4437 mm  
No credit taken for end caps, nozzles, wood, and miscellaneous parts.  
Distance from beginning edge of rods to the end of outside container  
midway between the 2 assemblies 147.18 mm

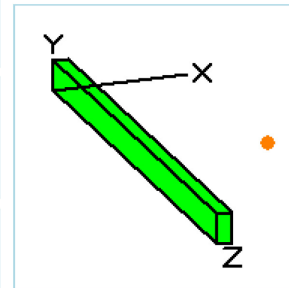
Note: There are tolerances in sizes. The above conceptual drawings may have some small errors in distances,  
but are good enough to demonstrate whether or not shielding is needed.

## APPENDIX D: MicroShield Inputs and Outputs

Case Summary of Framatome Atrium 11

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<b>MicroShield 8.03 AREVA (8.03-0000)</b>				
<b>Date</b>	<b>By</b>	<b>Checked</b>		
<b>Filename</b>	<b>Run Date</b>	<b>Run Time</b>	<b>Duration</b>	
Atrium 11 BLEU TN-B1heightunsh.ms	August 29, 2018	2:42:03 PM	00:00:01	
<b>Project Info</b>				
Case Title	Framatome Atrium 11			
Description	Framatome Atrium 11 with BLEU in TN-B1			
Geometry	13 - Rectangular Volume			
<b>Source Dimensions</b>				
Length	12.761 cm (5.0 in)			
Width	381.0 cm (12 ft 6.0 in)			
Height	25.522 cm (10.0 in)			
<b>Dose Points</b>				
<b>A</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	
#1	13.761 cm (5.4 in)	6.38 cm (2.5 in)	190.5 cm (6 ft 3.0 in)	
#2	112.761 cm (3 ft 8.4 in)	6.38 cm (2.5 in)	190.5 cm (6 ft 3.0 in)	
<b>Shields</b>				
<b>Shield N</b>	<b>Dimension</b>	<b>Material</b>	<b>Density</b>	
Source	1.24e+05 cm <sup>3</sup>	Uranium	2.98	
Shield 1	.057 cm	Zirconium	6.49	
Air Gap		Air	0.00122	
<b>Source Input: Grouping Method - Standard Indices</b> <b>Number of Groups: 25</b> <b>Lower Energy Cutoff: 0.015</b> <b>Photons &lt; 0.015: Included</b> <b>Library: Grove</b>				
<b>Nuclide</b>	<b>Ci</b>	<b>Bq</b>	<b>μCi/cm<sup>3</sup></b>	<b>Bq/cm<sup>3</sup></b>
Ac-225	1.2009e-011	4.4435e-001	9.6782e-011	3.5809e-006
Ac-227	1.7046e-006	6.3071e+004	1.3737e-005	5.0828e-001
Ac-228	1.7313e-010	6.4060e+000	1.3953e-009	5.1625e-005
At-217	1.2009e-011	4.4435e-001	9.6782e-011	3.5809e-006
Ba-137m	9.1944e-003	3.4019e+008	7.4097e-002	2.7416e+003
Bi-210	1.2297e-007	4.5498e+003	9.9097e-007	3.6666e-002
Bi-211	1.6676e-006	6.1701e+004	1.3439e-005	4.9724e-001
Bi-212	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Bi-213	1.2009e-011	4.4433e-001	9.6780e-011	3.5808e-006
Bi-214	1.2581e-006	4.6549e+004	1.0139e-005	3.7513e-001
Ce-144	1.4337e-005	5.3046e+005	1.1554e-004	4.2749e+000
Cs-134	1.4317e-004	5.2973e+006	1.1538e-003	4.2691e+001
Cs-137	9.7192e-003	3.5961e+008	7.8326e-002	2.8981e+003



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Fr-221	1.2009e-011	4.4435e-001	9.6782e-011	3.5809e-006
Fr-223	2.3524e-008	8.7037e+002	1.8957e-007	7.0142e-003
Nb-95	5.2175e-020	1.9305e-009	4.2047e-019	1.5557e-014
Nb-95m	2.0009e-022	7.4033e-012	1.6125e-021	5.9662e-017
Np-237	5.7900e-004	2.1423e+007	4.6661e-003	1.7265e+002
Pa-231	1.1618e-005	4.2988e+005	9.3631e-005	3.4644e+000
Pa-233	5.7900e-004	2.1423e+007	4.6661e-003	1.7265e+002
Pa-234	2.3680e-004	8.7616e+006	1.9083e-003	7.0609e+001
Pa-234m	1.4800e-001	5.4760e+009	1.1927e+000	4.4131e+004
Pb-209	1.2008e-011	4.4429e-001	9.6769e-011	3.5805e-006
Pb-210	1.2366e-007	4.5755e+003	9.9659e-007	3.6874e-002
Pb-211	1.6676e-006	6.1701e+004	1.3439e-005	4.9724e-001
Pb-212	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Pb-214	1.2581e-006	4.6549e+004	1.0139e-005	3.7514e-001
Po-210	1.0560e-007	3.9071e+003	8.5100e-007	3.1487e-002
Po-211	4.5525e-009	1.6844e+002	3.6689e-008	1.3575e-003
Po-212	1.2940e-002	4.7880e+008	1.0429e-001	3.8586e+003
Po-213	1.1750e-011	4.3474e-001	9.4689e-011	3.5035e-006
Po-214	1.2578e-006	4.6539e+004	1.0137e-005	3.7505e-001
Po-215	1.6676e-006	6.1703e+004	1.3439e-005	4.9725e-001
Po-216	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Po-218	1.2584e-006	4.6559e+004	1.0141e-005	3.7522e-001
Pr-144	1.4337e-005	5.3048e+005	1.1554e-004	4.2751e+000
Pr-144m	2.0502e-007	7.5857e+003	1.6522e-006	6.1133e-002
Pu-238	4.8325e-004	1.7880e+007	3.8944e-003	1.4409e+002
Pu-239	9.3672e-005	3.4659e+006	7.5490e-004	2.7931e+001
Pu-240	3.4163e-004	1.2640e+007	2.7532e-003	1.0187e+002
Ra-223	1.6676e-006	6.1703e+004	1.3439e-005	4.9725e-001
Ra-224	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Ra-225	1.2104e-011	4.4784e-001	9.7543e-011	3.6091e-006
Ra-226	1.2621e-006	4.6697e+004	1.0171e-005	3.7632e-001
Ra-228	1.7316e-010	6.4070e+000	1.3955e-009	5.1633e-005
Rh-103m	3.1990e-031	1.1836e-020	2.5780e-030	9.5387e-026
Rh-106	2.8860e-005	1.0678e+006	2.3258e-004	8.6056e+000
Rn-219	1.6676e-006	6.1703e+004	1.3439e-005	4.9725e-001
Rn-220	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Rn-222	1.2584e-006	4.6559e+004	1.0141e-005	3.7522e-001
Ru-103	3.2042e-031	1.1856e-020	2.5823e-030	9.5544e-026
Ru-106	2.8860e-005	1.0678e+006	2.3258e-004	8.6056e+000
Sb-125	1.2539e-003	4.6395e+007	1.0105e-002	3.7389e+002
Te-125m	3.0727e-004	1.1369e+007	2.4762e-003	9.1621e+001
Th-227	1.6582e-006	6.1354e+004	1.3364e-005	4.9445e-001
Th-228	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Th-229	1.2244e-011	4.5303e-001	9.8674e-011	3.6509e-006
Th-230	5.6927e-004	2.1063e+007	4.5877e-003	1.6974e+002

	5.3600e-002	1.9832e+009	4.3196e-001	1.5982e+004
Th-232	4.0656e-010	1.5043e+001	3.2765e-009	1.2123e-004
Th-234	1.4800e-001	5.4760e+009	1.1927e+000	4.4131e+004
Tl-207	1.6630e-006	6.1533e+004	1.3402e-005	4.9589e-001
Tl-208	7.2569e-003	2.6850e+008	5.8483e-002	2.1639e+003
Tl-209	2.5940e-013	9.5976e-003	2.0904e-012	7.7346e-008
U-232	2.0205e-002	7.4757e+008	1.6283e-001	6.0246e+003
U-233	2.5570e-008	9.4609e+002	2.0607e-007	7.6245e-003
U-234	6.1698e+000	2.2828e+011	4.9722e+001	1.8397e+006
U-235	5.3600e-002	1.9832e+009	4.3196e-001	1.5982e+004
U-236	8.0400e-001	2.9748e+010	6.4794e+000	2.3974e+005
U-238	1.4800e-001	5.4760e+009	1.1927e+000	4.4131e+004
Zr-95	2.3601e-020	8.7325e-010	1.9020e-019	7.0374e-015

**Buildup: The material reference is Source  
Integration Parameters**


X Direction	10
Y Direction	20
Z Direction	20

**Results - Dose Point # 1 - (13.761,6.38,190.5) 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
0.015	3.039e+10	1.196e-38	2.818e-22	1.026e-39	2.417e-23
0.02	1.634e+03	1.509e-67	2.020e-29	5.227e-69	6.996e-31
0.03	3.474e+08	1.607e-29	6.488e-24	1.593e-31	6.430e-26
0.04	1.511e+07	6.184e-15	6.381e-15	2.735e-17	2.822e-17
0.05	2.694e+08	2.651e-07	2.763e-07	7.062e-10	7.361e-10
0.06	2.585e+08	3.189e-04	3.365e-04	6.335e-07	6.684e-07
0.08	5.504e+08	3.829e-01	4.133e-01	6.060e-04	6.540e-04
0.1	6.496e+08	6.384e+00	7.019e+00	9.767e-03	1.074e-02
0.15	3.145e+08	2.941e+00	1.115e+01	4.842e-03	1.835e-02
0.2	1.596e+09	1.264e+02	1.837e+02	2.231e-01	3.243e-01
0.3	6.080e+07	3.168e+01	3.718e+01	6.009e-02	7.053e-02
0.4	1.656e+07	2.439e+01	2.859e+01	4.753e-02	5.570e-02
0.5	6.722e+07	1.951e+02	2.327e+02	3.830e-01	4.568e-01
0.6	5.588e+08	2.630e+03	3.179e+03	5.134e+00	6.205e+00
0.8	1.705e+08	1.555e+03	1.938e+03	2.957e+00	3.687e+00
1.0	6.983e+07	9.985e+02	1.265e+03	1.841e+00	2.331e+00
1.5	2.702e+07	7.696e+02	9.720e+02	1.295e+00	1.635e+00
2.0	1.656e+06	6.964e+01	8.848e+01	1.077e-01	1.368e-01
3.0	2.680e+08	1.806e+04	2.281e+04	2.450e+01	3.095e+01
<b>Totals</b>	<b>3.563e+10</b>	<b>2.447e+04</b>	<b>3.076e+04</b>	<b>3.657e+01</b>	<b>4.588e+01</b>

**Results - Dose Point # 2 - (112.761,6.38,190.5) cm**

		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
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Energy (MeV)	Activity (Photons/sec)	MeV/cm <sup>2</sup> /sec No Buildup	MeV/cm <sup>2</sup> /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.015	3.039e+10	8.160e-17	8.160e-17	6.999e-18	6.999e-18
0.02	1.634e+03	3.007e-33	1.188e-30	1.041e-34	4.115e-32
0.03	3.474e+08	9.175e-14	9.321e-14	9.093e-16	9.238e-16
0.04	1.511e+07	3.658e-08	3.747e-08	1.618e-10	1.657e-10
0.05	2.694e+08	4.557e-04	4.707e-04	1.214e-06	1.254e-06
0.06	2.585e+08	1.140e-02	1.188e-02	2.264e-05	2.359e-05
0.08	5.504e+08	4.930e-01	5.220e-01	7.802e-04	8.261e-04
0.1	6.496e+08	2.258e+00	2.421e+00	3.455e-03	3.704e-03
0.15	3.145e+08	1.302e+00	2.796e+00	2.143e-03	4.604e-03
0.2	1.596e+09	2.205e+01	2.909e+01	3.891e-02	5.135e-02
0.3	6.080e+07	3.330e+00	3.789e+00	6.316e-03	7.188e-03
0.4	1.656e+07	2.174e+00	2.482e+00	4.235e-03	4.835e-03
0.5	6.722e+07	1.630e+01	1.907e+01	3.200e-02	3.742e-02
0.6	5.588e+08	2.144e+02	2.554e+02	4.186e-01	4.985e-01
0.8	1.705e+08	1.249e+02	1.543e+02	2.376e-01	2.934e-01
1.0	6.983e+07	7.979e+01	1.003e+02	1.471e-01	1.848e-01
1.5	2.702e+07	6.086e+01	7.602e+01	1.024e-01	1.279e-01
2.0	1.656e+06	5.472e+00	6.856e+00	8.462e-03	1.060e-02
3.0	2.680e+08	1.412e+03	1.757e+03	1.916e+00	2.383e+00
<b>Totals</b>	<b>3.563e+10</b>	<b>1.945e+03</b>	<b>2.410e+03</b>	<b>2.918e+00</b>	<b>3.608e+00</b>

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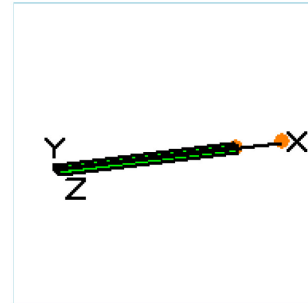


N° FS1-0039661	Rev. 2.0	<div style="text-align: center;"> <b>TN-B1 Shielding Evaluation</b> </div> <div style="text-align: right;"> <b>framatome</b> </div>
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<b>MicroShield 8.03</b> <b>AREVA (8.03-0000)</b>				
<b>Date</b>		<b>By</b>		<b>Checked</b>
<b>Filename</b>		<b>Run Date</b>	<b>Run Time</b>	<b>Duration</b>
Atrium 11 BLEU TN-B1lengthunsh.msd		August 29, 2018	3:09:07 PM	00:00:01
<b>Project Info</b>				
Case Title		Framatome Atrium 11		
Description		Framatome Atrium 11 with BLEU in TN-B1		
Geometry		13 - Rectangular Volume		
<b>Source Dimensions</b>				
Length	381.0 cm (12 ft 6.0 in)			
Width	25.522 cm (10.0 in)			
Height	12.761 cm (5.0 in)			
<b>Dose Points</b>				
<b>A</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	
#1	382.0 cm (12 ft 6.4 in)	6.38 cm (2.5 in)	12.761 cm (5.0 in)	
#2	481.0 cm (15 ft 9.4 in)	6.38 cm (2.5 in)	12.761 cm (5.0 in)	
<b>Shields</b>				
<b>Shield N</b>	<b>Dimension</b>	<b>Material</b>	<b>Density</b>	
Source	1.24e+05 cm <sup>3</sup>	Uranium	2.98	
Shield 1	.057 cm	Zirconium	6.49	
Air Gap		Air	0.00122	
<b>Source Input: Grouping Method - Standard Indices</b> <b>Number of Groups: 25</b> <b>Lower Energy Cutoff: 0.015</b> <b>Photons &lt; 0.015: Included</b> <b>Library: Grove</b>				
<b>Nuclide</b>	<b>Ci</b>	<b>Bq</b>	<b>μCi/cm<sup>3</sup></b>	<b>Bq/cm<sup>3</sup></b>
Ac-225	1.2009e-011	4.4435e-001	9.6782e-011	3.5809e-006
Ac-227	1.7046e-006	6.3071e+004	1.3737e-005	5.0828e-001
Ac-228	1.7313e-010	6.4060e+000	1.3953e-009	5.1625e-005
At-217	1.2009e-011	4.4435e-001	9.6782e-011	3.5809e-006
Ba-137m	9.1944e-003	3.4019e+008	7.4097e-002	2.7416e+003
Bi-210	1.2297e-007	4.5498e+003	9.9097e-007	3.6666e-002
Bi-211	1.6676e-006	6.1701e+004	1.3439e-005	4.9724e-001
Bi-212	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Bi-213	1.2009e-011	4.4433e-001	9.6780e-011	3.5808e-006
Bi-214	1.2581e-006	4.6549e+004	1.0139e-005	3.7513e-001
Ce-144	1.4337e-005	5.3046e+005	1.1554e-004	4.2749e+000
Cs-134	1.4317e-004	5.2973e+006	1.1538e-003	4.2691e+001
Cs-137	9.7192e-003	3.5961e+008	7.8326e-002	2.8981e+003



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Fr-221	1.2009e-011	4.4435e-001	9.6782e-011	3.5809e-006
Fr-223	2.3524e-008	8.7037e+002	1.8957e-007	7.0142e-003
Nb-95	5.2175e-020	1.9305e-009	4.2047e-019	1.5557e-014
Nb-95m	2.0009e-022	7.4033e-012	1.6125e-021	5.9662e-017
Np-237	5.7900e-004	2.1423e+007	4.6661e-003	1.7265e+002
Pa-231	1.1618e-005	4.2988e+005	9.3631e-005	3.4644e+000
Pa-233	5.7900e-004	2.1423e+007	4.6661e-003	1.7265e+002
Pa-234	2.3680e-004	8.7616e+006	1.9083e-003	7.0609e+001
Pa-234m	1.4800e-001	5.4760e+009	1.1927e+000	4.4131e+004
Pb-209	1.2008e-011	4.4429e-001	9.6769e-011	3.5805e-006
Pb-210	1.2366e-007	4.5755e+003	9.9659e-007	3.6874e-002
Pb-211	1.6676e-006	6.1701e+004	1.3439e-005	4.9724e-001
Pb-212	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Pb-214	1.2581e-006	4.6549e+004	1.0139e-005	3.7514e-001
Po-210	1.0560e-007	3.9071e+003	8.5100e-007	3.1487e-002
Po-211	4.5525e-009	1.6844e+002	3.6689e-008	1.3575e-003
Po-212	1.2940e-002	4.7880e+008	1.0429e-001	3.8586e+003
Po-213	1.1750e-011	4.3474e-001	9.4689e-011	3.5035e-006
Po-214	1.2578e-006	4.6539e+004	1.0137e-005	3.7505e-001
Po-215	1.6676e-006	6.1703e+004	1.3439e-005	4.9725e-001
Po-216	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Po-218	1.2584e-006	4.6559e+004	1.0141e-005	3.7522e-001
Pr-144	1.4337e-005	5.3048e+005	1.1554e-004	4.2751e+000
Pr-144m	2.0502e-007	7.5857e+003	1.6522e-006	6.1133e-002
Pu-238	4.8325e-004	1.7880e+007	3.8944e-003	1.4409e+002
Pu-239	9.3672e-005	3.4659e+006	7.5490e-004	2.7931e+001
Pu-240	3.4163e-004	1.2640e+007	2.7532e-003	1.0187e+002
Ra-223	1.6676e-006	6.1703e+004	1.3439e-005	4.9725e-001
Ra-224	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Ra-225	1.2104e-011	4.4784e-001	9.7543e-011	3.6091e-006
Ra-226	1.2621e-006	4.6697e+004	1.0171e-005	3.7632e-001
Ra-228	1.7316e-010	6.4070e+000	1.3955e-009	5.1633e-005
Rh-103m	3.1990e-031	1.1836e-020	2.5780e-030	9.5387e-026
Rh-106	2.8860e-005	1.0678e+006	2.3258e-004	8.6056e+000
Rn-219	1.6676e-006	6.1703e+004	1.3439e-005	4.9725e-001
Rn-220	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Rn-222	1.2584e-006	4.6559e+004	1.0141e-005	3.7522e-001
Ru-103	3.2042e-031	1.1856e-020	2.5823e-030	9.5544e-026
Ru-106	2.8860e-005	1.0678e+006	2.3258e-004	8.6056e+000
Sb-125	1.2539e-003	4.6395e+007	1.0105e-002	3.7389e+002
Te-125m	3.0727e-004	1.1369e+007	2.4762e-003	9.1621e+001
Th-227	1.6582e-006	6.1354e+004	1.3364e-005	4.9445e-001
Th-228	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Th-229	1.2244e-011	4.5303e-001	9.8674e-011	3.6509e-006
Th-230	5.6927e-004	2.1063e+007	4.5877e-003	1.6974e+002

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	5.3600e-002	1.9832e+009	4.3196e-001	1.5982e+004
Th-232	4.0656e-010	1.5043e+001	3.2765e-009	1.2123e-004
Th-234	1.4800e-001	5.4760e+009	1.1927e+000	4.4131e+004
Tl-207	1.6630e-006	6.1533e+004	1.3402e-005	4.9589e-001
Tl-208	7.2569e-003	2.6850e+008	5.8483e-002	2.1639e+003
Tl-209	2.5940e-013	9.5976e-003	2.0904e-012	7.7346e-008
U-232	2.0205e-002	7.4757e+008	1.6283e-001	6.0246e+003
U-233	2.5570e-008	9.4609e+002	2.0607e-007	7.6245e-003
U-234	6.1698e+000	2.2828e+011	4.9722e+001	1.8397e+006
U-235	5.3600e-002	1.9832e+009	4.3196e-001	1.5982e+004
U-236	8.0400e-001	2.9748e+010	6.4794e+000	2.3974e+005
U-238	1.4800e-001	5.4760e+009	1.1927e+000	4.4131e+004
Zr-95	2.3601e-020	8.7325e-010	1.9020e-019	7.0374e-015

**Buildup: The material reference is Source  
Integration Parameters**

X Direction	10
Y Direction	20
Z Direction	20


**Results - Dose Point # 1 - (382,6.38,12.761) 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
0.015	3.039e+10	0.000e+00	1.772e-22	0.000e+00	1.520e-23
0.02	1.634e+03	0.000e+00	1.270e-29	0.000e+00	4.399e-31
0.03	3.474e+08	1.935e-260	4.080e-24	1.917e-262	4.043e-26
0.04	1.511e+07	1.720e-124	2.415e-25	7.608e-127	1.068e-27
0.05	2.694e+08	1.787e-68	5.507e-24	4.760e-71	1.467e-26
0.06	2.585e+08	3.848e-42	6.594e-24	7.643e-45	1.310e-26
0.08	5.504e+08	5.672e-19	6.605e-19	8.975e-22	1.045e-21
0.1	6.496e+08	7.410e-10	9.061e-10	1.134e-12	1.386e-12
0.15	3.145e+08	6.513e-15	1.005e-07	1.072e-17	1.655e-10
0.2	1.596e+09	9.604e-06	1.706e-05	1.695e-08	3.011e-08
0.3	6.080e+07	7.946e-02	1.068e-01	1.507e-04	2.027e-04
0.4	1.656e+07	1.107e+00	1.528e+00	2.157e-03	2.977e-03
0.5	6.722e+07	2.733e+01	3.866e+01	5.364e-02	7.588e-02
0.6	5.588e+08	6.312e+02	8.986e+02	1.232e+00	1.754e+00
0.8	1.705e+08	5.957e+02	8.588e+02	1.133e+00	1.634e+00
1.0	6.983e+07	4.627e+02	6.637e+02	8.528e-01	1.223e+00
1.5	2.702e+07	4.170e+02	5.723e+02	7.016e-01	9.628e-01
2.0	1.656e+06	3.916e+01	5.329e+01	6.056e-02	8.241e-02
3.0	2.680e+08	1.035e+04	1.387e+04	1.404e+01	1.882e+01
<b>Totals</b>	<b>3.563e+10</b>	<b>1.252e+04</b>	<b>1.696e+04</b>	<b>1.808e+01</b>	<b>2.455e+01</b>

**Results - Dose Point # 2 - (481,6.38,12.761) cm**

		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
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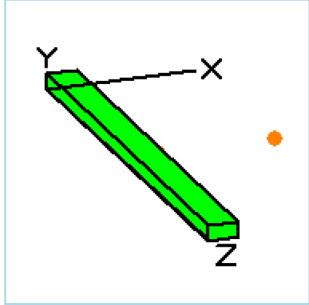
Energy (MeV)	Activity (Photons/sec)	MeV/cm²/sec No Buildup	MeV/cm²/sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.015	3.039e+10	0.000e+00	6.586e-24	0.000e+00	5.649e-25
0.02	1.634e+03	0.000e+00	4.721e-31	0.000e+00	1.635e-32
0.03	3.474e+08	1.466e-260	1.516e-25	1.452e-262	1.503e-27
0.04	1.511e+07	1.143e-124	8.975e-27	5.053e-127	3.969e-29
0.05	2.694e+08	8.619e-69	2.047e-25	2.296e-71	5.453e-28
0.06	2.585e+08	1.313e-42	2.451e-25	2.608e-45	4.868e-28
0.08	5.504e+08	1.064e-19	1.239e-19	1.684e-22	1.960e-22
0.1	6.496e+08	8.441e-11	1.030e-10	1.291e-13	1.576e-13
0.15	3.145e+08	1.015e-15	8.816e-09	1.672e-18	1.452e-11
0.2	1.596e+09	8.059e-07	1.428e-06	1.422e-09	2.520e-09
0.3	6.080e+07	2.950e-03	3.929e-03	5.595e-06	7.453e-06
0.4	1.656e+07	2.596e-02	3.507e-02	5.058e-05	6.832e-05
0.5	6.722e+07	4.907e-01	6.716e-01	9.633e-04	1.318e-03
0.6	5.588e+08	9.608e+00	1.311e+01	1.875e-02	2.559e-02
0.8	1.705e+08	7.548e+00	1.033e+01	1.436e-02	1.965e-02
1.0	6.983e+07	5.348e+00	7.268e+00	9.858e-03	1.340e-02
1.5	2.702e+07	4.452e+00	5.884e+00	7.490e-03	9.900e-03
2.0	1.656e+06	4.120e-01	5.491e-01	6.371e-04	8.492e-04
3.0	2.680e+08	1.084e+02	1.443e+02	1.471e-01	1.958e-01
<b>Totals</b>	<b>3.563e+10</b>	<b>1.363e+02</b>	<b>1.822e+02</b>	<b>1.992e-01</b>	<b>2.665e-01</b>

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<b>MicroShield 8.03</b> <b>AREVA (8.03-0000)</b>				
<b>Date</b>	<b>By</b>	<b>Checked</b>		
<b>Filename</b>		<b>Run Date</b>	<b>Run Time</b>	<b>Duration</b>
Atrium 11 BLEU TN-B1wideunsh.ms		August 29, 2018	3:48:42 PM	00:00:01
<b>Project Info</b>				
Case Title	Framatome Atrium 11			
Description	Framatome Atrium 11 with BLEU in TN-B1			
Geometry	13 - Rectangular Volume			
<b>Source Dimensions</b>				
Length	25.522 cm (10.0 in)			
Width	381.0 cm (12 ft 6.0 in)			
Height	12.761 cm (5.0 in)			
<b>Dose Points</b>				
<b>A</b>	<b>X</b>	<b>Y</b>	<b>Z</b>	
#1	26.522 cm (10.4 in)	6.38 cm (2.5 in)	190.5 cm (6 ft 3.0 in)	
#2	126.522 cm (4 ft 1.8 in)	6.38 cm (2.5 in)	190.5 cm (6 ft 3.0 in)	
<b>Shields</b>				
<b>Shield N</b>	<b>Dimension</b>	<b>Material</b>	<b>Density</b>	
Source	1.24e+05 cm <sup>3</sup>	Uranium	2.98	
Shield 1	.057 cm	Zirconium	6.49	
Air Gap		Air	0.00122	



<b>Source Input: Grouping Method - Standard Indices</b> <b>Number of Groups: 25</b> <b>Lower Energy Cutoff: 0.015</b> <b>Photons &lt; 0.015: Included</b> <b>Library: Grove</b>				
<b>Nuclide</b>	<b>Ci</b>	<b>Bq</b>	<b>μCi/cm<sup>3</sup></b>	<b>Bq/cm<sup>3</sup></b>
Ac-225	1.2009e-011	4.4435e-001	9.6782e-011	3.5809e-006
Ac-227	1.7046e-006	6.3071e+004	1.3737e-005	5.0828e-001
Ac-228	1.7313e-010	6.4060e+000	1.3953e-009	5.1625e-005
At-217	1.2009e-011	4.4435e-001	9.6782e-011	3.5809e-006
Ba-137m	9.1944e-003	3.4019e+008	7.4097e-002	2.7416e+003
Bi-210	1.2297e-007	4.5498e+003	9.9097e-007	3.6666e-002
Bi-211	1.6676e-006	6.1701e+004	1.3439e-005	4.9724e-001
Bi-212	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Bi-213	1.2009e-011	4.4433e-001	9.6780e-011	3.5808e-006
Bi-214	1.2581e-006	4.6549e+004	1.0139e-005	3.7513e-001
Ce-144	1.4337e-005	5.3046e+005	1.1554e-004	4.2749e+000
Cs-134	1.4317e-004	5.2973e+006	1.1538e-003	4.2691e+001
Cs-137	9.7192e-003	3.5961e+008	7.8326e-002	2.8981e+003

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Fr-221	1.2009e-011	4.4435e-001	9.6782e-011	3.5809e-006
Fr-223	2.3524e-008	8.7037e+002	1.8957e-007	7.0142e-003
Nb-95	5.2175e-020	1.9305e-009	4.2047e-019	1.5557e-014
Nb-95m	2.0009e-022	7.4033e-012	1.6125e-021	5.9662e-017
Np-237	5.7900e-004	2.1423e+007	4.6661e-003	1.7265e+002
Pa-231	1.1618e-005	4.2988e+005	9.3631e-005	3.4644e+000
Pa-233	5.7900e-004	2.1423e+007	4.6661e-003	1.7265e+002
Pa-234	2.3680e-004	8.7616e+006	1.9083e-003	7.0609e+001
Pa-234m	1.4800e-001	5.4760e+009	1.1927e+000	4.4131e+004
Pb-209	1.2008e-011	4.4429e-001	9.6769e-011	3.5805e-006
Pb-210	1.2366e-007	4.5755e+003	9.9659e-007	3.6874e-002
Pb-211	1.6676e-006	6.1701e+004	1.3439e-005	4.9724e-001
Pb-212	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Pb-214	1.2581e-006	4.6549e+004	1.0139e-005	3.7514e-001
Po-210	1.0560e-007	3.9071e+003	8.5100e-007	3.1487e-002
Po-211	4.5525e-009	1.6844e+002	3.6689e-008	1.3575e-003
Po-212	1.2940e-002	4.7880e+008	1.0429e-001	3.8586e+003
Po-213	1.1750e-011	4.3474e-001	9.4689e-011	3.5035e-006
Po-214	1.2578e-006	4.6539e+004	1.0137e-005	3.7505e-001
Po-215	1.6676e-006	6.1703e+004	1.3439e-005	4.9725e-001
Po-216	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Po-218	1.2584e-006	4.6559e+004	1.0141e-005	3.7522e-001
Pr-144	1.4337e-005	5.3048e+005	1.1554e-004	4.2751e+000
Pr-144m	2.0502e-007	7.5857e+003	1.6522e-006	6.1133e-002
Pu-238	4.8325e-004	1.7880e+007	3.8944e-003	1.4409e+002
Pu-239	9.3672e-005	3.4659e+006	7.5490e-004	2.7931e+001
Pu-240	3.4163e-004	1.2640e+007	2.7532e-003	1.0187e+002
Ra-223	1.6676e-006	6.1703e+004	1.3439e-005	4.9725e-001
Ra-224	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Ra-225	1.2104e-011	4.4784e-001	9.7543e-011	3.6091e-006
Ra-226	1.2621e-006	4.6697e+004	1.0171e-005	3.7632e-001
Ra-228	1.7316e-010	6.4070e+000	1.3955e-009	5.1633e-005
Rh-103m	3.1990e-031	1.1836e-020	2.5780e-030	9.5387e-026
Rh-106	2.8860e-005	1.0678e+006	2.3258e-004	8.6056e+000
Rn-219	1.6676e-006	6.1703e+004	1.3439e-005	4.9725e-001
Rn-220	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Rn-222	1.2584e-006	4.6559e+004	1.0141e-005	3.7522e-001
Ru-103	3.2042e-031	1.1856e-020	2.5823e-030	9.5544e-026
Ru-106	2.8860e-005	1.0678e+006	2.3258e-004	8.6056e+000
Sb-125	1.2539e-003	4.6395e+007	1.0105e-002	3.7389e+002
Te-125m	3.0727e-004	1.1369e+007	2.4762e-003	9.1621e+001
Th-227	1.6582e-006	6.1354e+004	1.3364e-005	4.9445e-001
Th-228	2.0197e-002	7.4730e+008	1.6277e-001	6.0224e+003
Th-229	1.2244e-011	4.5303e-001	9.8674e-011	3.6509e-006
Th-230	5.6927e-004	2.1063e+007	4.5877e-003	1.6974e+002

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	5.3600e-002	1.9832e+009	4.3196e-001	1.5982e+004
Th-232	4.0656e-010	1.5043e+001	3.2765e-009	1.2123e-004
Th-234	1.4800e-001	5.4760e+009	1.1927e+000	4.4131e+004
Tl-207	1.6630e-006	6.1533e+004	1.3402e-005	4.9589e-001
Tl-208	7.2569e-003	2.6850e+008	5.8483e-002	2.1639e+003
Tl-209	2.5940e-013	9.5976e-003	2.0904e-012	7.7346e-008
U-232	2.0205e-002	7.4757e+008	1.6283e-001	6.0246e+003
U-233	2.5570e-008	9.4609e+002	2.0607e-007	7.6245e-003
U-234	6.1698e+000	2.2828e+011	4.9722e+001	1.8397e+006
U-235	5.3600e-002	1.9832e+009	4.3196e-001	1.5982e+004
U-236	8.0400e-001	2.9748e+010	6.4794e+000	2.3974e+005
U-238	1.4800e-001	5.4760e+009	1.1927e+000	4.4131e+004
Zr-95	2.3601e-020	8.7325e-010	1.9020e-019	7.0374e-015

**Buildup: The material reference is Source  
Integration Parameters**

X Direction	10
Y Direction	20
Z Direction	20

**Results - Dose Point # 1 - (26.522,6.38,190.5) 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
0.015	3.039e+10	1.700e-62	2.557e-22	1.458e-63	2.193e-23
0.02	1.634e+03	2.617e-92	1.833e-29	9.067e-94	6.349e-31
0.03	3.474e+08	1.814e-44	5.887e-24	1.798e-46	5.835e-26
0.04	1.511e+07	6.369e-22	6.584e-22	2.817e-24	2.912e-24
0.05	2.694e+08	4.097e-11	4.293e-11	1.091e-13	1.144e-13
0.06	2.585e+08	1.656e-06	1.761e-06	3.290e-09	3.498e-09
0.08	5.504e+08	4.146e-02	4.530e-02	6.561e-05	7.169e-05
0.1	6.496e+08	2.269e+00	2.534e+00	3.472e-03	3.877e-03
0.15	3.145e+08	4.731e-01	3.860e+00	7.791e-04	6.357e-03
0.2	1.596e+09	6.465e+01	9.893e+01	1.141e-01	1.746e-01
0.3	6.080e+07	2.774e+01	3.304e+01	5.262e-02	6.267e-02
0.4	1.656e+07	2.280e+01	2.688e+01	4.443e-02	5.237e-02
0.5	6.722e+07	1.836e+02	2.194e+02	3.603e-01	4.307e-01
0.6	5.588e+08	2.461e+03	2.966e+03	4.804e+00	5.789e+00
0.8	1.705e+08	1.431e+03	1.767e+03	2.721e+00	3.360e+00
1.0	6.983e+07	9.060e+02	1.133e+03	1.670e+00	2.089e+00
1.5	2.702e+07	6.852e+02	8.539e+02	1.153e+00	1.437e+00
2.0	1.656e+06	6.161e+01	7.731e+01	9.527e-02	1.196e-01
3.0	2.680e+08	1.591e+04	1.989e+04	2.159e+01	2.698e+01
<b>Totals</b>	<b>3.563e+10</b>	<b>2.176e+04</b>	<b>2.707e+04</b>	<b>3.261e+01</b>	<b>4.051e+01</b>

**Results - Dose Point # 2 - (126.522,6.38,190.5) cm**

		Fluence Rate	Fluence Rate	Exposure Rate	Exposure Rate
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Energy (MeV)	Activity (Photons/sec)	MeV/cm <sup>2</sup> /sec No Buildup	MeV/cm <sup>2</sup> /sec With Buildup	mR/hr No Buildup	mR/hr With Buildup
0.015	3.039e+10	3.645e-30	1.522e-23	3.126e-31	1.306e-24
0.02	1.634e+03	5.123e-48	1.091e-30	1.775e-49	3.779e-32
0.03	3.474e+08	2.104e-22	2.138e-22	2.085e-24	2.119e-24
0.04	1.511e+07	2.632e-12	2.709e-12	1.164e-14	1.198e-14
0.05	2.694e+08	2.023e-06	2.101e-06	5.388e-09	5.597e-09
0.06	2.585e+08	3.672e-04	3.853e-04	7.293e-07	7.654e-07
0.08	5.504e+08	8.926e-02	9.569e-02	1.412e-04	1.514e-04
0.1	6.496e+08	7.956e-01	8.649e-01	1.217e-03	1.323e-03
0.15	3.145e+08	3.106e-01	9.599e-01	5.115e-04	1.581e-03
0.2	1.596e+09	9.472e+00	1.338e+01	1.672e-02	2.362e-02
0.3	6.080e+07	1.655e+00	1.906e+00	3.140e-03	3.615e-03
0.4	1.656e+07	1.083e+00	1.239e+00	2.111e-03	2.414e-03
0.5	6.722e+07	8.127e+00	9.497e+00	1.595e-02	1.864e-02
0.6	5.588e+08	1.071e+02	1.276e+02	2.090e-01	2.490e-01
0.8	1.705e+08	6.306e+01	7.840e+01	1.199e-01	1.491e-01
1.0	6.983e+07	4.100e+01	5.235e+01	7.558e-02	9.650e-02
1.5	2.702e+07	3.266e+01	4.230e+01	5.495e-02	7.117e-02
2.0	1.656e+06	3.004e+00	3.938e+00	4.645e-03	6.089e-03
3.0	2.680e+08	7.880e+02	1.029e+03	1.069e+00	1.396e+00
<b>Totals</b>	<b>3.563e+10</b>	<b>1.056e+03</b>	<b>1.361e+03</b>	<b>1.573e+00</b>	<b>2.019e+00</b>

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