

## APPENDIX A

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**Table 11** — *Minimum shielding requirements for 200 kV<sup>a</sup> therapy installations*

WUT <sup>b</sup> in mA min		Distance in meters from source to occupied area											
40,000	1.5	2.1	3.0	4.2	6.1	8.4	12.2						
20,000		1.5	2.1	3.0	4.2	6.1	8.4	12.2					
10,000			1.5	2.1	3.0	4.2	6.1	8.4	12.2				
5,000				1.5	2.1	3.0	4.1	6.2	8.4	12.2			
2,500					1.5	2.1	3.0	4.2	6.1	8.4	12.2		
1,250						1.5	2.1	3.0	4.2	6.1	8.4	12.2	
625							1.5	2.1	3.0	4.2	6.1	8.4	
Type of Area	Material	Primary protective barrier thickness <sup>c</sup>											
Controlled	Lead, mm <sup>d</sup>	6.6	6.1	5.5	5.0	4.5	4.0	3.6	3.1	2.7	2.3	1.9	1.6
Noncontrolled	Lead, mm <sup>d</sup>	8.4	7.6	7.2	6.8	6.2	5.8	5.2	4.7	4.2	3.7	3.2	2.8
Controlled	Concrete, cm <sup>e</sup>	43.5	40.5	37.5	35	32.5	29.5	27	24.5	21.5	19.5	17	14.5
Noncontrolled	Concrete, cm <sup>e</sup>	52	50	46.5	44	41.5	39	36	33.5	30.5	28	25.5	23
Secondary protective barrier thickness <sup>c</sup>													
Controlled	Lead, mm <sup>d</sup>	4.25	3.7	3.2	2.7	2.15	1.7	1.4	1.15	0.9	0.75	0.6	0.05
Noncontrolled	Lead, mm <sup>d</sup>	6.0	5.45	4.95	4.4	3.9	3.4	2.85	2.35	1.8	1.5	1.25	1.0
Controlled	Concrete, cm <sup>e</sup>	27	24.5	22	19.5	17	14	11.5	9.5	7	5	3.5	0.5
Noncontrolled	Concrete, cm <sup>e</sup>	35.5	33	30.5	28	25.5	23	20	17.5	15	12.5	10	8

<sup>a</sup> Peak pulsating x-ray tube potential.<sup>b</sup> W—weekly workload in mA min, U—use factor, T—occupancy factor.<sup>c</sup> Constant potential requires about 20 percent larger thicknesses of lead and about 10 percent larger thicknesses of concrete than those given here for pulsating potential.<sup>d</sup> See Table 26 for conversion of thickness in millimeters to inches or to surface density.<sup>e</sup> Thickness based on concrete density of 2.35 g cm<sup>-3</sup> (147 lb ft<sup>-3</sup>).**Table 12** — *Minimum shielding requirements for 200 kV<sup>a</sup> therapy installations*

WUT <sup>b</sup> in mA min		Distance in meters from source to occupied area											
40,000	1.5	2.1	3.0	4.2	6.1	8.4	12.2						
20,000		1.5	2.1	3.0	4.2	6.1	8.4	12.2					
10,000			1.5	2.1	3.0	4.2	6.1	8.4	12.2				
5,000				1.5	2.1	3.0	4.2	6.1	8.4	12.2			
2,500					1.5	2.1	3.0	4.2	6.1	8.4	12.2		
1,250						1.5	2.1	3.0	4.2	6.1	8.4	12.2	
625							1.5	2.1	3.0	4.2	6.1	8.4	
Type of Area	Material	Primary protective barrier thickness <sup>c</sup>											
Controlled	Lead, mm <sup>d</sup>	11.45	10.6	9.65	8.8	7.9	7.05	6.2	5.4	4.6	3.9	3.2	2.5
Noncontrolled	Lead, mm <sup>d</sup>	14.55	13.2	12.15	11.8	10.85	9.95	9.05	8.2	7.35	6.5	5.65	4.9
Controlled	Concrete, cm <sup>e</sup>	49	45.5	42.5	40	37	34.5	31.5	29	26	23.5	20.5	18
Noncontrolled	Concrete, cm <sup>e</sup>	58	55.5	52.5	49.5	46.5	43.5	41	38	34	32.5	29.5	27
Secondary protective barrier thickness <sup>c</sup>													
Controlled	Lead, mm <sup>d</sup>	7.2	6.3	5.4	4.5	3.65	2.8	2.3	1.9	1.55	1.25	1.1	0.05
Noncontrolled	Lead, mm <sup>d</sup>	10.1	9.25	8.35	7.5	6.6	5.7	4.85	3.95	3.1	2.5	2.05	1.65
Controlled	Concrete, cm <sup>e</sup>	31.5	28.5	26.5	23.5	20.5	18	15	12.5	9.5	7.5	4.5	0.5
Noncontrolled	Concrete, cm <sup>e</sup>	41	38	36	33	30	27	24	22	19	16	12.5	10

<sup>a</sup> Peak pulsating x-ray tube potential.<sup>b</sup> W—weekly workload in mA min, U—use factor, T—occupancy factor.<sup>c</sup> Constant potential requires about 20 percent larger thicknesses of lead and about 10 percent larger thicknesses of concrete than those given here for pulsating potential.<sup>d</sup> See Table 26 for conversion of thickness in millimeters to inches or to surface density.<sup>e</sup> Thickness based on concrete density of 2.35 g cm<sup>-3</sup> (147 lb ft<sup>-3</sup>).

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Table 13 — Minimum shielding requirements for <sup>300</sup>200 kV<sup>a</sup> therapy installations

WUT <sup>b</sup> in mA min		Distance in meters from source to occupied area													
40,000		1.5	2.1	3.0	4.2	6.1	8.4	12.2							
20,000			1.5	2.1	3.0	4.2	6.1	8.4	12.2						
10,000				1.5	2.1	3.0	4.2	6.1	8.4	12.2					
5,000					1.5	2.1	3.0	4.2	6.1	8.4	12.2				
2,500						1.5	2.1	3.0	4.2	6.1	8.4	12.2			
1,250							1.5	2.1	3.0	4.2	6.1	8.4	12.2		
625								1.5	2.1	3.0	4.2	6.1	8.4	12.2	
Type of Area	Material	Primary protective barrier thickness <sup>c</sup>													
Controlled	Lead, mm <sup>d</sup>	17.65	16.25	14.85	13.45	12.05	10.75	9.4	8.2	6.9	5.8	4.7	3.75		
Noncontrolled	Lead, mm <sup>d</sup>	22.5	21.1	19.6	18.15	16.7	15.3	13.85	12.55	11.2	9.85	8.55	7.35		
Controlled	Concrete, cm <sup>e</sup>	55	51.5	48.5	45	42	39	36	33.5	30	27	24	21		
Noncontrolled	Concrete, cm <sup>e</sup>	64.5	62	59	56	53	49.5	46.5	43.5	40	37	34	31		
Secondary protective barrier thickness <sup>c</sup>															
Controlled	Lead, mm <sup>d</sup>	12.0	10.55	9.05	7.6	6.1	4.65	3.55	2.95	2.5	2.1	1.8	1.6		
Noncontrolled	Lead, mm <sup>d</sup>	16.9	15.45	13.95	12.5	11.05	9.55	8.1	6.6	5.15	3.75	3.1	2.65		
Controlled	Concrete, cm <sup>e</sup>	33	30	27	24	21	18	14.5	11.5	9	6	3.5	1.5		
Noncontrolled	Concrete, cm <sup>e</sup>	43	40	37	34	31	28	25	22.5	19	15.5	12.5	10		

<sup>a</sup> Peak pulsating x-ray tube potential.<sup>b</sup> W—weekly workload in mA min, U—use factor, T—occupancy factor.<sup>c</sup> Constant potential requires about 20 percent larger thicknesses of lead and about 10 percent larger thicknesses of concrete than those given here for pulsating potential.<sup>d</sup> See Table 26 for conversion of thickness in millimeters to inches or to surface density.<sup>e</sup> Thickness based on concrete density of 2.35 g cm<sup>-3</sup> (147 lb ft<sup>-3</sup>).

Table 14 — Minimum shielding requirements for 1 MV therapy installations

WUT <sup>b</sup> in mA min		Distance in meters from source to occupied area													
5,000		1.5	2.1	3.0	4.2	6.1	8.4	12.2							
2,500			1.5	2.1	3.0	4.2	6.1	8.4	12.2						
1,250				1.5	2.1	3.0	4.2	6.1	8.4	12.2					
625					1.5	2.1	3.0	4.2	6.1	8.4	12.2				
313						1.5	2.1	3.0	4.2	6.1	8.4	12.2			
156							1.5	2.1	3.0	4.2	6.1	8.4	12.2		
78								1.5	2.1	3.0	4.2	6.1	8.4	12.2	
Type of Area	Material	Primary protective barrier thickness													
Controlled	Lead, cm <sup>b</sup>	11	10.5	10	9	9	7	6.5	6	5	4	3.5	3		
Noncontrolled	Lead, cm <sup>b</sup>	14	13	12.5	11.5	11	10	9	8.5	7.5	7	6	5		
Controlled	Concrete, cm <sup>c</sup>	70	66	62	57	53	48	43	39	35	30	26	21		
Noncontrolled	Concrete, cm <sup>c</sup>	85	81	77	72	68	63	59	54	50	45	40	36		
Secondary protective barrier thickness <sup>d</sup>															
Controlled	Lead, cm <sup>b</sup>	6	5.5	5.5	4.5	4	3	2.5	2	1.5	1	0.5	0		
Noncontrolled	Lead, cm <sup>b</sup>	9	8	7	6.5	5.5	5	4.5	4	3.5	2.5	2	1.5		
Controlled	Concrete, cm <sup>c</sup>	46	42	37	33	28.5	24	19	15	10.5	6	1.5	0		
Noncontrolled	Concrete, cm <sup>c</sup>	61	57	52	48	43	39	35	30	25	20.5	16.5	12		

<sup>a</sup> W—weekly workload in mA min, U—use factor, T—occupancy factor.<sup>b</sup> See Table 26 for conversion of thickness in millimeters to inches or to surface density.<sup>c</sup> Thickness based on concrete density of 2.35 g cm<sup>-3</sup> (147 lb ft<sup>-3</sup>).<sup>d</sup> Shielding for tube housing leakage based on a weekly workload (WUT) of 5,000 mA min corresponding to a weekly workload (WUT) of 100,000 R at 1 meter (X<sub>n</sub> = 20 R per mA min at 1 meter).