

## Syringe Shielding Evaluation for Lu-177 and Ga-68

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Author : IRA & FOPH

### 1. Introduction

The goal of this study was to gain information about the dose to the extremity with different type and brands of syringe shieldings when working with 200 MBq of Ga-68 or 7.5 GBq of Lu-177. We tried to evaluate which kind of the tested syringe shieldings is the best to use when working with these two isotopes. We received 10 different syringe shieldings (6 shieldings for 3 ml syringes, 3 shieldings for 5 ml syringes and 1 shielding for the 10 ml syringes) from the FOPH for testing.

### 2. Material

Table 1 summarizes the characteristics of each syringe shielding tested, as indicated by the company. Figures 1 and 2 show pictures of them, Figure 3 shows the syringes employed for the tests.

Syringe shielding test n°	Volume	Kind of material	Thickness
1	3 ml	High density lead glass	5 mm
2	3 ml	90% Tungsten,10% balance Ni-Cu, lead glass windows	5 mm for tungsten, 9 mm lead glass
3	3 ml	Acrylic glass	8 -10 mm
4	3 ml	Tungsten	2.25 mm
5	3 ml	Tungsten	2.25 mm
6	3 ml	90% Tungsten,10% balance Ni-Cu, lead glass windows	7.5 mm for tungsten, 11-13 mm lead glass
7	5 ml	Acrylic glass	8 - 10 mm
8	5 ml	Tungsten	2.3 mm
9	5 ml	90% Tungsten,10% balance Ni-Cu, lead glass windows	7.5 mm for tungsten, 11-13 mm lead glass
10	10 ml	Acrylic glass	10 mm

Table 1: Summary of syringe shielding characteristics as indicated by the companies.

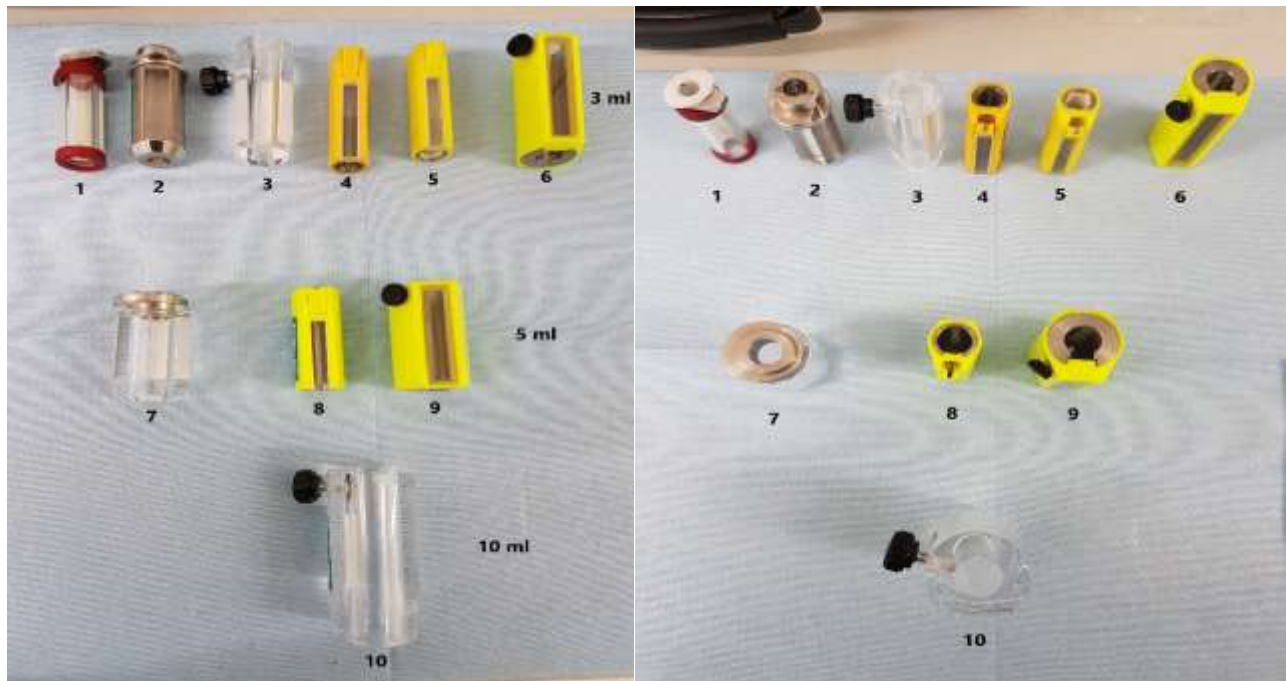


Figure 1 and 2: Pictures of syringe shieldsings 1-10.



Figure 3: Syringes employed for the experiment.

### 3. Methods

#### 3.1. Experiments

A syringe of 3 ml, 5 ml or 10 ml was filled up to the maximum corresponding volume of the syringe with a solution containing either Ga-68 or Lu-177. The syringe was measured in a dose calibrator and the activity and the time of the measurement were registered. Afterwards, the syringe was inserted in the syringe shielding with the 6 TLD MCP (A, B, C, D, E, F) already taped (see Figure 4). The TLD MCP (G) was taped on the top of the filled syringe plunger and exposed for 1, 3 or 5 minutes.

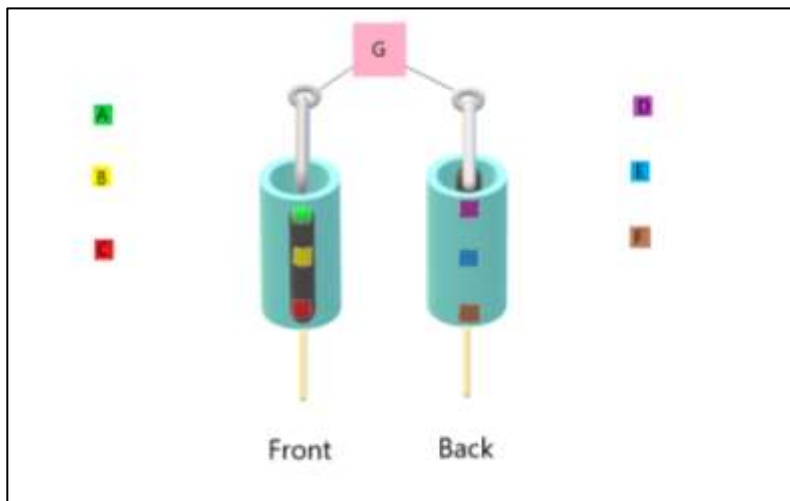


Figure 4: Positions of the TLD MCP, left side shows the setup on the side with the window for volume reading (front, A, B and C), right side shows the setup for the back of the shielding (D, E, and F), G indicates the measured point on the plunger.

## 4. Results

### 4.1. Results for the nuclide Ga-68

The table below shows the results from the tests done with a solution of Ga-68. The syringe shielding number corresponds to the one as defined in Table 1.

Dose to the extremity when using a 200 MBq Ga-68 solution in a syringe with a syringe shielding				
Syringe shielding n°	TLD MCP position	1 minute [mSv]	3 minutes [mSv]	5 minutes [mSv]
1	A	1.14	3.43	5.72
	B	1.53	4.60	7.66
	C	1.21	3.62	6.03
	D	1.09	3.27	5.45
	E	1.62	4.85	8.08
	F	1.43	4.28	7.14
	G	0.08	0.23	0.38
2	A	0.76	2.29	3.81
	B	1.09	3.27	5.45
	C	0.87	2.62	4.36
	D	0.51	1.53	2.55
	E	0.62	1.86	3.11
	F	0.55	1.66	2.77
	G	0.06	0.19	0.32
3	A	0.35	1.06	1.77
	B	1.11	3.32	5.54
	C	0.83	2.49	4.14
	D	0.36	1.09	1.82
	E	1.14	3.42	5.71
	F	0.89	2.68	4.46
	G	0.07	0.20	0.34

4	A	0.99	2.98	4.97
	B	1.10	3.29	5.49
	C	0.75	2.24	3.73
	D	0.18	0.54	0.90
	E	1.34	4.01	6.68
	F	0.88	2.63	4.38
	G	0.04	0.12	0.20
5	A	0.28	0.83	1.38
	B	1.22	3.65	6.09
	C	0.91	2.74	4.57
	D	0.21	0.63	1.05
	E	1.18	3.55	5.91
	F	1.05	3.16	5.26
	G	0.04	0.12	0.20
6	A	0.14	0.43	0.71
	B	0.40	1.20	2.00
	C	0.31	0.93	1.55
	D	0.07	0.21	0.35
	E	0.33	1.00	1.67
	F	0.32	0.97	1.61
	G	0.04	0.13	0.22
7	A	0.47	1.41	2.34
	B	1.08	3.23	5.38
	C	0.97	2.91	4.86
	D	0.38	1.15	1.92
	E	0.95	2.85	4.74
	F	0.91	2.72	4.54
	G	0.08	0.25	0.42
8	A	0.27	0.82	1.36
	B	0.98	2.95	4.91
	C	0.82	2.45	4.09
	D	0.17	0.51	0.85
	E	0.92	2.77	4.61
	F	<b>1.06</b>	<b>3.19</b>	<b>5.32</b>
	G	0.06	0.18	0.30
9	A	0.13	0.39	0.66
	B	0.38	1.14	1.90
	C	0.35	1.04	1.74
	D	0.07	0.21	0.35
	E	0.23	0.68	1.13
	F	0.23	0.70	1.16
	G	0.08	0.25	0.42
10	A	<b>1.87</b>	<b>5.62</b>	<b>9.37</b>
	B	0.78	2.35	3.91
	C	0.53	1.59	2.65
	D	0.20	0.61	1.02
	E	0.69	2.06	3.43
	F	0.50	1.51	2.52
	G	0.21	0.64	1.07

#### 4.2. Lu-177

The table below show the test done with a solution of Lu-177. The syringe shielding number corresponds to the one as defined in Table 1.

Dose to the extremity when using a 7,5 GBq Lu-177 solution in a syringe with different syringe shieldings				
Syringe shielding n°	TLD MCP position	1 minute [mSv]	3 minutes [mSv]	5 minutes [mSv]
1	A	0.150	0.451	0.752
	B	0.238	0.713	1.188
	C	0.205	0.616	1.027
	D	0.175	0.524	0.874
	E	0.272	0.816	1.359
	F	0.255	0.764	1.274
	G	0.034	0.103	0.172
2	A	0.036	0.107	0.179
	B	0.068	0.205	0.342
	C	0.069	0.207	0.345
	D	0.010	0.030	0.049
	E	0.011	0.032	0.053
	F	0.017	0.052	0.086
	G	0.028	0.085	0.142
3	A	0.473	1.419	2.365
	B	1.453	4.359	7.265
	C	1.116	3.347	5.578
	D	0.471	1.413	2.354
	E	1.405	4.214	7.024
	F	0.945	2.836	4.726
	G	0.038	0.113	0.189
4	A	0.137	0.412	0.686
	B	0.169	0.506	0.843
	C	0.114	0.342	0.569
	D	0.011	0.034	0.056
	E	0.106	0.319	0.531
	F	0.105	0.316	0.526
	G	0.027	0.080	0.134
5	A	0.146	0.438	0.730
	B	0.194	0.583	0.971
	C	0.137	0.410	0.683
	D	0.013	0.038	0.064
	E	0.110	0.330	0.549
	F	0.107	0.320	0.533
	G	0.032	0.096	0.160
6	A	0.006	0.017	0.028
	B	0.020	0.061	0.102
	C	<b>0.028</b>	<b>0.083</b>	<b>0.138</b>
	D	0.001	0.004	0.006
	E	0.003	0.008	0.013
	F	0.007	0.020	0.033
	G	0.024	0.072	0.120
7	A	0.589	1.767	2.945
	B	1.223	3.670	6.117

	C	1.058	3.175	5.291
	D	0.590	1.769	2.948
	E	1.151	3.452	5.753
	F	0.983	2.949	4.915
	G	0.049	0.148	0.246
<b>8</b>	A	<b>0.152</b>	<b>0.457</b>	<b>0.762</b>
	B	0.138	0.413	0.689
	C	0.123	0.369	0.615
	D	0.009	0.027	0.045
	E	0.091	0.272	0.454
	F	0.119	0.358	0.596
	G	0.036	0.107	0.178
<b>9</b>	A	0.005	0.015	0.026
	B	0.017	0.051	0.084
	C	<b>0.065</b>	<b>0.194</b>	<b>0.323</b>
	D	0.001	0.003	0.004
	E	0.002	0.007	0.012
	F	0.023	0.068	0.113
	G	0.037	0.112	0.186
<b>10</b>	A	0.232	0.695	1.159
	B	0.846	2.537	4.228
	C	0.639	1.916	3.193
	D	0.197	0.592	0.987
	E	0.805	2.415	4.024
	F	0.621	1.862	3.104
	G	0.035	0.104	0.174

### 4.3 Summary Tables for 3-ml-Syringes (prepared by FOPH from 4.1 and 4.2)

3-ml-Syringe with 0.2 GBq Ga-68 (1 min)		
accumulated Dose (mSV)		Shielding type
Average of all TLD positions	Maximum Value	
<b>0.230</b>	<b>0.40</b>	Tungsten 7.5 mm
0.637	1.09	Tungsten 5 mm
0.679	1.14	Acrylic glass 8-10mm
0.699	1.22	Tungsten 2.25mm
0.754	1.34	Tungsten 2.25mm
<b>1.157</b>	<b>1.62</b>	Lead glass 5mm
5	4	Ratio highest/lowest

3-ml-Syringe with 7.5 GBq Lu-177 (1 min)		
accumulated Dose (mSV)		Shielding type
Average of all TLD positions	Maximum Value	
<b>0.013</b>	<b>0.028</b>	Tungsten 7.5 mm
0.034	0.069	Tungsten 5 mm
0.096	0.169	Tungsten 2.25 mm
0.106	0.194	Tungsten 2.25 mm
0.190	0.272	Lead glass 5 mm
<b>0.843</b>	<b>1.453</b>	Acrylic glass 8-10 mm
66	52	Ratio highest/lowest

Note: The order of the shielding type is arranged from the lowest to highest dose in descending order. Beneath the columns the ratio of the highest to the lowest accumulated TLD dose is shown.

## 5. Discussion and Conclusion (IRA & FOPH)

The results express the dose to the extremity, in mSv, that you receive when you are working and handling a syringe with a solution containing 200 MBq of Ga-68 or a solution with 7.5 GBq of Lu-177 set in different types and brands of syringe shieldings, working for 1, 3 or 5 minutes.

The study indicates that if the syringe is filled to the maximum volume (3, 5, 10 ml), the highest exposure to radiation is often in the middle of the syringe shielding and at the side where the glass window is present. The TLD placed on the top of the plunger receive always the lowest dose; the distance to the solution in the syringe outweighs the missing shielding in this direction.

For manipulation of Ga-68 and Lu-177, the shielding with 7.5 mm thickness of tungsten and 11-13 mm thickness lead glass window (shielding number 9, see Table 1) achieves the best shielding, For Lu-177, acrylic glass has the poorest shielding effect by far. For Ga-68, lead glass is the poorest, whereas acrylic glass shields as good as the thinner tungsten shieldings.

The difference in the shielding effect is much more pronounced for Lu-177 (ca. factor 50 between best and worst) than for Ga-68 (ca. factor 5).

The finger doses from 200 MBq Ga-68 is always higher than from 7.5 GBq of Lu-177 no matter which shielding is used.